XXI MEĐUNARODNA NAUČNA KONFERENCIJA

DEVELOPMENT OF INTEGRATIVE FITNESS – DIF KONFERENCIJA

„MEĐUNARODNA KONFERENCIJA NAUKA O SPORTU, FIZIČKOM VASPITANJU I ZDRAVLJU“

09. i 10. decembar 2022, Beograd, Srbija

Zbornik radova

Urednici:

Ivana Milanović, Nikola Majstorović

Univerzitet u Beogradu – Fakultet sporta i fizičkog vaspitanja

Beograd, 2023

Publisher: University of Belgrade - Faculty of Sport and Physical Education
Izdavač: Univerzitet u Beogradu - Fakultet sporta i fizičkog vaspitanja

For the Publisher / Za Izdavača: Saša Jakovljević, Dean/Dekan

Editors / Urednici: Ivana Milanović
Nikola Majstorović

Layout / Tehnička obrada: Ivana Milanović, Nikola Majstorović

Proofreading / Lektura: Gordana Vekarić

Design and Cover / Dizajn i korice: Nikola Majstorović

Printed by / Štampa: "Birograf", Beograd 2023.

Edition / Tiraž: 50 copies / primeraka

Organizer / Organizator: University of Belgrade - Faculty of Sport and Physical Education
Univerzitet u Beogradu - Fakultet sporta i fizičkog vaspitanja

In cooperation with / U suogranizaciji sa: Ministry of Education, Science and Technological Development of the Republic of Serbia
Ministarstvo prosvete, nauke i tehnološkog razvoja Republike Srbije

Supported by / Uz podršku: Ministry of Youth and Sport of the Republic of Serbia
Ministarstvo omladine i sporta Republike Srbije

Olympic Committee of the Republic of Serbia
Olimpijski komitet Srbije

SCIENTIFIC BOARD / NAUČNI ODBOR

President / Predsednik
Prof. Ivana Milanović, PhD - Faculty of Sport and Physical Education.

Members from the Institution / Članovi institucije:
Prof. Saša Jakovljević, PhD;
Assis. prof. Aleksandra Popović, PhD;
Assoc. prof. Branka Marković, PhD;
Prof. Sanja Mandarić, PhD;
Assis. prof. Olivera Knežević, PhD;
Assoc. prof. Vladimir Mrdaković, PhD;
Assoc. prof. Miloš Marković, PhD;
Prof. Milivoj Dopsaj, PhD;
Assoc. prof. Ana Orlić, PhD.

International Members / Članovi iz inostranstva:
Prof. Đorđe Jakovljević, PhD, Institute for Health and Wellbeing, Faculty of Health and Lifesciences, Coventry University, United Kingdom;
Assoc. prof Tamás Csányi, PhD, Head of Department at Hungarian University of Sports Science; Hungarian School Sport Federation, Hungary;
Assis. prof. Matija Mato Škerbić, PhD, Faculty of Croatian studies, University of Zagreb, Croatia;
Prof. Mirjana Milić, PhD, Faculty of Kinesiology, University of Split, Croatia;
Prof. Ifet Mahmutović, PhD, Faculty of sport and physical education, University of Sarajevo, Bosnia and Herzegovina;
Prof. Gordana Furjan-Mandić, PhD, Faculty of Kinesiology, University of Zagreb, Croatia;
Prof. Alen Miletić, PhD, Faculty of Kinesiology, University of Split, Croatia;
Assoc. prof. Jadranka Vlašić, PhD, Faculty of Kinesiology, University of Zagreb, Croatia;
Assoc. prof. Ivica Kelam, PhD, Faculty of Kinesiology, University of Osijek, Croatia;
Assoc. prof. Ivana Zagorac, PhD, Faculty of Philosophy, University of Zagreb, Croatia;
Assis. prof. Robert Podstawski, PhD, Faculty of Environmental Sciences, University of Warmia and Mazury in Olsztyn, Poland;
Assis. prof. Marko Zadražnik, PhD, Faculty of sports, University of Ljubljana, Slovenia;
Assis. prof. Sunčica Bartoluci, PhD, Faculty of Kinesiology, University of Zagreb, Croatia.

ORGANIZATIONAL BOARD / ORGANIZACIONI ODBOR

President / Predsednik
Assis. Prof. Nikola Majstorović, PhD.

General secretary / Generalni sekretar
Assis. Marko Vasiljević.

Members / Članovi:
Assoc. prof. Miloš Mudrić, PhD;
Assoc. prof. Goran Prebeg, PhD;
Assoc. prof. Igor Ranisavljev, PhD;
Assis. prof. Gordana Vekarić, PhD;
Assis. prof. Ivan Ćuk, PhD;
Assis. prof. Vladimir Milošević, PhD;
Ass. Sanja Mirković DMedSc;
Ass. Marko Erak.

Dear Colleagues and Conference participants

We would like to welcome you to the Faculty of Sport and Physical Education of the University of Belgrade and our 21st International Scientific Conference, traditionally held to mark the Faculty anniversary. We are very happy that this year's conference is live, after a long period of not being able to organize live events due to the emergency situation caused by the COVID-19 pandemic. This year the Conference is entitled "International Conference of Sport Science, Physical Education and Health", and also this year the working group for the organization of the Conference came up with a new name of the conference in English as a tribute to the abbreviated well-known, traditional name of our Faculty "DIF" (Development of integrative fitness – DIF Conference).

The organization of this Conference, as in previous years, was supported by the Ministry of Education, Science and Technological Development of the Republic of Serbia, the Ministry of Youth and Sports of the Republic of Serbia and the Olympic Committee of Serbia.

The Conference is organized to present theoretical knowledge, scientific research and practical experience that assess the effects of applying physical activity on physical fitness of children, youth and adults, as well as the possibilities of implementation of the obtained results in practice of physical education, sport and health. According to the defined criteria, a large number of papers were submitted within thematic areas, and after the review, the Scientific Board accepted 71 abstracts in Serbian and English. After publishing the Book of abstracts, the Book of Proceedings was also published with 35 papers divided into three thematic areas.

We are pleased to inform you that, besides a large number of scientists, professors and students from Serbia, the Conference hosted a number of our respected colleagues from the region, as well as from other countries such as Turkey, Greece, Russia, Bulgaria and Romania.

President of the Scientific Board

Prof. Ivana Milanović, PhD

Poštovane kolege i učesnici Konferencije

Želimo Vam dobrodošlicu na Fakultet sporta i fizičkog vaspitanja Univerziteta u Beogradu i našu 21. međunarodnu naučnu konferenciju, koja se tradicionalno održava povodom Dana fakulteta. Veoma smo radosni što ove godine imamo priliku da konferenciju organizujemo uživo, nakon dužeg perioda nemogućnosti održavanja konferencije na ovaj način, usled situacije izazvane pandemijom Kovid-19. Ove godine Konferencija nosi naziv „Međunarodna konferencija nauka o sportu, fizičkom vaspitanju i zdravlju", a takođe ove godine radna grupa za organizaciju konferencije je osmislila i novi naziv konferencije na engleskom jeziku u čast našeg skraćenog opštepoznatog, tradicionalnog naziva fakulteta – DIF (*Development of integrative fitness – DIF Conference*). Podršku organizaciji Konferencije ove, kao i prethodnih godina dali su Ministarstvo prosvete, nauke i tehnološkog razvoja Republike Srbije, Ministarstvo omladine i sporta Republike Srbije i Olimpijski komitet Srbije.

Konferencija je organizovana sa ciljem prezentacije teorijskih saznanja, naučnih istraživanja i iskustava kojima se procenjuju efekti primene fizičke aktivnosti na antropomotorički status dece, omladine i odraslih, kao i mogućnosti implementacije dobijenih saznanja u praksi fizičkog vaspitanja, sporta i zdravlja. Prema definisanim kriterijumima, u okviru tematskih područja prijavljen je veliki broj radova, a nakon recenzija Naučni odbor je prihvatio 71 sažetak rada, na srpskom i engleskom jeziku. Odabrani radovi raspoređeni su u 4 sesije za usmene prezentacije i jednu poster sesiju. Nakon objavljenog Zbornika sažetaka objavljen je i Zbornik radova sa 35 naučnih radova podeljena na tri tematske oblasti.

Posebno nam je zadovoljstvo da Vas obavestimo da na Konferenciji Fakulteta pored velikog broja naučnika, profesora i studenata iz Srbije učestvovao izuzetno značajan broj naših poštovanih koleginica i kolega iz država regiona, kao i drugih zemalja kao što su Turska, Grčka, Rusija, Bugarska i Rumunija.

Predsednik Naučnog odbora

dr Ivana Milanović, redovni profesor

CONTENTS/ SADRŽAJ

PHYSICAL AND HEALTH EDUCATION, INCLUSIVE SPORTS

FIZIČKO I ZDRAVSTVENO VASPITANJE, INKLUZIVNI SPORT

Introductory lecture

PHYSICAL ACTIVITY POLICES IN SCHOOL: LESSONS LEARNED FOR OBESITY PREVENTION FROM THE STOP PROJECT

Maroje Sorić[1,2]

[1] University of Zagreb, Faculty of Kinesiology, Zagreb, Croatia
[2] University of Ljubljana, Faculty of Sport, Ljubljana, Slovenia

Introduction

Regular physical activity (PA) is essential for optimal growth and development of children. It improves cardiovascular, metabolic and bone health; reduces adiposity and can also reduce symptoms of depression and anxiety and improve cognitive function, including academic performance (Janssen and LeBlanc, 2010). Insufficient PA alongside unhealthy eating habits is one of the main contributors to childhood obesity (Janssen and LeBlanc, 2010). It seems that there is more to the association of PA and weight than simply counting the calories expended (i.e., quantifying the volume of PA). Nevertheless, it has been established that an obesity intervention has very little chance of success if the PA component is not included (Oude Luttikhuis et al., 2009). On the other hand, accumulating evidence points to the fact that sedentary behaviour is not interchangeable with PA. Consequently, we cannot expect sedentary behaviours to decrease simply by increasing PA (Tremblay et al., 2011). Still, policies aimed at reducing sedentary behaviours have not been frequently designed and evaluated. Although both PA and sedentary behaviours affect daily energy expenditure, it seems that PA has a greater effect on weight control, but it is less clear whether the effects are additive. Furthermore, it is not clear whether favouring vigorous activity with consequent gains in fitness outperforms other, less intensive, interventions. Although there is little doubt that PA, physical fitness, and sedentary time are independently related to premature death and poor health, there is an ongoing debate as to which of these (if any) should have precedence within public health strategies (Bouchard et al., 2015).

Obesity, PA and sedentary pursuits are complex phenomena that require population-based solutions. For children, schools are frequently identified as an ideal setting for introducing lifestyle change and the prevention of weight gain. In most countries, school is obligatory, at least by mid-adolescence; hence, all children can be reached, which makes schools a perfect setting to reduce health inequalities. In addition, children spend a significant portion of the day in school. Because academic activities are mostly sedentary, ample opportunities for PA should be provided to increase energy expenditure and introduce the well-known benefits of PA for health and academic performance. As schools enable universal reach and represent an ideal setting for obesity prevention policies the STOP research mainly focused on school related PA. Over the last twenty years we have witnessed an accelerated increase in the quantity of interventions to increase children's physical activity worldwide. Yet, these interventions have had only a small effect on children's total activity volume (Dobbins, 2013, Metcalf et al., 2012). Policies on PA have been mostly fragmented, included just one domain and have failed to rely on a multi-stakeholder approach.

Concerns for children's physical fitness, obesity and well-being have increased with the recent emergence of COVID-19 pandemics and related containment measures that have changed our lifestyle in an unprecedented way for which long-term consequences are yet to be seen.

PA-related work within the STOP project was designed to bridge current research gaps, was focused on school PA policies and was aligned with four specific aims:

1. examine and compare policies on 2 distinct though interrelated factors influencing children's PA: a) active transport to school and b) built environment;
2. collate evidence on strategies to increase energy expenditure and compare the effectiveness of policies aimed at enhancing fitness, increasing PA or reducing sedentary behaviour and examine whether one of these concepts should take precedence in public health;
3. investigate the costs and the effectiveness of a scaled-up, real-world, school-based PA intervention on obesity prevention and assess the barriers to implementing it in 5 different European settings;
4. examine the short-term and mid-term effects of COVID-19 related movement restrictions on physical fitness of children and adolescents leveraging data regularly collected through a national physical fitness surveillance system in Slovenia;

In line with these aims, the objective of this paper is to provide a collective summary of the innovative research on PA policies conducted within the STOP project divided into 4 sections on: 1) active travel; 2) school-based PA interventions; 3) Physical Education interventions studied through the Healthy Lifestyle Intervention case study, and 4) trends in physical fitness during and after the COVID-19 related movement restrictions.

Active travel

Under this policy area we addressed two different, but linked, topics: the evaluation of the effectiveness of active travel interventions tailored for children and adolescents and the analysis of the factors hindering or promoting active travel of youth. We conducted a systematic review of the literature and identified 53 individual studies addressing active travel in children (35 for effectiveness of interventions and 18 for facilitators and barriers) (Sorić et al.,2018). We found that active travel interventions are generally effective at increasing active travel to school, although caution is warranted because of both high heterogeneity in terms of intervention type and duration, outcome measures, follow-up duration, or study locality, and generally high risk of bias. In sum, 31/35 studies reported an increase in active transportation to school following the interventions; however, the degree of change varied. In about half of these studies 10-20% of children switched to active travel, 40% of the studies found that over 20% of children switched to active transport, and in 10% of studies less than 10% of students changed their mode of transport. Of note, most of these studies involved primary age children, while the evidence for adolescence was scarce and inconclusive.

Environmental factors found to promote AT include safety, social interactions, and the presence of facilities to assist walking and cycling. Distance from school was a hindrance to the relevance of AT interventions for home-school journeys, a radius of no more than 1.5 km by foot (about 15 minutes) / 3 km by bicycle was the limit. As stressed above, factors like the built environment characteristics, the parents' perception about the safety and security of the home-school journey, the socio-economic status of the families, the parents' sensibility to the children physical activity and other minor factors, play an important role in the choices of the modes of transport, but they are only all relevant if the home-school distance is considered affordable. It is also important to note that the 'acceptable' duration of an active trip depends on the country where the children live.

As moderators of intervention effectiveness vary according to the part of the word where these measures have to be implemented, it is imperative they are designed in accordance with local cultures and behaviours taking into account the related country contexts.

School-based PA interventions

Schools enable universal reach and represent an ideal setting for obesity strategies. We performed a systematic search of the literature to compare the effects of interventions that targeted sedentary behaviours or PA or physical fitness on primary prevention of obesity in 6- to 12-year-old children (Podnar et al., 2020). The search identified 146 reports that provided relevant data for meta-analysis. Most studies focused on PA, followed by physical fitness, with or without trying to reduce sedentary behaviour. The number of studies that targeted exclusively sedentary behaviour was very small and precluded meta-analysis in this segment.

Across all studies combined there was a reduction in Body Mass Index (BMI) (−0.16 kg/m^2, 95% CI = −0.25 to −0.07), for children in the PA intervention group. Next, point estimates for changes in % body fat were higher for fitness interventions compared with PA interventions (standardized mean difference = −0.11%; 95% CI = −0.26 to 0.04, and −0.04%; 95% CI = −0.15 to 0.06, respectively). These small effects have limited clinical significance, but it should be considered that intervention effects are probably underestimated because of the well-known limitations of BMI in distinguishing fat from fat-free mass on one side and the large measurement error of commonly used methods for assessing body composition on the other side. Including sedentary behaviour to a PA- or fitness-oriented intervention was not accompanied by an increase in intervention effectiveness, as the point estimates were slightly smaller compared with those for PA- or fitness-only interventions. Overall, intervention effects tended to be larger in girls than in boys, especially for PA + sedentary behaviour interventions. There was some evidence for inequality, as the effects on body mass index were seen when interventions were delivered in the general population (standardized mean difference = −0.05, 95% CI = −0.07 to −0.02), but not in groups of disadvantaged children (standardized mean difference = −0.01, 95% CI = −0.29 to 0.19). Parents of this group of children are very hard to reach and therefore schools should remain a focus of public health policies aimed at reducing health inequalities.

All in all, we found that school-based PA interventions produce small shifts at the population level that can incur significant public health benefits by reducing weight gain in healthy weight children. Equally, these programmes appear to be very safe, with low injury rates being reported. The most effective approach includes combining episodes of PA with educational content to increase knowledge and change attitudes about PA. Programmes that span over at least one year, include a diet component, involve parents, improve physical fitness, and extend to the home and community setting appear to be the most promising approach. However, raising awareness about the downsides of sedentary behaviour in addition to promoting PA did not provide additional benefits for obesity prevention so far. Nevertheless, given the unprecedented increase in exposure to screens faced by children, it is of paramount importance to invest in new, more effective strategies for controlling the time children spend in front of screens.

Physical Education Interventions

School-based PA interventions have been verified as an effective strategy in the primary prevention of childhood obesity and Physical Education is the cornerstone of PA policies in schools. Although the beneficial health effects of initiating PA intervention programmes during childhood are well documented, most of this evidence comes from short-term efficacy trials conducted in well-controlled settings, usually without implementing large scale, or scalable, population-based

approaches. On the other hand, a greater impact on population health can be achieved only if interventions are successfully up scaled to population level. The current lack of successfully implemented school-based PA interventions in real world settings impedes the fight against childhood obesity pandemic. To this end, we leveraged a natural experiment in Slovenia and calculated the costs and effects of a real-world, nationwide, PA intervention that delivered 2-3 extra hours of Physical Education to 6-14-year-old Slovenian children over 8 years (Jurić et al., 2022). We compared over 34,000 participants from >200 schools to a similar number of nonparticipants from the same schools and used Generalized Estimating Equations to estimate the effects of differing exposure to the programme on BMI in children with normal weight, overweight or obesity at baseline.

Effectiveness

We found that BMI was lower in the intervention group, irrespective of participation duration, or baseline weight status. The difference in BMI between intervention and control group increased with programme duration, with maximal effects seen after 3-4 years of participation, and effects being consistently larger for children with obesity (peaking at 1.4 kg/m^2; 95%CI=1.0-1.9 for girls with obesity, and 0.9 kg/m^2; 95%CI=0.6-1.3 for boys with obesity). It should be noted that the effects were consistently the greatest in children initially presenting with obesity, such that the programme was able to benefit children needing support the most. In the context of obesity treatment, the programme started to be effective in reversing obesity after 3 years, while the lowest numbers needed to treat (NNT) were observed after 5 years (NNT=17 for girls; 12 for boys). In sum, our study indicated that to be effective at reducing obesity for children of both sexes aged 6-14, the intervention should probably last a minimum of 3 consecutive years, without funding interruption as we have observed that even a temporary disruption attenuated long-term effectiveness of the Slovenian programme. Hence, policy makers and funding bodies should be aware that obesity is a chronic condition that needs to be dealt with over a longer time frame, and that easy solutions and immediate effects are neither realistic, nor sustainable.

Cost-effectiveness

On the other hand, the cost analysis of the Slovenian population-wide PA programme revealed that the annual costs per person (<€70) was among the lowest reported costs of interventions targeting childhood obesity (Starc et al., 2021a). Furthermore, we found that additional Physical Education contributed to a smaller increase in BMI compared to no intervention, at a cost between €124 and €774 per BMI unit reduced. Similarly, we also showed that 1- and 2-year exposure to intervention had low cost-effectiveness for reversal of obesity, but that programme lasting over 3 years were much more cost-effective. The highest cost-effectiveness of obesity case reversed was seen after 5 years of the programme and totalled €680 per obesity case reversed in boys and € 2,219 in girls. Across all programme durations, cost effectiveness on BMI units decrease and obesity cases reversed was higher in girls than in boys. Finally, simplified simulations using predicted 10-year medical costs of obesity showed that 5-year programme of additional PE would provide return on costs after less than 2 months and that all programmes lasting over 2 years would become cost-saving in less than a year.

Barriers to a wider implementation in EU context

Even though educational systems of European countries pursue similar goals and try to provide children and youth with competencies that enable independent, healthy, and productive life in adulthood, there are many specifics in every national, and sometimes even regional setting.

This means that every educational system may also have specific barriers or facilitators regarding the implementation of various interventions. Hence, we examined the potential barriers to transferability of a similar Physical Education intervention to 5 different settings across Europe (Starc et al., 2021b). The focus of this assessment are the objective conditions in which a PA intervention programme, similar to the Slovenian Healthy Lifestyle, could function, while at the same time acknowledging the specifics which could present an obstacle in the implementation of the intervention. We designed a tailored questionnaire and distributed it to five public health institutes located in Italy, Finland, Spain, Portugal, and Estonia. We sought data on school PA practices and governance (e.g., number of hours of mandatory Physical Education classes, human capital, opportunities for PA in school, school infrastructure etc.). Perceived barriers to implementing a population-based supplementary Physical Education programme ranked by importance are depicted in Figure 1.

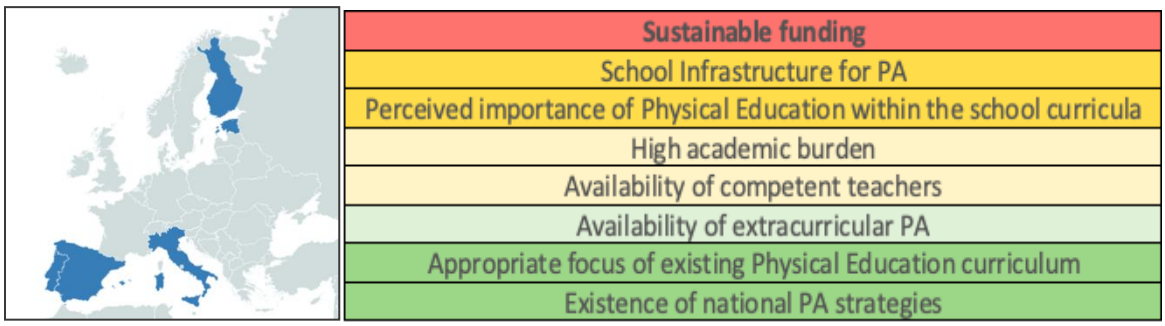


Figure 1. Examined obstacles to population-level implementation of a Physical Education programme similar to HLI in five other European settings (Italy, Finland, Spain, Portugal, and Estonia). Obstacles are ranked by perceived importance (red denotes the highest importance and dark green the lowest importance)

The communication with experts from educational field of the included countries revealed that potential lack of funding was the most prevalent perceived barrier. There was an overall agreement that large-scale PA interventions would be feasible if the funding was ensured. The prevailing opinion was that all other possible barriers could be bridged if the funding was secured. The sentiment of a lesser importance of PE in comparison to other "academic" subjects was observed in all surveyed countries which shows the widespread persistence of the idea of separation between somatic and cognitive development of children. Although this idea has been refuted by scientific evidence it could affect the acceptance of PA intervention programmes and could render them unimportant. This also depicts the need to better educate wider public about the numerous benefits of regular PA for children's development. Next, in comparison to Slovenia, all five involved countries are also facing the problem of suboptimal availability of sport infrastructure in school settings. This shows that national and local governments have not yet succeeded in providing equal opportunities for somatic and motor development to all children, which means that a potential PA intervention could be hindered by unavailability of sport facilities and equipment. Other potentially important barriers include too high school workload and the lack of competent personnel.

All in all, this stream of STOP work confirmed that strategies to improve the quality and provision of PE should be prioritised as a cost-effective solution to improving the health and wellbeing of children across Europe.

Children's fitness and COVID-19

COVID-19 related containment measures have changed our lifestyle in an unprecedented way and the long-term consequences are yet unknown. Children's opportunities to engage in daily physical activity were dramatically reduced, hindering their optimal physical and mental development potential. In response to the COVID-19 pandemic, STOP conducted unplanned innovative research in an emerging field: the effect of pandemic-related movement restrictions on children's physical fitness and physical development**.** We designed two distinct cohort studies and used data collected through Slovenian national physical fitness surveillance system (SLOfit) in 4 waves: before the pandemic in spring 2019, after the first school lockdown in spring 2020, after the second lockdown in spring 2021, and finally in spring 2022, one year after the ending of movement restrictions.

In the first study we examined differences in physical fitness development dynamics over one year between children affected by the COVID-19 mitigation measures and their peers who were growing-up in Slovenia in the pre-pandemic period (Grašić et al., 2022). In this cohort study, we used population data from two consecutive birth cohorts of children in the first triennia of primary school. We employed a difference-in- difference (DiD) regression framework to compare changes in indicators of body composition and physical fitness in the first three grades of two cohorts of children, those affected by the mitigation measures of the first wave COVID-19 pandemic while attending 3rd grade in 2020 (n=5,045) and those from a preceding 2019 cohort, who were in grade 3 before the pandemic (n=13,465). We found that children affected by the COVID-19 mitigation measures experienced 15·6% decline of general physical fitness in grade 3, while the control cohort at the same time improved by 3·3% (DiD coefficient -10.08 percentiles [95% CI –11.29 to -8.88]). The larger increase in BMI and subcutaneous fat from grade 2 to grade 3 seen in the affected cohort also resulted in 2.7-times larger annual increase of obesity (DiD coefficient 0.013 % points [0.007-0.020]). All individual fitness components in the affected cohort significantly deteriorated, whereas in the pre-pandemic control cohort they remained stable or improved. The drop in general fitness among the affected cohort was twice higher for children in the fitter terciles compared to the least fit children.

In the second study we examined changes in physical fitness in response to COVID-19 imposed restrictions, but also a year after the restrictions were terminated, and compared these trends between boys and girls living with normal weight, overweight or obesity before the pandemic (Martinko et al. 2022). We followed 41 787 children (girls: 20 116, age=5-14) who had their fitness measured annually from 2019 to 2022. Raw data were translated to centile values using national standards and a multiple group latent growth model was fit separately for boys and girls to compare trends in total fitness index (TFI; calculated as the average centile of 9 fitness tests and BMI), body composition, cardiorespiratory fitness, and muscle fitness in children with normal weight, overweight or obesity before the pandemic. Models with quadratic slopes performed best for all fitness components, indicating a non-linear change over time ($p<.001$ all). In all groups combined TFI dropped sharply in both girls and boys over first two years (-7.8 and -8.6 centiles, respectively), and then recovered mildly between 2021 and 2022 by 3.5 and 4.7 centiles, respectively (all $p<.001$), still ending up at a much lower level in 2022 vs. 2019. When comparing trends by weight status, we saw similar magnitudes of both downward and upward trends in TFI among children with normal weight and overweight. On the other hand, children with obesity

exhibited a smaller decrease in average TFI centile compared to their peers with normal weight (boys: -3.8 vs. -9.0; girls; -4.9 vs. -8.1, p<.001), but also a slightly better recovery afterwards (boys: 3 vs. 4.8; girls: 2.0 vs. 3.6, p<.001). Identical between-group patterns were observed for cardiorespiratory fitness, upper body strength and body composition. For trunk strength we found a more pronounced decline and slightly better recovery in boys and girls with obesity compared to other two groups, while for lower body strength both downward and upward trends were of similar magnitude in all groups.

Conclusion

- Active travel: interventions focused on increasing active travel for school journeys are successful in primary age children, while the evidence for adolescents is still inconclusive. However, distance from school is a major barrier, a radius of no more than 1.5 km by foot (15-16 minutes) / 3 km by bicycle seems to be the limit. Environmental factors found to promote active travel include safety, social interactions, and the presence of facilities to assist walking and cycling.
- School-based PA interventions appear to be an effective strategy in the primary prevention of childhood obesity among 6- to 12-year-old children, but targeting sedentary behaviour in addition to PA or fitness does not seem to increase the effectiveness of the intervention. Preliminary evidence points to lower effectiveness of current PA programmes delivered exclusively to socially deprived children.
- PE intervention that provided 2-3 additional lessons per week remained effective in the prevention of obesity after scaling-up to the population level. The greatest effect was present in children initially presenting with obesity, such that the programme was able to benefit children needing support the most, while the number needed to treat for obesity reversal decreased with intervention duration, emphasising the need for long-term PA programmes.
- The most prevalent barriers to implementing additional PE seem to be lack of sustainable funding, low perceived importance of PE in the educational system, and inadequate infrastructure for physical activity in schools. Other potentially important barriers include high school workload and the lack of human resources.
- The COVID-19 pandemic restrictions had a profound negative effect on children's physical fitness and childhood obesity has increased dramatically. The dramatic drop of physical fitness hasn't recovered anywhere near the pre-pandemic values by 2022. All this calls for urgent population-based policies that will provide ample opportunities for children to engage in PA.

References

Bouchard, C., Blair, S. N., & Katzmarzyk, P. T. (2015). Less sitting, more physical activity, or higher fitness? In Mayo Clinic Proceedings (Vol. 90, No.11, pp. 1533-1540)

Dobbins M, Husson H, Decorby K, Larocca RL. (2013). School-based physical activity programs for promoting physical activity and fitness in chil- dren and adolescents aged 6 to 18. Cochrane Database Syst Rev. 2013;2013(2).

Grašić, K et al. (2022) Decline in physical fitness and increase of obesity in children following COVID-19 mitigation measures. Scientific Reports (in Review)

Janssen, I., and LeBlanc, A.G. (2010). Systematic review of the health benefits of physical activity and fitness in school-aged children and youth. Int. J. Behav. Nutr. Phys. Act. 7: 40.

Jurić, P et al. (2022). Effectiveness of a population-scaled, school-based, physical activity intervention for the prevention of childhood obesity: a natural experiment. Obesity (accepted for publication)

Martinko, A et al., (2022). Changes in physical fitness during and in the aftermath of COVID-19 restrictions among children in Slovenia: is there evidence for weight-based inequalities. International Congress on Obesity; 22-26 October; Melbourne (Australia)
Metcalf, B., Henley, W., & Wilkin, T. (2012). Effectiveness of intervention on physical activity of children: systematic review and meta-analysis of controlled trials with objectively measured outcomes (EarlyBird 54). Bmj, 345, e5888.
Oude Luttikhuis, H., Baur, L., Jansen, H., Shrewsbury, V. A., O'Malley, C., Stolk, R. P., & Summerbell, C. D. (2009). Cochrane review: Interventions for treating obesity in children. Evidence-based child health: A Cochrane Review Journal, 4(4), 1571-1729.
Podnar, H. et al. (2021). Comparative effectiveness of school-based interventions targeting physical activity, physical fitness or sedentary behaviour on obesity prevention in 6- to 12-year-old children: A systematic review and meta-analysis. Obesity Reviews;22 (2)
Sorić, M, et al. D7.1 (2018). Systematic review and evidence synthesis report.
Starc, G, et al. D7.4: (2021) Report on the cost effectiveness of the Healthy Lifestyle Intervention.
Starc, G, et al. D7.5: (2021) Report on the requirements and barriers to implementation of the Healthy Lifestyle intervention model in five countries;
Tremblay, M.S., LeBlanc, A.G., Kho, M.E., Saunders, T.J., Larouche, R., Colley, R.C., et al. (2011). Systematic review of sedentary behaviour and health indicators in school-aged children and youth. Int. J. Behav. Nutr. Phys. Act. 8: 98.

ANALYSIS OF CHILDRENS' PSYCHOSENSORY STATUS BY USING TESTS OF THE NTC SYSTEM OF LEARNING

Dario Vrdoljak[1], Luka Penga[2], Diana Aranza[2], Alen Miletić[1], Mirjana Milić[1]

[1] University of Split, Faculty of kinesiology, Split, Croatia
[2] University of Split, University Department of Health Studies, Split, Croatia

Introduction

The human body acts as a unique and adaptable system based on constant learning and taking information from the environment. Nerve cells, the neurons, play the primary role in the transmission and processing of stimuli. A special structure composed of two neurons – the synapsis, is responsible for transmitting signals, which takes less than one millisecond. Axonal transmission and synaptic signalization represent the principal mode of rapid and accurate remote signaling in any organism with a developed nervous system (Judaš & Kostović, 1997). The nervous system should be stimulated and developed from the earliest age. Namely, Dryden (2001) states that newborns have over 100 billion active brain cells. In the process of creating synapses and dendrites, the brain selectively strengthens or removes neurons based on certain neuronal activity; the selection strengthens the synapses that the brain considers the most important and necessary at a given time (Cegledi, 2018). Furthermore, the cerebellum has more neurons than any other part of the brain and it has an important role in movement, balance, posture, and gross motor skills.

Stimulation of children's development is based on developing the mental abilities needed to understand the environment. Precisely, children develop mental abilities in regard to the environment in which they grow. Also, this developing process for children, in terms of cognitive abilities, is much needed for them to properly function during their childhood. According to Piaget (1952), the adaptation process refers to a child's cognitive development, whereas assimilation refers to the process in which a child attempts to interpret new experiences based on previous information. The stimulation of cognitive learning from an early age is crucial, considering that cognitive functions depend on the creation of synapses, which are mostly formed by the age of five (50%), seven (75%), and twelve (95%) (Rajović, 2016). One of the essential mechanisms of stimulating learning occurs through physical activity as an indispensable factor in every segment of child development. The stimulation through physical activity is often referred to development of motor skills during pre-school period (Timmons, Naylor & Pfeiffer, 2007).Unquestionably, early physical activity is important, given its positive impact on a child's health as well as intellectual and motor development (Latorre-Román, Mora-López & García-Pinillos, 2016). It is important to adopt a learning approach that, through a variety of physical activities, also gradually stimulates mental development, thus providing a holistic and interesting experience, which in turn leads to improvement of intellectual abilities. Furthermore, by studying a child's inner needs, it is concluded that play is the most important child's activity, through which children learn and discover the world that surrounds them (Ružić, 2015; Červar, 2017). Play should include rotation, balance, fine motor skills, speech, eye accommodation, and cognitive processes (Rajović, 2016).

By a specially designed approach that incorporates various developmental factors, Dr. Ranko Rajović connected children's everyday life with contemporary medical knowledge and created the "NTC system of learning". Based on neurology, neuropsychology, and pedagogy, the NTC system of learning (Nikola Tesla Center – MENSA Department for gifted children, 2009) set

new standards by introducing a learning approach dominated by interaction, thinking activity, and child's development (Rajović, 2009). The system explains how learning affects theoretical knowledge and provides insight on connecting theory and educational practice. Certain studies have been conducted so far investigating the efficacy of the NTC system in comparison to the traditional approach (Rajović, 2017; Girgin, 2019). The studies have shown a significant impact of the NTC system on the improvement of child development, where children developed intellectual abilities, induced concentration and attention later in school (dyslexia), coordination of movements and motor skills, and rapid thinking and reasoning (functional knowledge).

Targeted learning methods that stimulate development from the earliest age and consequently prevent possible health problems are an essential factor for the improvement of children's quality of life. Moreover, parents' overprotectiveness of children, decreased stimulation of brain activity under the influence of external factors, and lack of interactive and properly directed physical activity are the main obstacle in the development and realization of biological potentials (Rajović, 2016; Rajović, 2017). By understanding current problems of children's lifestyle habits, this study was conducted with the aim of analyzing fine motor skills in children through several easy tasks.

The importance of this study is in its results, which attempt to motivate the persons in a child's environment to influence and strive to improve the anthropological characteristics of children. The aim was to determine the psychosensory status of preschool children by using motor tasks of the NTC system of learning.

Methods

The total sample of children (N=308) was tested in 8 Croatian kindergartens. The children were divided into four age groups from <4 to 7 years. The age group of <4 years included the smallest number of participants (7.14%, i.e., 22 children), whereas the age group of 5-6 years had the highest number of participants (31.82%, i.e., 98 children).

Of the total sample of participants (N=308), 165 (53.57%) were girls, and 143 (46.43%) were boys. Regarding parents' education level, most of the fathers (66.56%, i.e., N=205) graduated high school, whereas a small percentage of them had only elementary school education (1.62%, i.e., N=5) or specialization, Master's Degree or Ph.D. (0.65%, i.e., N=2). A similar distribution of education level was seen in mothers. Most of them graduated high school (60.71%, i.e., N=187), whereas the smallest percentage of them had only elementary school education (1.62%, i.e., N=5) or specialization, Master's Degree or Ph.D. (1.62%, i.e., N=5).

The results were obtained by a measuring instrument for monitoring the conditions and elements of psychophysical development of children (NTC system of learning; Rajović, 2009). The instrument included neuromotor qualities for monitoring and measuring children: lifting index finger, lifting ring finger, lifting index and ring finger, tying shoelaces, and catching the ball. Aforementioned tasks were included because they should determine the level of children's motor skills and perception. Also, the quality of these abilities is important because it showcases the children's level of adapted motor skills, during their early development. All participants went through familiarization phase, after which the tasks were conducted. Participants had 3 tries in each motor task and the best result were taken (or successful attempt (lifting the fingers and tying the shoelaces)).

Descriptive parameters include the frequency (absolute) and percentage (relative) of children grouped re age and sex.. The other variables define the psychosensory tasks, child's

bedtime, and the number of digital devices in a child's room on the total sample of participants (N=308).

By a non-parametric Kruskal-Wallis H test, the difference in the rank sum of the psychosensory tasks according to age and sex was calculated on the total sample (N=308). Also, Chi-Square test was implied to the results. All the data were analyzed by using the Statistica Ver 13.00 computer program.

Results

The analysis of the results of the questionnaire for parents regarding children's bedtime shows that children mostly go to bed between 9 or 10 PM i.e., 75.32% of them, 13.96% of children go to bed at 8 or 8:30 PM whereas 5.19% of children go to bed after 10:30 PM. Other 5.53% of the children go to bed before 8 PM. The results of the questionnaire for parents regarding the number of digital devices (TV, computer, video games) in a child's room show that 42.53%, i.e., 131 children, have one or more digital devices in their room, whereas 177 (57.47%) children have none.

The results of frequency (absolute) and percentage (relative) of the motor performance calculated for the total sample of participants (N=308) are presented in Table 1.

Table 1. Frequencies and percentages for the psychosensory tasks on the total sample (N=308)

	Variables		**F**	**%**
Lifting the 2nd finger	Did not succeed		11	3.57
	Succeeded		297	96.43
Lifting the 4th finger	Did not succeed		155	50.32
	Succeeded		153	49.68
Lifting the 2nd+4th finger	Did not succeed		239	77.6
	Succeeded		69	22.4
Tying shoelaces	Did not succeed		224	72.73
	Succeeded		84	27.27
Catching a ball 10x		0	11	3.57
		1	9	2.92
		2	9	2.92
		3	9	2.92
		4	15	4.87
		5	18	5.84
		6	13	4.22
		7	24	7.79
		8	45	14.61
		9	32	10.39
		10	120	38.96
	Missing data		3	0.97

Legend: F – frequency; CF – cumulative frequency; % – percentage, relative; C% – cumulative percentage, relative.

The differences in the rank sum of psychosensory tasks according to age and sex calculated by a nonparametric Kruskal-Wallis test on the total sample of participants (N=308) are presented in Tables 2 and 3.

By analyzing Table 1, we can see that the *catching a ball* task, 23.05%, i.e., 71 children succeeded in catching up to 5 balls, 132 children (37.01%) caught the ball 6 to 9 times, whereas 38.96% (N=120) of children caught the ball ten times.

Table 2. Differences in the rank sum of psychosensory tasks according to age on the total sample (N=308)

Variables	H	p-level	X^2	df	p-level
Lifting the 2nd finger	15.694	0.001	0	3	1
Lifting the 4th finger	38.119	0	38.244	3	0
Lifting the 2nd+4th finger	20.029	0	20.095	3	0
Tying shoelaces	59.478	0	59.672	3	0
Catching a ball 10x	57.674	0	43.747	3	0

Legend: H – coefficient of the level of significance of the Kruskal-Wallis test; p-level – level of significance; x^2 – coefficient of the level of significance of Chi-square; df-degrees of freedom; p-level – level of significance.

Table 2 shows significant differences between the age groups in *lifting the 4th finger*, *lifting the 2nd+4th finger*, *tying shoelaces*, and *catching a ball*, with the significance level of 0.000. The age group of 4-5 years had significantly lower results in all the tasks. The age group of 5-6 years had the best results in the tasks of *lifting the finger off the surface*, whereas the age group of 6-7 years had better results in *tying shoelaces* and *catching a ball*.

Table 3. Differences in the rank sum of psychosensory tasks according to sex on the total sample (N=308)

Variables	F(N=165)	M (N=143)	H	p-level	X^2	df	p-level
Lifting the 2nd finger	25630	21956	0.301	0.583	0	1	0.642
Lifting the 4th finger	25806	21780	0.216	0.642	0.216	1	0.642
Lifting the 2nd+4th finger	25344	22242	0.07	0.791	0.07	1	0.792
Tying shoelaces	27186.5	20399.5	7.937	0.005	7.963	1	0.005
Catching a ball 10x	25350	21315	0.307	0.58	0.08	1	0.778

Legend: F - girls; M - boys; H – coefficient of the level of significance of the Kruskal-Wallis test; p-level – level of significance; x^2 – coefficient of the level of significance of Chi-square; df-degrees of freedom p-level – level of significance.

Table 3 shows a significant difference between the sexes in the *tying shoelaces* task, with the significance level of 0.005 and the coefficient of the level of significance of x^2 =7.97. The girls had much better results than the boys in the *tying shoelaces* task.

Discussion

The analysis of the results in the rank sum according to sex showed that the girls (N=165) had better results than the boys (N=143) only in the tying shoelaces task. The level of significance in the tying shoelaces task was p=0.005. Silva (2018) investigated the differences between the

sexes through motoric tasks. Precisely, throwing and catching skills, material balance, jumping skills, hand skills, eye-hand coordination.The results showed that girls performed better than boys. In terms of age groups, older children (5-6 years) performed better than younger children (4-5 years). Other studies have also confirmed the differences between the sexes – girls achieve better results than boys in different tasks of motor skills and fine motor skills. However, this thesis depends on children's age and the type of tasks, as boys achieve better results than girls in older age categories and tasks of strength (jumping skills) (Pahlevanian & Ahmadizadeh 2014; Rodríguez-Negro, Huertas-Delgado & Yanci 2021).

The analysis of difference in rank sum according to age category yielded expected results. There was a significant difference according to age in all tasks except for the *lifting the 2nd finger* task. The level of significance in the *lifting the 4th finger*, *lifting the 2nd+4th finger*, *tying shoelaces*, and *catching a ball* task was p=0.000.

If the total sample of participants (N=308), 22.40% of children succeeded in *lifting the 2nd+4th finger*. Furthermore, a relative value of 27.27%, i.e., 84 children, was determined in the *tying shoelaces* task. In the psychosensory task of *catching a ball*, 35.06% of children had a below-average result of 7 or fewer balls caught. These low results have been confirmed by other studies (Rajović, 2017; Roth, 2010). In his research, Rajović conducted tasking of motor skills improvement after applying the NCT system of learning (Rajović, 2017). The results achieved before the application of the learning program confirm the deterioration of motor skills. In a comparative study, Roth (2010) showed a decline in motor skills in children in the year 2007 as compared to children in 1985. The correlation between bedtime and the number of digital devices made no significant contribution to the conducted research.

Numerous studies (Aron, Poldrack & Wise, 2009; Chaddock-Heyman et al., 2014; Sibley & Etnier, 2003) have confirmed that motor skills affect the development of cognitive skills, especially in preschool children, due to the extensive development of the synaptic network. A study conducted on 3, 4, and 5-year-olds in 22 preschools over a period of 18 months showed that children with poorer motor skills were less active than children with better-developed motor skills (Williams et al., 2008). These findings can be very important for children's health, especially in obesity prevention.

In conclusion, clinicians should work with parents to monitor motor skills and motivate children to engage in activities that promote motor skills, suggesting the importance of proper early psychophysical stimulation. A stimulating and diverse motor environment significantly affects children's intellectual function and the development of their potential abilities (Čoh, 2021). This was also proven by a study conducted in Turkey, which showed that activities based on the NTC system of learning affect students' success (Ramo Akgun & Girigin, 2019).

Conclusion

The results of the study showed poor motor skills in preschool children. The study attempts to motivate the persons in a child's environment to influence and strive to improve the anthropological characteristics of children. Such research provides an analysis of children's psychosensory status and can serve as a good tool for future testing and assessment of children's progress. Future research should include additional psychosensory tests in a longitudinal study of motor skills after applying the NCT system of learning.

References

Aron, A.R., Poldrack, R.A., & Wise, S.P. (2009). Cognition: Basal ganglia role. *Encyclopedia of Neuroscience*, 2, 1069-1077.

Cegledi, N. (2018). Od dječjeg do adolescentskog mozga. Pogled kroz prozor. Digitalni časopis za obrazovne stručnjake [From child to adolescent brain. Window View. Digital journal for educational professionals]

Chaddock-Heyman, L., Erickson, K.I., Holtrop, J.L., Voss, M.W., Pontifex, M.B., Raine, L.B., et al. (2014). Aerobic fitness is associated with greater white matter integrity in children. *Frontiers in Human Neuroscience*, 8, 584

Červar, S. (2017). Računalo ili gumi-gumi? Tradicionalno ili moderno? [PC or rubber band? Traditional or modern?] (Doctoral dissertation, University of Pula. Faculty of Educational Sciences.).

Čoh, M. (2021). Motor and intellectual development in children: a review. Facta Universitatis, Series: Physical Education and Sport, 515-523.

Dryden, G., Vos, J. (2001). Revolucija u učenju. Zagreb: Educa. [The learning revolution.]

Girgin, D. & Ramo Akgun, N. (2019). Implementation of Activities Based on the NTC System of Learning and Their Impact on the Students' Success in Turkey. *Educational Policy Analysis and Strategic Research*, *14*(4), 137-150.

Judaš, M., Kostović, I. (1997). Temelji neuroznanosti. Zagreb: Medicinska dokumentacija. [Fundamentals of Neuroscience]

Pahlevanian, A. A., & Ahmadizadeh, Z. (2014). Relationship between gender and motor skills in preschoolers. *Middle East Journal of Rehabilitation and Health*, *1*(1).

Latorre-Román, P. Á., Mora-López, D., & García-Pinillos, F. (2016). Intellectual maturity and physical fitness in preschool children. *Pediatrics International*, *58*(6), 450-455.

Piaget, J. (1952). The origins of intelligence in children. New York: International Universities Press.

Rajović, R. (2016). Kako uspešno razvijati IQ deteta kroz igru–NTC sistem učenja. [How to successfully develop your child's IQ through play-the NTC System of Learning.]. Novi Sad: Smart production.

Rajović, R., 2009., Mensa-Ntc-način učenja, [NTC system of learning], Novi Sad.

Rajović, R., Berić, D., Bratić, M., Živković, M., & Stojiljković, N. (2017). Effects of an "NTC" exercise program on the development of motor skills in preschool children. Facta Universitatis, 14(3), 315-329.

Ramo Akgun, N., & Girgin, D. (2019). Implementation of Activities Based on the NTC System of Learning and Their Impact on the Students' Success in Turkey. Educational Policy Analysis and Strategic Research, 14(4), 137-150.

Rodríguez-Negro, J., Huertas-Delgado, F. J., & Yanci, J. (2021). Motor skills differences by gender in early elementary education students. *Early Child Development and Care*, *191*(2), 281-291.

Roth, K., Ruf, K., Obinger, M., Mauer, S., Ahnert, J., Schneider, W., ... & Hebestreit, H. (2010). Is there a secular decline in motor skills in preschool children?. *Scandinavian Journal of Medicine & Science in Sports*, *20*(4), 670-678.

Ružić, M. (2015). Gremo u ćap. Pula: Sveučilište Jurja Dobrile u Puli. [Let's Flock Together] Pula: Juraj Dobrila University of Pula.

Timmons, B. W., Naylor, P. J., & Pfeiffer, K. A. (2007). Physical activity for preschool children—how much and how? *Applied Physiology, Nutrition, and Metabolism*, *32*(S2E), S122-S134.

Williams, H. G., Pfeiffer, K. A., O'neill, J. R., Dowda, M., McIver, K. L., Brown, W. H., & Pate, R. R. (2008). Motor skill performance and physical activity in preschool children. Obesity, 16(6), 1421-1426.

TRADITIONAL CHILDREN'S GAMES IN THE TEACHING OF PHYSICAL AND HEALTH EDUCATION

Vladan Erenfrid[1], Ivana Milanović[1], Miloš Marković[1], Vladimir Milošević[1]
[1] University of Belgrade, Faculty of sport and physical education, Belgrade, Serbia

Introduction

Traditional culture represents the entire social heritage of a community, which is expressed through folk traditions and has a significant role in the life of every individual. Through the processes of education students get to know their roots, social circumstances, and the way of life of their ancestors, and thus acquire and develop awareness of their personal and collective identity (Sekulić, 2022). As part of the traditional culture, there are also traditional games that are most often treated as games in rural areas, which were passed down from generation to generation, so that they can still be seen today. Among them stand out traditional children's games, which are assumed to have developed from rituals and other customs of adults. As Duran (1988) states, inclusion in the community is based on a series of real and symbolic connections with representatives of previous generations - from parents to distant ancestors, on the one hand, and on the other hand, it develops in the society of peers, so certain elements of behavior are acquired thru the games and do not have to be an integral part of culture. This supports Duran's (1988) claim that studying the genesis of play within the framework of the mutual relationship between children and adults is a fruitful way to understand children's play in general.

It is assumed that play has existed since human society, that it is as old as education, as evidenced by numerous objects found during archaeological excavations: toys, drawings in caves, drawings on dishes, etc. The way children play was most often dictated by general social conditions, so that this activity among various peoples was treated depending on the level of culture of the population, but also on economic conditions. According to Lukić (2020), the game in the old century was seen as an aid to learning, getting used to regulations and rituals, military training, training for social life, developing competitive spirit, patience, modesty, but also as entertainment. However, as Lukić (2020) states, it was considered that a balance should be made between play and learning, so that there would be neither laziness in children, nor resistance to learning.

Different ways of playing traditional games throughout Serbia were mainly determined by the landforms (plains, mountains, etc.), and therefore also by the way of life of the people from those areas, i.e., their occupations (herders, farmers, etc.) (Aksić, 2019). Thus, throughout Serbia, one can observe a variety of games, in some cases quite different, but still the same in some of their characteristics. Again, in contrast to this, identical games can be found in Serbia, with possibly changed names and some of their elements. Zečević mentions that this is a consequence of being transferred from one territory to another "by mutual contact and mutual influence, which, however, led to their uniformity, especially in neighboring regions" (Zečević, 1983, p. 27).

The first material with descriptions of children's games collected in the 19th century can be found in Vuk Karadžić's Dictionary from 1852, which recorded some games that were played in the villages of Serbia at that time (Aksić, 2019). However, Tihomir Đorđević was one of the first who recognized the former elements of ritual practice in children's play and pointed out the

transformation of rituals from symbolic content to entertainment. Đorđević (1907) noticed that children's games faithfully preserve the traces and remains of cart and orc games, and that in them the circle of players moving with certain movements reminds of the remains of old times and the beginning of orc games. Also, Zečević (1983) in his analysis of Serbian folk games, says that all games (he means orc games) start in a circle, and that the circle is a creation of civilization in general, so over time the games in the circle acquired a magical meaning. Some other sources from which one can learn something about traditional games are the material that was collected during the former Yugoslavia and recorded in certain issues of the Serbian ethnographic collection, then in a small number of monographs and manuscripts related to children's folk games (Zečević, 1983; Krel, 2005; Jakovljević-Šević, 2011; Marjanović, 2005). In the period after World War II, the most important project for collecting traditional children's games was the international project on traditional children's games of the World Organization for Preschool Education (OMEP), in which Professor Ivan Ivić and his colleagues played an important role. This project was finalized by the book "Traditional Games and Children of Today" (1986), published by the Association of Psychological Societies of the SR of Serbia with the support of UNESCO.

Analyzing the available literature on traditional children's games, we can see different games that were and/or are being implemented in Serbia. Some that are mentioned in the literature are games in which content structure certain ritual elements can be observed, such as the Luca games played on Saint Lucia (December 12), when masked girls from the Catholic areas of Bačka and Banat visit households with jumping and playing, then Poklade games, Beating eggs, Watering games played by children from Orthodox, Catholic and Protestant communities during the Easter holidays (Marjanović, 2002). In addition to these games, in the available literature, it can be found descriptions of folk music games (mainly circle - kola), as well as descriptions of traditional children's games that are most common in all parts of Serbia, such as: Kolarić Panić, Klis, Jelečkinje or Aračkinje Barjačkinje, Janjina, Rotten mares, Hide-and-seek, Šuge, Blind man's buff, Pulling the rope, Marbles, Školice, Colorful eggs and others (Aksić, 2019).

As already mentioned, through the educational process at school, students should get to know the tradition and way of life of their ancestors and thus gain awareness of their personal and collective identity. In her work, Sekulić (2022) tried to determine the extent to which teaching contents that have characteristics of the traditional culture, such as: language, values, moral principles, customs, folk art, beliefs, rituals, and ceremonies, are represented in current curricula. that is, in teaching subjects. Through the analysis of plans and programs, she came to the conclusion that they are the most represented and realized through the goals and tasks of compulsory teaching subjects: Serbian language, The world around us (first and second grade), Nature and society (third and fourth grade), Art culture, Musical culture and to a lesser extent Physical and health education, as well as through optional subjects: Religious education, Folk tradition and Mother tongue with elements of national culture (Sekulić, 2022). When it comes to the subject of Physical and Health Education (hereinafter - PHE, the programs stipulate that in each grade one folk dance (circle) is taught, as well as a folk dance - circle from the region where the school is located (PHE Programs, 2017-2021). Since 2017, the national folk dance - Kolo has been on the UNESCO list as part of the intangible cultural heritage of Serbia and plays a major role in the education of children and young people, as it contributes to the heritage of the traditional culture of the Serbian people, because the folk dance - Kolo are "one of the most picturesque ways in which the spiritual, cultural and

historical past of our people are presented in our culture" (Milošević 2021, p. 40). However, in addition to folk dances, which are of undoubted importance in the education of children and young people, other traditional children's games should also be taught in PHE classes, which can help in the development of intellectual, emotional and moral characteristics of students, and at the same time can teach students about the customs and culture of the ancestors they come from. PHE should have one of the leading roles in introducing students to traditional children's games. It is very important that all teachers, especially teachers of physical and health education, find the time and way to familiarize students with the tradition of our people, as well as with traditional children's games, through various curricular and extracurricular activities. For this reason, this research aimed to examine the possibility of applying traditional children's games in the teaching of PHE, as well as to examine the knowledge of elementary school students about them.

Methods

The sample of participants had two subsamples. A sub-sample of students (100) of primary school age (from 11 to 14 years old) and a sub-sample of physical and health education teachers (20) from the territory of the city of Valjevo. In September 2022, participants filled out two non-standardized online questionnaires about traditional children's games. The questionnaire for students consisted of 17 questions, questions related to general information (gender, age, parents' education, playing sports), questions related to knowledge of traditional children's games and questions related to the application of these games in teaching FZV and in the students' free time. The questionnaire for FZV teachers consisted of 13 questions, questions related to general information (gender, years of experience) and questions related to the application of these games in FZV classes in students' free time. Also, in the questionnaire there were questions related to the comparison of the current and former situation in FZV teaching regarding the application of traditional children's games. The results were processed using descriptive statistics, and the Chi-square test was applied to determine the differences in the answers obtained in relation to gender and age, when it comes to students, as well as differences in relation to gender and seniority, when it comes to teachers.

Results and Discussion

The results obtained in this research are analyzed and presented in two parts. The first part refers to the results obtained from the PHE teacher examination, and the second part to the results obtained from the student examination.

In this research, 14 (73.7%) male teachers and 6 (26.3%) female teachers were interviewed. Looking at the sample of respondents in relation to their years of service, it can be concluded that most teachers have 10 to 20 years of service (35.7%). Teachers with longer working experience answered the questions in more detail because they probably wanted to convey the current situation in the school as realistically as possible, while teachers who have been engaged in this work for a shorter period of time gave much shorter and more specific answers.

When asked if they apply children's traditional games in PHE classes, 72.2% of teachers answered that they rarely apply them in classes, 11.1% of teachers do not apply them at all, while only 16.7% of teachers apply them in almost all classes. Knowing that tradition is passed down

from generation to generation, although the sample of respondents is not large, the percentage of teachers who apply traditional children's games in their classes is not satisfactory. In addition to the family, which should play a significant role in transmitting traditional values to younger members, the school and teachers must introduce students to traditional customs and games. PHE teachers should, in addition to folk dances, which they are obliged to teach students in every grade, include other traditional children's games of their region in the teaching plan and program, as well as find time and a way to at least introduce students to them. Also, traditional children's games should be nurtured and applied through various educational projects that can be implemented in schools.

When asked whether current generations of students know less about traditional children's games compared to earlier ones, most participants (88.9%) believe that earlier generations were more knowledgeable and knew more about traditional children's games than the current ones. This answer is completely expected, because in the era of technology, children socialize less and spend time less with their peers in parks, fields, and playgrounds. As a result, children are less and less physically active, and if we add to that that they are not introduced to traditional children's games in schools, the result is certainly less knowledge of traditional children's games compared to earlier generations.

The situation is somewhat better in extracurricular activities, as 61.1% of teachers apply traditional children's games during these activities. Extracurricular activities (field trips, school sections, vacations, etc.) are very suitable for the application of traditional children's games, and teachers should use these games more during their implementation. Within the field trips, which are mainly planned with the aim of the students getting to know some famous historical places, teachers can organize and prepare so that the students get to know some traditional children's games of the region. Also, if teachers organize vacations or camping trips, they represent a real opportunity to show students certain traditional children's games.

Tradition refers to beliefs, objects or customs practiced in the past, originating from it, transmitted through time by teaching from one generation to the next. Consequently, traditional children's games should be preserved and passed down from generation to generation. Participants were asked what their attitude is towards our tradition and traditional children's games. Out of the total number of them, 61.1% of teachers answered that it is important to nurture and pass on tradition, while 38.9% of teachers answered that they are not sure about the importance of tradition and traditional children's games in PHE teaching.

The obtained results are unexpected considering that the percentage of teachers who are not sure about the importance of passing on traditions and traditional children's games to young generations is not small. Using the Chi square test, gender differences were obtained in the answers to this question ($c^2(1, N=20) = 5.115, p < .05$). Although in this research the sample of participants, especially the female population, is relatively small, it should be pointed out that not a single PHE female teacher answered that she was not sure about the importance of passing on traditions and traditional children's games to the younger generation. It is possible that the female population has a slightly different attitude towards the importance of our tradition, comparing to some male teachers in this sample. As for all other questions, no significant differences were obtained in relation to the teacher's gender and years of service.

Data obtained on the students, data analysis, and conclusions are presented in the second part of the paper. In the research, 55 female students (55%) and 45 male students (45%) were examined. Students of all grades (ages 11 to 14) were equally included in the research, so the sample of fifth-grade students was 23%, sixth-grade students 28%, seventh-grade students 25%, and eighth-grade students 24%.

Physical activity is one of the most important external factors affecting children's development. When we talk about children's physical activity, we mean their overall activity that is related to muscle work, regardless of the forms: physical education classes, play, sports recreation, or sports activity. One of the questions was about how often students are physically active during a week. Positive answers were received to this question, as 41.8% of the students exercise 3-5 times a week, 31.6% of the students exercise 5-7 times a week and 26.5% from 1 to 3 times a week. Considering how physically inactive today's children are (Pašić et al., 2014), the percentage of students who declare themselves to be physically active is quite satisfactory. In addition, 71.4% of students answered that they play some sport, while the remaining 28.6% do not play any sport. Of the total number of those who play sports, the largest percentage of students play basketball (28.7%), volleyball (17.8%) and football (12.3%), while a slightly smaller percentage play tennis (9.6%), water polo (8.2%), swimming 6 (8.2%), boxing (4.1%) and other sports.

Regarding the very important question for this paper, whether students are familiar with the concept of traditional children's games, it can be said that relatively positive answers were received, as 73.5% of the students answered in the affirmative manner. However, 26.5% of them are not familiar with this term, which means that they have never heard of traditional children's games. Within the educational process, regardless of whether the students use certain traditional games, they should be taught that they at least know about this concept, that they are familiar with the traditions of their region, as well as with the games that were used. Among students who are familiar with this term, 39.6% answered that their parents had the main role in their education, followed by FZV teaching with 27.5%. These are the expected answers because students most often acquire knowledge about traditions and traditional children's games from their parents or teachers. It must be noted that grandparents also have a certain merit, because 18.7% of students answered that they heard about traditional children's games from their grandparents. As for the knowledge of traditional children's games of the Valjevo region, 61.9% of students declared that they are familiar with them, while the rest are not familiar with the games of this region. This data shows that not all students are familiar with the traditions of their region, which should be changed if we want young people not to forget the customs of their ancestors.

To the question "Do you play some traditional children's game in your free time?", 45.9% of the students answered yes, while the rest gave a negative answer to the question. The number of affirmative answers is higher than expected, because these games are outdated, and nowadays children play new and more modern games. A deeper analysis of the answers to this question was done by examining whether there are differences in relation to the gender and age of the students. Applying the Chi square test, significant differences were obtained only in relation to the age of the students ($c^2(3)= 31.993$; $p<.00$). As age increases, the percentage of students who play traditional children's games in their free time decreases. This is the expected result, because in many other studies it has been found that the physical activity of male and female students decreases with age

(Radisavljević Janić and Milanović, 2020), so it is expected that older students play less games in general, including traditional children's games.

One of the last questions in the questionnaire was related to whether students play traditional children's games with their friends in PHE classes. The largest percentage of students (41.7%) answered that they play sometimes, while only 7.3% of them answered that they play in every class. This answer is correlated with the answers given by the teachers of PHE, who stated that they do not apply these games in all classes, so it is logical that students cannot play these games in all classes. Also, the analysis of the answers to this question was done by examining whether there are differences in relation to the gender and age of the students. Applying the Chi square test, significant differences were obtained only in relation to the age of the students (c^2 (3) = 22.661; $p<.05$). It can be seen that students in the seventh and eighth grade almost do not play these games at all in PHE classes, while students in the fifth and sixth grade more often state that they at least sometimes play traditional games.

To the last question in this questionnaire: "Did the teacher teach you a traditional children's game in the PHE classes?", 74.7% gave a negative answer, while the remaining 25.3% of students answered positively, which correlates with the percentage that received to the question: "Who introduced you to the concept of traditional children's games?". The answers to this question are not satisfactory. They indicate that according to the answers of the students in this research, our physical and health education teachers are not sufficiently involved in educating students about traditional children's games.

Conclusion

The aim of the research was to examine the possibility of applying traditional children's games in the teaching of PHE. Also, the aim of this paper was to examine elementary school students' knowledge of traditional children's games. The sample of participants consisted of the sub-sample of teachers and the sub-sample of students. The sub-sample of teachers consisted of 20 teachers from the territory of the city of Valjevo, and the sub-sample of students consisted of 100 students from the 5th to 8th grade of the "First Elementary School" in Valjevo. In this research, data were obtained using non-standardized questionnaires for teachers and students that contained open and closed questions.

The result of the entire processing of the teachers' answers is partially positive. The conclusion was reached that teachers rarely apply traditional children's games in PHE classes, which can be justified by the small amount of PHE lessons, so that the teacher would devote himself to this topic during the lesson, and perhaps also by the fact that it is certainly more interesting for students to play new, more modern games. However, the data obtained in this research that a certain number of teachers are not sure about the importance of passing on traditions and traditional children's games to the younger generation, as well as that there are gender differences among teachers in this matter, is unexpected and somewhat worrying. Not a single female teacher of physical and health education answered that she is not sure about the importance of passing on traditions and traditional children's games to the younger generation, unlike male teachers. Such answers cannot be justified, especially when we are talking about the population of teachers who are responsible for the education of young people.

By analyzing the obtained students' results, it can be concluded that they are mostly positive. Students are physically active to a large extent (71.4%), most often from 3 to 5 times a week. Answers to questions related to knowledge of traditional children's games are satisfactory because most students (73.5%) are familiar with the concept of traditional children's games, for which parents are mainly responsible, and partly grandparents. Unfortunately, PHE teachers do not have a lot to do with it, because the majority of students (74.7%) answered that the teachers did not teach them any traditional children's games. This is not in favor of our profession. It indicates that according to the answers of the students in this survey, our PHE teachers are not sufficiently involved in educating students about traditional children's games. We believe that teachers are among the last custodians of traditional children's games and if this trend continues in the future the results will be increasingly worrying. We hope that there are still teachers who do their work professionally, thoroughly and dedicatedly, in order to avoid an increasingly uncertain situation regarding the application of traditional children's games in PHE classes.

One of the tasks in this paper was to examine the differences in relation to the gender and age of the students according to the answers about traditional children's games. In the research, no differences were obtained in relation to the gender of the students, and when it comes to the age of the students, significant differences were obtained in relation to the answers to the questions about whether students play traditional games in their free time and in PHE classes. It can be seen that students' interest in playing these games in their free time and in PHE classes decreases with age.

The general conclusion of this research is that schools and PHE teachers must do more to nurture traditions and traditional children's games. It is necessary to conduct more extensive research, with a larger sample of participants, in order to obtain additional and more reliable information on this topic.

References

Aksić, N. (2019). Tradicionalne društvene igre u Srbiji. Zbornik radova Filozofskog fakuleteta, XLIX, 2, 25-42.

Gligorijević, B. (1961). Dečija igra i njena vaspitna vrednost, Rad, Beograd.

Duran, M. et al. (1988). Simboličke igre i stvaralaštvo, Zavod za udžbenike i nastavna sredstva, Beograd.

Đorđević, R. T. (ur.). (1907). Srpske narodne igre. Srpski etnografski zbornik, knj. 9.

Zečević, S. (1983). Srpske narodne igre poreklo i razvoj. Beograd: „Vuk Karadžić" i Etnografski muzej.

Ivić, I, Marjanović A. (1986). Traditional Games and Children of Today, Savez društava psihologa SR Srbije, UNESKO.

Jakovljević-Šević, T. (2011). Dečije igre u Novom Sadu u prvoj polovini dvadesetog veka. Novi Sad: Muzej grada Novog Sada.

Krel, A. (2005). Dečije igre, Tradicionalne srpske takmičarske dečije igre u Tovariševu (Bačka). Beograd: Srpski genealoški centar.

Lukić, V. (2020). Dečije igre u prošlosti, Čudo, elektronski časopis, www. čudo.rs/dečije- igre- u -proslosti/

Marjanović, V. (2002). Tradicionalne dečje igre u Vojvodini od druge polovine do kraja veka (Međuetnički odnosi u tradicionalnim dečjim igrama Vojvodine). *Kodovi slovenskih kultura*, 7, 147–170.

Marjanović, V. (2005). Tradicionalne dečje igre u Vojvodini. Novi Sad: Matica srpska.

Milošević (2021). Tradicionalna narodna kola u nastavi muzičke kulture za mlađi školski uzrast. Norma, 26 (1), 39-51.

Pašić, M., Milanović, I., Radisavljević Janić, S., Jurak, G., Sorić, M., & Mirkov, D. (2014). Physical activity levels and energy expenditure in urban Serbian adolescents - a preliminary study. *Nutrición Hospitalaria, 30*(5), 1044-1053.

Radisavljević Janić, S., Milanović, I. (2020). Fizička aktivnost i fizičke sposobnosti učenika osnovne škole, Fakultet sporta i fizičkog vaspitanja.

Sekulić, B.D. (2022). Tradicionalna kultura u prvom ciklusu osnovnog obrazovanja u Republici Srbiji, Baština, 56, 527-538.

TRADICIONALNE DEČJE IGRE U NASTAVI FIZIČKOG I ZDRAVSTVENOG VASPITANJA

Vladan Erenfrid[1], Ivana Milanović[1], Miloš Marković[1], Vladimir Milošević[1]
[1] Univerzitet u Beogradu, Fakultet sporta i fizičkog vaspitanja, Beograd, Srbija

Uvod

Tradicionalna kultura predstavlja celokupno društveno nasleđe neke zajednice koje je izraženo kroz narodnu tradiciju i zauzima značajno mesto u životu svakog pojedinca. Učenici kroz procese obrazovanja i vaspitanja upoznaju svoje korene, društvene prilike i način života svojih predaka, i tako stiču i razvijaju svest o svom ličnom i kolektivnom identitetu (Sekulić, 2022). Kao deo tradicionalne kulture, pojavljuju se i tradicionalne igre koje se najčešće tretiraju kao igre u seoskim sredinama, koje su se prenosile sa generacije na generaciju, tako da se mogu i danas videti. Među njima se izdvajaju tradicionalne dečje igre, za koje se pretpostavlja da su se razvile iz obrednih i drugih običaja odraslih. Kako Duran (1988) navodi, uključivanje u zajednicu zasniva se na nizu realnih i simboličkih veza sa predstavnicima prethodnih pokolenja – od roditelja do dalekih predaka, sa jedne strane, a sa druge strane, razvija se u društvu vršnjaka, pa određeni elementi ponašanja preuzeti putem igre i ne moraju biti sastavni deo kulture. Ovome ide u prilog tvrđenje Durana (1988) da proučavanje geneze igre u okviru uzajamnog odnosa deteta i odraslih, predstavlja plodotvoran put za razumevanje dečje igre uopšte.

Pretpostavlja se da igra postoji otkad i ljudsko društvo, da je ona stara koliko i vaspitanje, o čemu svedoče brojni predmeti pronađeni arheološkim iskopavanjima: igračke, crteži u pećinama, crteži na posuđu i dr. Način igranja dece najčešće su diktirali opšti društveni uslovi, tako da je ova aktivnost kod raznih naroda tretirana u zavisnosti od nivoa kulture stanovništva, ali i od ekonomskih uslova. Prema Lukiću (2020), na igru se u starom veku gledalo kao na pomoć učenju, privikavanju na propise i rituale, vojničku obuku, osposobljavanje za društveni život, razvijanje takmičarskog duha, strpljenja, skromnosti, ali i kao na zabavu. Ipak, kako Lukić (2020) navodi, smatralo se da treba napraviti balans između igre i učenja, kako ne bi došlo ni do pojave lenstvovanja kod dece, ali ni do otpora prema učenju.

Različiti načini igranja tradicionalnih igara u čitavoj Srbiji su uglavnom bili uslovljeni pre svega geografskim reljefom (ravnica, planina i dr.), pa samim tim i načinom življenja ljudi sa tih terena, tj. njihovim zanimanjima (stočari, zemljoradnici i dr.) (Aksić, 2019). Tako se u čitavoj Srbiji mogu primetiti raznovrsne igre, u ponečemu sasvim različite, a opet po nekim svojim osobinama iste. Opet, nasuprot ovome, sreću se po Srbiji i identične igre, sa eventualno izmenjenim nazivom i ponekim njihovim elementom. Zečević pominje da je to posledica prenošenja s jedne na drugu teritoriju „međusobnim dodirima i uzajamnim uticajima, a što je, međutim, dovodilo do njihovog ujednačavanja, naročito u susednim krajevima“ (Zečević, 1983).

Prva građa sa opisima dečjih igara prikupljenim u 19. veku može se pronaći u Rječniku Vuka Karadžića iz 1852. godine, u kome su zabeležene neke igre koje su se u to vreme igrale po selima Srbije (Aksić, 2019). Međutim, jedan od prvih koji je u dečjoj igri prepoznao nekadašnje elemente obredne prakse i ukazao na transformaciju obreda od simboličkog sadržaja do zabave, jeste Tihomir Đorđević. Đorđević (1907) je uočio da dečje igre verno čuvaju tragove i ostatke kola i

orskih igara, te da u njima krug igrača koji se kreće određenim pokretima podseća na ostatke starih vremena i početno doba orskih igara. Takođe, Zečević (1983) u analizi srpskih narodnih igara, kaže da sve igre (misli se na orske igre) započinju u krugu, te da je kolo opšte civilizacijska tvorevina pa su vremenom igre u kolu stekle magijsko značenje. Neki drugi izvori iz kojih se može saznati nešto o tradicionalnim igrama je građa koja je sakupljana u vreme nekadašnje Jugoslavije i zabeležena u pojedinim brojevima Srpskog etnografskog zbornika, zatim u ne velikom broju monografija i radova vezanih za dečje narodne igre (Zečević, 1983; Krel, 2005; Jakovljević-Šević, 2011; Marjanović, 2005). U periodu posle Drugog svetskog rata najznačajniji projekat za prikupljanje tradicionalnih dečjih igara je bio međunarodni projekat o tradicionalnim dečjim igrama Svetske organizacije za predškolsko vaspitanje (OMEP) u kome su važnu ulogu imali profesor Ivan Ivić i njegovi saradnici. Ovaj projekat je zaokružen knjigom „Traditional Games and Children of Today" (1986) koju je objavio Savez društava psihologa SR Srbije uz podršku UNESKO-a.

Analizirajući dostupnu literaturu o tradicionalnim dečjim igrama uočavaju se različite igre koje su se primenjivale i/ili se primenjuju u Srbiji. Neke koje se pominju u literaturi su igre u čijoj se strukturi sadržaja mogu zapaziti određeni obredni elementi, kao što su na primer igre *Luce* koje se igraju na Svetu Luciju (12. decembar), kada maskirane devojčice iz katoličkih sredina Bačke i Banata obilaze domaćinstva uz poskakivanje i igranje, zatim igre *Poklade*, *Tucanje jajima, Polivanja* koje igraju deca iz pravoslavnih, katoličkih i protestantskih sredina u vreme uskršnjih praznika (Marjanović, 2002). Pored ovih igara, u dostupnoj literaturi se mogu pronaći i opisi narodnih muzičkih igara (uglavnom kola), ali i opisi tradicionalnih dečjih igara koje su najzastupljenije u svim krajevima Srbije kao što su: *Kolariću Paniću, Klis, Jelečkinje ili Aračkinje Barjačkinje, Janjine, Trule kobile, Žmurke, Šuge, Ćorave bake, Nadvlačenje konopca, Klikeri, Školice, Šarenih jaja* i druge (Aksić, 2019).

Kao što je već pomenuto, učenici bi kroz vaspitno-obrazovni proces u školi trebalo da se upoznaju sa tradicijom, načinom života svojih predaka i da tako stiču svest o svom ličnom i kolektivnom identitetu. Sekulić (2022) je u svom radu pokušala da utvrdi koliko su zastupljeni nastavni sadržaji koji imaju obeležja tradicionalne kulture, kao što su: jezik, vrednosti, moralna načela, običaji, narodno stvaralaštvo, verovanja, rituali i obredi u aktuelnim nastavnim planovima i programima, odnosno u nastavnim predmetima. Analizom planova i programa došla je do zaključka da su oni najviše zastupljeni i da se ostvaruju kroz ciljeve i zadatke obaveznih nastavnih predmeta: Srpski jezik, Svet oko nas (prvi i drugi razred), Priroda i društvo (treći i četvrti razred), Likovna kultura, Muzička kultura i u manjoj meri Fizičko i zdravstveno vaspitanje, kao i kroz izborne predmete: Verska nastava, Narodna tradicija i Maternji jezik sa elementima nacionalne kulture (Sekulić, 2022). Kada je u pitanju predmet Fizičko i zdravstveno vaspitanje (u daljem tekstu – FZV), programima je predviđeno da se u svim razredima nauči po jedno narodno kolo, kao i narodno kolo iz kraja u kome se škola nalazi (Programi FZV, 2017-2021). Narodno kolo se od 2017. godine nalazi na listi Uneska kao deo nematerijalnog kulturnog nasleđa Srbije i ima veliku ulogu u obrazovanju i vaspitanju dece i mladih, jer doprinosi baštini tradicionalne kulture srpskog naroda, zato što su kola „jedan od najslikovitijih načina na koji su u našoj kulturi predstavljena duhovna, kulturna i istorijska prošlost našeg naroda" (Milošević 2021). Međutim, pored narodnih kola, koja su od nesumnjivog značaja u obrazovanju i vaspitanju dece i mladih, u nastavi FZV bi trebalo da se primenjuju i druge tradicionalne dečje igre koje mogu da pomognu u razvoju intelektualnih, emocionalnih i moralnih karakteristika učenika, a ujedno mogu da nauče učenike o običajima i

kulturi naroda iz koga potiču. FZV bi trebalo da ima jednu od vodećih uloga u upoznavanju učenika sa tradicionalnim dečjim igrama. Veoma je važno da svi nastavnici, a posebno nastavnici fizičkog i zdravstvenog vaspitanja, pronađu vreme i način da kroz različite nastavne i vannastavne aktivnosti upoznaju učenike sa tradicijom našeg naroda, kao i sa tradicionalnim dečjim igrama. Iz tog razloga ovo istraživanje je imalo za cilj da ispita mogućnost primene tradicionalnih dečjih igara u nastavi FZV, kao i znanja učenika osnovne škole o njima.

Metode

Uzorak ispitanika je imao dva poduzorka. Poduzorak učenika (100) osnovnoškolskog uzrasta (od 11. do 14. godina) i poduzorak nastavnika FZV (20) sa teritorije grada Valjevo. Ispitanici su u toku septembra 2022. godine popunjavali dva nestandardizovana onlajn upitnika o tradicionalnim dečjim igrama. Upitnik namenjen učenicima se sastojao od 17 pitanja vezanih za opšte informacije (pol, uzrast, obrazovanje roditelja, bavljenje sportom), od pitanja koja su se odnosila na poznavanje tradicionalnih dečjih igara, kao i od pitanja koja su se odnosila na primenu ovih igara u nastavi FZV i u slobodnom vremenu učenika. Upitnik namenjen nastavnicima FZV se sastojao od 13 pitanja vezanih za opšte informacije (pol, godine staža), pitanja koja su se odnosila na primenu ovih igara u nastavi FZVi u slobodnom vremenu učenika. Takođe, u upitniku su bila i pitanja koja su se odnosila na poređenje aktulenog i nekadašnjeg stanja u nastavi FZV po pitanju primene tradicionalnih dečjih igara. Rezultati su obrađeni primenom deskriptivne statistike, a Hi kvadrat test je primenjen kako bi se utvrdile razlike u dobijenim odgovorima u odnosu na pol i uzrast, kada su u pitanju učenici, kao i razlike u odnosu na pol i radni staž, kada su u pitanju nastavnici.

Rezultati i diskusija

Rezultati dobijeni u ovom istraživanju su obrađeni i prikazani u dva dela. Prvi deo se odnosi na rezultate dobijene ispitivanjem nastavnika FZV, a drugi deo na rezultate dobijene ispitivanjem učenika.

U toku ovog istraživanja ispitano je 14 (odnosno 73,7%) nastavnika i 6 (26,3%) nastavnica. Posmatrajući uzorak ispitanika u odnosu na radni staž, može se konstatovati da je najviše nastavnika sa 10 do 20 godina radnog staža (35,7%). Ono što se može primetiti analizom upitnika jeste da su nastavnici sa dužim radnim stažom detaljnije odgovarali na pitanja, jer su verovatno želeli da prenesu što realniju trenutnu situaciju u školi, dok su nastavnici koji se kraći vremenski period bave ovim poslom, davali dosta kraće i konkretnije odgovore.

Na pitanje da li primenjuju dečje tradicionalne igre na časovima FZV, 72,2% nastavnika je odgovorilo da ih retko primenjuju na časovima, 11,1% nastavnika ih uopšte ne primenjuje, dok samo 16,7% nastavnika ih primenjuje skoro na svim časovima. Znajući da je tradicija nešto što se prenosi sa generacije na generaciju, iako uzorak ispitanika nije veliki, procenat nastavnika koji primenjuje tradicionalne dečje igre na časovima nije zadovoljavajući. Pored porodice koja bi trebalo da ima značajnu ulogu u prenošenju tradicionalnih vrednosti na mlađe članove, škola i nastavnici imaju obavezu da učenike upoznaju sa tradicionalnim običajima i igrama. Nastavnici FZV bi trebalo da pored narodnih kola koja su u obavezi da u svakom razredu nauče učenike, uključe i druge tradicionalne dečje igre njihovog kraja u plan i program nastave, kao i da pronađu vreme i način da

makar upoznaju učenike sa njima. Takođe, tradicionalne dečje igre bi trebalo negovati i primenjivati kroz različite edukativne projekte koji se mogu realizovati u školama.

Na pitanje da li sadašnje generacije učenika manje poznaju tradicionalne dečije igre u odnosu na ranije, većina ispitanika (88,9%) smatra da su ranije generacije bile upućenije i više poznavale tradicionalne dečje igre nego sadašnje. Ovakav odgovor je potpuno očekivan jer se u eri tehnologije deca sve manje socijalizuju i provode vreme sa svojim vršnjacima po parkovima, poljima i igralištima. Kao rezultat toga deca su sve manje fizički aktivna, a ukoliko se tome doda da se ni u školama ne upoznaju sa tradicionalnim dečjim igrama, rezultat je sigurno manje poznavanje tradicionalnih dečjih igara u odnosu na ranije generacije.

Nešto bolja situacija je kada je u pitanju primena tradicionalnih dečjih igara na vannastavnim aktivnostima jer 61,1 % nastavnika primenjuje ove igre tokom vannastavnih aktivnosti. Vannastavne aktivnosti (izleti, školske sekcije, letovanja i sl.) su veoma pogodne za primenu tradicionalnih dečjih igara i trebalo bi da nastavnici više primenjuju ove igre tokom njihove realizacije. U okviru izleta koji su uglavnom planirani sa ciljem da učenici upoznaju neka znamenita istorijska mesta, nastavnici se mogu organizovati i pripremiti tako da učenici upoznaju i neke tradicionalne dečje igre toga kraja. Takođe, ukoliko nastavnici organizuju letovanja ili logorovanja, ona predstavljaju pravu priliku da se učenicima prikažu i određene tradicionalne dečje igre.

Tradicija se odnosi na uverenja, objekte ili običaje upražnjavane u prošlosti, poreklom iz nje, prenoseći se kroz vreme predavanjem sa jedne generacije na sledeću. Shodno tome, tradicionalne dečje igre bi trebalo očuvati i prenositi sa generacije na generaciju. Ispitanicima je postavljeno pitanje kakav je njihov stav prema našoj tradiciji i tradicionalnim dečjim igrama. Od ukupnog broja ispitanika 61,1% nastavnika je odgovorilo da je važno negovati i prenositi tradiciju, dok je 38,9% nastavnika dalo odgovor da nisu sigurni u važnost tradicije i tradicionalnih dečjih igara u nastavi FZV. Dobijeni rezultati su neočekivani uzimajući u obzir da procenat nastavnika koji nisu sigurni u to da je važno prenositi tradiciju i tradicionalne dečje igre mladim generacijama, nije mali. Primenom Hi kvadrat testa, dobijene su polne razlike u odgovorima na ovo pitanje ($\chi^2(1)= 5.115$; $p<.05$). Iako je u ovom istraživanja uzorak ispitanika, posebno ženske populacije, relativno mali, ipak treba istaći da ni jedna nastavnica FZV nije dala odgovor da nije sigurna u važnost prenošenja tradicije i tradicionalnih dečjih igra na mlade generacije. Moguće je da ženska populacija ima malo drugačiji stav prema važnosti naše tradicije, nego što su to pokazali pojedini nastavnici muškog pola u ovom uzroku ispitanika. Što se tiče svih drugih pitanja, nisu dobijene značajne razlike u odnosu na pol i radni staž nastavnika.

U okviru drugog dela prikazani su rezultati učenika dobijeni u ovom istraživanju, njihova analiza i određeni zaključci. U istraživanju je ispitano 55 učenica (55%) i 45 učenika (45%). Istraživanje je koncipirano tako što su podjednako obuhvaćeni učenici svih razreda (uzrast od 11 do 14 godina), pa je uzorak učenika petog razreda bio 23%, učenika šestog razreda 28%, učenika sedmog razreda 25% i učenika osmog razreda 24%.

Fizička aktivnost je jedan od najvažnijih spoljašnjih faktora koji utiče na razvoj dece. Kad se govori o fizičkoj aktivnosti dece, misli se na njihovu sveukupnu aktivnost koja je povezana sa radom mišića, bez obzira na oblike: nastava fizičkog vaspitanja, igra, sportska rekreacija ili sportska aktivnost. Jedno od pitanja se odnosilo na to koliko često su učenici fizički aktivni u toku jedne nedelje. Na ovo pitanje su dobijeni veoma pozitivni odgovori, jer 41,8% ispitanika upražnjava

fizičku aktivnost 3-5 puta nedeljno, čak 31,6 % ispitanika upražnjava 5-7 puta nedeljno i 26,5 % od 1 do 3 puta nedeljno. Imajući u vidu koliko su današnja deca fizički neaktivna (Pašić et al., 2014), procenat učenika koji se izjašnjavaju kao fizički aktivni je sasvim zadovoljavajući. Osim toga, 71,4% učenika je odgovorilo da se bavi nekim sportom, dok se preostalih 28,6% ne bavi nijednim sportom. Od ukupnog broja onih koji se bave sportom, najveći procenat učenika se bavi košarkom (28,7%), odbojkom (17,8%) i fudbalom (12,3%), dok se nešto manji procenat bavi tenisom (9,6%), vaterpolom (8,2%), plivanjem 6 (8,2%), boksom (4,1%) i drugim sportovima.

Na veoma značajno pitanje za ovaj rad, da li su učenici upoznati sa pojmom tradicionalnih dečjih igara, može se reći da su dobijeni relativno pozitivni odgovori, jer je 73,5% učenika odgovorilo potvrdno. Ipak 26,5 % njih nije upoznato sa ovim pojmom, a to znači da nikada nisu čuli za tradicionalne dečje igre. Ono na čemu bi obavezno trebalo raditi u okviru obrazovno-vaspitnog procesa, bez obzira da li se sa učenicima primenjuju određene tradicionalne igre, jeste da svi učenici bar poznaju ovaj pojam, da su upoznati sa tradicijom svoga kraja, kao i sa igrama koje su se nekada igrale. Kod učenika koji poznaju ovaj pojam, 39,6% je odgovorilo da su roditelji imali glavnu ulogu u njihovoj edukaciji, a na drugom mestu je nastava FZV sa 27,5%. Ovo su očekivani odgovori jer učenici najčešće stiču znanja o tradiciji i tradicionalnim dečijim igrama od strane roditelja ili nastavnika. Mora se napomenuti da određenu zaslugu imaju i bake i deke, jer je 18,7% učenika odgovorilo da je upravo od njih čulo o tradicionalnim dečjim igrama. Što se tiče poznavanja tradicionalnih dečjih igara karakterističnih za valjevski kraj, 61,9% učenika se izjasnilo da ih poznaje, dok ostatak nije upoznat sa igrama koje su zastupljene u tom kraju. I ovaj podatak govori o tome da nisu svi učenici upoznati sa tradicijom svoga kraja, na čemu bi trebalo raditi ukoliko se želi da mlade generacije ne zaborave običaje svojih predaka.

Na pitanje „Da li se igraš u slobodno vreme nekom tradicionalnom dečjom igrom?“, 45,9% ispitanika je odgovorilo potvrdno dok je ostatak dao negativan odgovor na postavljeno pitanje. Broj potvrdnih odgovora je veći od očekivanog, jersu ove igre prevaziđene, a u današnje vreme deca se igraju novim i modernijim igrama. Dublja analiza odgovora na ovo pitanje je urađena tako što se ispitalo da li postoje razlike u odnosu na pol i uzrast učenika. Primenom Hi kvadrat testa dobijene su značajne razlike samo u odnosu na uzrast učenika ($\chi^2(3)= 31.993$; $p<.00$). Sa povećanjem uzrasta smanjuje se procenat učenika koji se u slobodno vreme igraju tradicionalnih dečjih igara. To je očekivan rezultat jer je i u mnogim drugim istraživanjima dobijen podatak da se fizička aktivnost učenika i učenica smanjuje sa uzrastom (Radisavljević Janić i Milanović, 2020), pa je očekivano da se učenici starijih uzrasta manje igraju igara uopšte, pa tako i tradicionalnih dečjih igara.

Jedno od poslednjih pitanja u upitniku se odnosilo na to da li se učenici igraju sa svojiim drugovima/drugaricama tradicionalnih dečijih igara na časovima FZV. Najveći procenat ispitanika (41,7%) je odgovorio da se ponekad igra, dok je odgovor da se na svakom času igra dalo samo 7,3% ispitanika. Ovaj odgovor je u korelaciji sa odgovorima koje su dali nastavnici FZV, koji su naveli da ne primenjuju ove igre na svim časovima, pa je onda logično i da se učenici ne mogu igrati na svim časovima ovih igara. Takođe, analiza odgovora na ovo pitanje je urađena tako što se ispitalo da li postoje razlike u odnosu na pol i uzrast učenika. Primenom Hi kvadrat testa dobijene su značajne razlike samo u odnosu na uzrast učenika ($\chi^2(3)= 22.661$; $p<.05$). Na osnovu dobijenih odgovora može se videti kako se učenici u sedmom i osmom razredu skoro uopšte

ne igraju ovih igara na časovima FZV, dok učenici petog i šestog razreda češće navode da se bar ponekad igraju tradicionalnih igara.

Na poslednje pitanje u ovom upitniku koje glasi: „Da li te je profesor naučio nekoj tradicionalnoj dečjoj igri na časovima FZV?“, čak 74,7 % je dalo negativan odgovor na ovo pitanje, dok je preostalih 25,3% ispitanika odgovorilo pozitivno, što korelira sa procentom koji je dobijen na pitanje: „Ko te je upoznao za pojmom tradicionalnih dečjih igara?“ Odgovori na ovo pitanje nisu zadovoljavajući i ne idu u prilog našoj struci, odnosno ukazuju na to da se prema odgovorima učenika u ovom istraživanju naši nastavnici fizičkog i zdravstvenog vaspitanja ne bave mnogo obrazovanjem učenika o tradicionalnim dečjim igrama.

Zaključak

Cilj istraživanja je bio da se ispita mogućnost primene tradicionalnih dečjih igara u nastavi FZV. Takođe, cilj rada je bio ispitati znanja o tradicionalnim dečjim igrama učenika osnovne škole. Uzorak ispitanika činili su poduzorak nastavnika i poduzorak učenika. Poduzorak nastavnika činilo je 20 nastavnika sa teritorije grada Valjeva, a poduzorak učenika činilo je 100 učenika od 5. do 8. razreda „Prve osnovne škole“ u Valjevu. U ovom istraživanju podaci su dobijeni primenom nestandardizovanih upitnika za nastavnike i učenike koji su sadržali pitanja otvorenog i zatvorenog tipa.

Rezultat celokupne obrade ankete nastavnika je delimično pozitivan. Došlo se do zaključka da nastavnici retko primenjuju tradicionalne dečje igre u nastavi FZV što se može opravdati malim fondom časovima FZV kako bi se u toku nastave nastavnik posvetio i ovoj temi, a možda i činjenicom da je učenicima sigurno zanimljivije da se igraju novih, modernijih igara. Ipak, podatak koji je dobijen u ovom istraživanju da određeni broj nastavnika nije siguran u važnost prenošenja tradicije i tradicionalnih dečjih igara na mlade generacije, kao i da postoje polne razlike među nastavnicima po ovom pitanju, neočekivan je i pomalo zabrinjavajući. Ni jedna nastavnica fizičkog i zdravstvenog vaspitanja nije dala odgovor da nije sigurna u važnost prenošenja tradicije i tradicionalnih dečjih igra na mlade generacije, za razliku od nastavnika muškog pola. Ovakvi odgovori ne mogu imati opravdanje, posebno kada se govori o populaciji nastavnika koja je odgovorna za obrazovanje i vaspitavanje mladih.

Analizirajući dobijene rezultate učenika može se zaključiti da su oni uglavnom pozitivni. Učenici su u velikoj meri fizički aktivni (71,4%), najčešće od 3 do 5 puta nedeljno. Odgovori na pitanja vezana za poznavanje tradicionalnih dečjih igara su zadovoljavajući, jer većina učenika (73,5%) poznaje pojam tradicionalnih dečjih igara, za šta su uglavnom odgovorni roditelji, a delimično i bake i deke. Nažalost, nastavnici FZV nemaju mnogo udela u tome, jer je većina učenika (74,7%) odgovorila da ih nastavnici nisu naučili ni jednoj tradicionalnoj dečjoj igri. Ovo ne ide u prilog našoj struci, odnosno ukazuje na to da se prema odgovorima učenika u ovom istraživanju naši nastavnici FZV ne bave mnogo obrazovanjem učenika o tradicionalnim dečjim igrama. Smatramo da su nastavnici među poslednjim negovateljima tradicionalnih dečjih igara i ako se ovakav trend nastavi u budućnosti rezultati će biti sve više zabrinjavajući. Nadamo se da i dalje ima nastavnika koji stručno, temeljno i posvećeno rade svoj posao kako bismo izbegli sve neizvesnije stanje po pitanju primene tradicionalnih dečjih igara na časovima FZV.

Jedan od zadataka u ovom radu je bio i da se ispitaju razlike u odnosu na pol i uzrast učenika u odnosu na odgovore koje su davali odgovarajući o tradicionalnim dečjim igrama. U

istraživanju nisu dobijene razlike u odnosu na pol učenika, a kada je u pitanju uzrast učenika, značajna razlike dobijene su u odnosu na odgovore na pitanja da li se učenici igraju tradicionalnih igara u slobodno vreme i na časovima FZV, gde se može videti da sa uzrastom opada interesovanje učenika da se igraju ovih igara u slobodno vreme i na časovima FZV.

Generalni zaključak ovog istraživanja jeste da se škole i nastavnici FZV moraju više baviti negovanjem tradicije i tradicionalnih dečjih igara. Neophodno je uraditi obimnija istraživanja, sa većim uzorkom ispitanika, kako bi se dobile dodatne i pouzdanije informacije o ovoj temi.

Literatura

Aksić, N. (2019). Tradicionalne društvene igre u Srbiji. Zbornik radova Filozofskog fakuleteta, XLIX, 2, 25-42.

Gligorijević, B. (1961). Dečija igra i njena vaspitna vrednost, Rad, Beograd.

Duran, M. et al. (1988). Simboličke igre i stvaralaštvo, Zavod za udžbenike i nastavna sredstva, Beograd.

Đorđević, R. T. (ur.). (1907). Srpske narodne igre. Srpski etnografski zbornik, knj. 9.

Zečević, S. (1983). Srpske narodne igre poreklo i razvoj. Beograd: „Vuk Karadžić“ i Etnografski muzej.

Ivić, I, Marjanović A. (1986). Traditional Games and Children of Today, Savez društava psihologa SR Srbije, UNESKO.

Jakovljević-Šević, T. (2011). Dečije igre u Novom Sadu u prvoj polovini dvadesetog veka. Novi Sad: Muzej grada Novog Sada.

Krel, A. (2005). Dečije igre, Tradicionalne srpske takmičarske dečije igre u Tovariševu (Bačka). Beograd: Srpski genealoški centar.

Lukić, V. (2020). Dečije igre u prošlosti, Čudo, elektronski časopis, www. čudo.rs/dečije- igre- u -proslosti/

Marjanović, V. (2002). Tradicionalne dečje igre u Vojvodini od druge polovine do kraja veka (Međuetnički odnosi u tradicionalnim dečjim igrama Vojvodine). *Kodovi slovenskih kultura*, 7, 147–170.

Marjanović, V. (2005). Tradicionalne dečje igre u Vojvodini. Novi Sad: Matica srpska.

Milošević (2021). Tradicionalna narodna kola u nastavi muzičke kulture za mlađi školski uzrast. Norma, 26 (1), 39-51.

Pašić, M., Milanović, I., Radisavljević Janić, S., Jurak, G., Sorić, M., & Mirkov, D. (2014). Physical activity levels and energy expenditure in urban Serbian adolescents - a preliminary study. *Nutrición Hospitalaria, 30*(5), 1044-1053.

Radisavljević Janić, S., Milanović, I. (2020). Fizička aktivnost i fizičke sposobnosti učenika osnovne škole, Fakultet sporta i fizičkog vaspitanja.

Sekulić, B.D. (2022). Tradicionalna kultura u prvom ciklusu osnovnog obrazovanja u Republici Srbiji, Baština, 56, 527-538.

PHYSICAL ACTIVITY AMONG BOYS AND GIRLS AGED 15 TO 18 YEARS IN THEIR FREE TIME

Martin Andonovski[1], Goran Nikovski[1]
[1] University of Skopje, Faculty of physical education, sport and health, Skopje, Republic of North Macedonia

Introduction

The modern way of living, in the era of technological development, has largely eliminated physical activity as one of the basic human needs for a long and healthy life. The level of physical activity among adolescents is decreasing, while overweight is increasing and is a global problem in the world. Physical activity is one of the key factors for proper growth and development of the young organism. In children and adolescents, physical activity has been found to benefit the following health outcomes: improved physical fitness, cardio metabolic health, bone health, cognitive performance, mental health, and reduction of subcutaneous fat (WHO, 2020).

WHO guidelines on physical activity and sedentary behavior, recommends that children and adolescents can be physically active as part of recreation, physical education, through walking and cycling or household activities. WHO recommendations are at least 60 minutes of moderate or vigorous physical activity every day. Global trends in adolescent physical inactivity indicate that urgent action is needed to increase physical activity levels among girls and boys aged 11 to 17 years (WHO, 2020).

The study, published in the journal Lancet Child & Adolescent Health and produced by researchers from the World Health Organization WHO in 2019, found that more than 80% of school-going adolescents globally did not meet current recommendations of at least one hour of physical activity per day, i.e. 85% of girls and 78% of boys (Regina, Fiona, Leanne, & Gretchen, 2019).

The student's free time is the time he has left after school and home duties to satisfy his personal needs. Free time is the time that is used for entertainment and rest, and it positively affects physical and mental development, develops creative abilities and enables the development of positive personality traits (Kleiber, 1999). General Comment No. 17 of the Committee on the Rights of the Child defines free time as free or unobligated time, which does not include formal education, work, domestic responsibilities and performing other activities. In other words, it is largely discretionary time used by the child himself (CRC, 2013). Usually, the division is based on active and passive quality time spent, whether the activities are organized by an adult or a child, how structured they are and what the activities are that take place (Halpern, 2005).

Today, the relationship between time spent at school and free time is increasingly changing among children and young people. Children are busy with many school duties, so it is important that they finish the rest of the day with active rest, positive development, physical activity, socialization, socializing and personal development.

Methods

The sample of respondents was formed by a total of 503 students (249 male) of both genders from the 1st to the 4th year from secondary schools SUGS "Orce Nikolov" - Skopje, DUFK "Metodi Mitevski - Brico" - Skopje, SUGS "Shaip Yusuf" - Skopje, SOSU "Ilinden" - Skopje, enrolled in the academic year 2020/21, with an average age of +-15 to +-18 years.

The data were obtained through the Health Behavior in School-aged Children (HBSC) questionnaire of the World Health Organization. The results obtained are used by the World Health Organization to inform policy and practice in countries and regions across Europe, with the aim of improving the lifestyles of young people. (Roberts, et al., 2007). The questionnaire is anonymous. During the survey, respondents were informed how to correctly fill out the survey sheet, as well as the meaning of the results that will be obtained from the survey. The research was conducted through an online questionnaire that contains questions from different topics, and in this research the focus is on data related to physical activity and free time.

The data were processed with the statistical package SPSS for Windows Version 26.0. Data processing was performed based on the values of the χ2 square, numerically by frequencies (f) and percentage (%).

Results

The results obtained from the research are divided into two groups, according to:gender (male vs. female) and age (15-16 years and from 17-18 years), separately for male and female respondents.

First will be presented the differences in the level of physical activity vs free time in relation to gender.

Table 1 shows the answers to the question: „In the past 7 days, on how many days were you physically active at least 60 minutes?“, with a choice of answers from "zero" to "7 days". The results show that a higher percentage of boys, 30.5%, were physically active more than 6 days a week for at least 60 minutes, compared to girls with 16.6%. While 30.4% of girls and 23.3% of boys were physically active one or less day a week. The values of the χ2 test (χ2 (1) = 22,136; p = .000) show that there are statistically significant differences in the answers to this question between male and female respondents.

Table 1 – "How many days were you physically active, for at least 60min., in the past 7 days?"

Gender	< 1 day %	2-3 days %	4-5 days %	≥ 6 days %	Total %
Male	23.3	26.1	20.1	30.5	100
Female	30.4	39.1	13.8	16.6	100
Total	26.9	32.7	16.9	23.5	100

Table 2 shows the respondents' answers to the question: How much free time do you have during the day, outside of school and home duties? The results show that 61% of boys and 45.1% of girls have 4 and more than 4 hours of free time, while 7.2% of boys and 22.5% of girls declared that they have 2 and less than 2 hours of free time. The values of the χ2 test (χ2 (2) = 26,046; p = .000) show

that there are statistically significant differences in the answers to this question between male and female respondents.

Table 2 – "How much free time do you have during the day, outside of school and home duties?"

Gender	< 2 h %	2-3 h %	≥ 4 h %	Total %
Male	7.2	31.3	61.4	100
Female	22.5	32.4	45.1	100
Total	14.9	31.9	53.2	100

Next will be presented the differences in the level of physical activity vs free time in relation to age (15-16 years and from 17-18 years, separately for male and female respondents). Table 3 shows the answers to the question: In the past 7 days, on how many days were you physically active for at least 60 minutes?, with a choice of answers from "zero" to "7 days". The values of the χ2 test (χ2 (3) = 5,687; p = .0128) show that there are no statistically significant differences in the level of physical activity in relation to age among male respondents.

Table 3 – "How many days were you physically active, for at least 60 min., in the past 7 days?" (male respondents)

Age	≤ 1 day %	2-3 days %	4-5 days %	≥ 6 days %	Total %
15-16	22.0	29.8	22.7	25.5	100
17-18	25.0	21.3	16.7	37.0	100
Total	23.3	26.1	20.1	30.5	100

Table 4 shows the respondents' answers to the question: How much free time do you have during the day, outside of school and home duties? The values of the χ2 test (χ2 (4) = 2,728; p = .256) show that there are no statistically significant differences in free time outside of school and home duties in relation to age among male respondents.

Table 4 – "How much free time do you have during the day, outside of school and home duties?" (male respondents)

Age	< 2 h %	2-3 h %	≥ 4 h %	Total %
15-16	5.0	33.3	61.7	100
17-18	10.2	28.7	61.1	100
Total	7.2	31.3	61.4	100

Table 5 shows the answers to the question: In the past 7 days, on how many days did you do physical activity for at least 60 minutes?, with a choice of answers from "zero" to "7 days". The values of the χ2 test (χ2 (5) = 4,641; p = .200) show that there are no statistically significant differences in the level of physical activity in relation to age among female respondents.

Table 5. "How many days were you physically active, for at least 60min., in the past 7 days?" (female respondents)

Age	≤ 1 day %	2-3 days %	4-5 days %	≥ 6 days %	Total %
15-16	34,3	39,4	13,9	12,4	100
17-18	25.9	38.8	13.8	21.6	100
Total	30,4	39,1	13,8	16,6	100

Table 6 shows the respondents' answers to the question: How much free time do you have during the day, outside of school and home duties? The values of the χ2 test (χ2 (6) = 1,266; p = .531) show that there are no statistically significant differences in free time outside of school and home duties in relation to the age of the female respondents.

Table 6 – "How much free time do you have during the day, outside of school and home duties?" (female respondents)

Age	< 2 h %	2-3 h %	≥ 4 h %	Total %
15-16	24.8	29.9	45.3	100
17-18	19.8	35.3	44.8	100
Total	22,5	32,4	45,1	100

Discussion

Based on the results obtained in terms of gender, and in relation to the level of *"Physical activity"*, it is noted that 23.3% of boys and 30.4% of girls were physically active one or less day a week, which is not meet the recommended daily needs of physical activity for at least 60 minutes every day. This is a major indicator of physical inactivity. The results show that 30.5% of boys and only 16.6% of girls are physically active every day, for at least 60 minutes. According to this, compared to girls, boys are more physically active. This is also proven through research conducted in May 2020, by a group of professors, where the results showed that less than 20% of adolescents are engaged in physical activity every day, and almost 20% are never engaged in physical activity. Regardless of country, region or age group, this research found that girls adolescent had consistently lower levels of PA than boys (Marques, et al., 2020).

Regarding *"Free time"*, outside of school and home duties, respondents declared that 7.2% of boys and 22.5% of girls have less than 2 hours of free time during the day, while the majority of boys or 61 .4% and 45.1% of girls declared that they have 4 or more hours of free time during the day. According to the data, boys declared that they have more free time than girls. Today's children are busy, and when a child enters middle school schedules can get even busier. But free time is important for children (Auhuber, Vogel, Grafe, Kiess, & Poulain, 2019), especially as they enter puberty and adolescence. While too much free time can become problematic (Meldrum & Barnes, 2017), it's important for parents to make sure that their tween has a balance between scheduled activities and time for themself. Studies show that children who are overscheduled often feel overwhelmed and pressured, and that can lead to a number of problems including behavioral issues

and emotional challenges (Brown, Nobiling, Teufel, & Birch, 2011). In other words, overscheduled children can be stressed out.

Based on the results obtained in terms of age, in relation to the level of *"Physical activity",* it is noted that there are no statistically significant differences between 15-16 years and 17-18 years old respondents (for males and females). Regarding the results obtained from *"Free* time" outside of school and home duties in relation to the age of 15-16 and 17-18 years (for males and females), there are no statistically significant differences.

Researchers found a spike in physical activity levels in only one age group: the 20-something-year-old adults. People in this group tended to be more active in the early morning. Surprisingly, the study found that teenagers were at the highest risk of being physically inactive, and in their late teens, this group was likely to get as little exercise as seniors (Sandoiu, 2017).

Conclusion

Regular physical activity of adolescents has an essential role in maintaining their good health and well-being. Besides the school activities, it is extremely important for them, to be physically active on a daily basis and in their free time. The environment, in which they grow and develop, has a big role in this regard, and the involvement of all family members is particularly significant.

It is important that all children and adolescents are provided with safe and fair opportunities and encouragement to participate in physical activities that are enjoyable, offer variety and are appropriate for their age and ability. It is better to be engaged in some physical activity, rather than to do nothing. It is necessary to start with small physical activities, in order to gain the attention and interest of the youth, and then to gradually increase the intensity and duration (WHO, 2020).

If the children are not interested in spending their free time doing certain physical activities, in this case the family plays a very important role, and it should be engaged in finding certain activities through which it will gain the children's interest in physical activity. This doesn't have to be a structured sport, but could be a dance class, yoga, jogging or running in a group without formal competition. Furthermore, a solution needs to be found to help them continue that activity on an ongoing basis, as well as how to not talk about physical activity in a negative way or in relation to body shape. An excellent way to help a child to be active is to lead by example. Showing them how physical activity can be fun and doesn't have to be sanctioned. The participation of the parents/family in the activities can be a model in itself, in order to encourage the child to participate in it. This again can include activities such as walking, biking, hiking, yard and garden maintenance, and a variety of other outdoor activities.

In addition to parents, educational institutions and the state system play an important role in creating habits and opportunities for young people to spend quality and active free time. Schools through the dissemination of educational messages and the creation of curricula that will enable the reduction of sedentary time for children, through the implementation of planned physical education classes in schoolyards, parks or somewhere in nature, providing adjustable tables for sitting/standing that will enable children to stand during lectures, in order to reduce sedentary time in school. While the state through the construction of walking paths, parks that will be safe for playing, multi-functional playgrounds, bicycle paths to every school in order for children to travel

to school by bicycle, as well as providing access to various sports facilities and school yards after completion of the classes.

References

Auhuber, L., Vogel, M., Grafe, N., Kiess, W., & Poulain, T. (2019). Leisure Activities of Healthy Children and Adolescents. International Journal of Environmental Research and Public Health, 12-16.

Brown, S. L., Nobiling, B. D., Teufel, J., & Birch, D. A. (2011). Are Kids Too Busy? Early Adolescents' Perceptions of Discretionary Activities, Overscheduling, and Stress. Journal of School Health, 80-81.

CRC, C. o. (2013, April 17). United Nations.

Halpern, R. (2005). Book Review: Examining adolescent leisure time across cultures: New Directions for Child and Adolescent Development. Journal of Adolescent Research, 20-22.

Kleiber, D. (1999). Leisure experience and human development: A dialectical interpretation. New York: NY: Basic Books.

Marques, A., Henriques-Neto, D., Peralta, M., Martins, J., Demetriou, Y., Schönbach, D. M., & Matos, M. G. (2020). Prevalence of Physical Activity among Adolescents from 105 Low, Middle, and High-Income Countries. International Journal of Environmental Research and Public Health, 17-18.

Meldrum, R. C., & Barnes, J. C. (2017). Unstructured Socializing with Peers and Delinquent Behavior: A Genetically Informed Analysis. Journal of Youth and Adolescence, 1968–1981.

Regina, G., Fiona, B. C., Leanne, R. M., & Gretchen, S. A. (2019, November 21). Global trends in insufficient physical activity among adolescents: a pooled analysis of 298 population-based surveys with 1•6 million participants. The Lancet Child & Adolescent Health, pp. 23-35.

Roberts, C., Currie, C., Samdal, O., Currie, D., Smith, R., & Maes, L. (2007). Measuring the health and health behaviours of adolescents through cross-national survey . In Health Behaviour in School-aged Children study (pp. 179-86). J Public Health.

Sandoiu, A. (2017, June 19). Medical News Today. Retrieved from Teens get as much physical activity as 60-year-olds, study shows:

WHO. (2020). WHO guidelines on physical activity and sedentary behavior. Geneva: Eddy Hill Design.

WHO, W. H. (2020, October 5). Physical Activity.

THE STUDENTS' FREE TIME

Živorad Marković[1], Antonio Antonov[2], Jelena Jančić[1]

[1] University of Kragujevac, Faculty of Pedagogical sciences, Jagodina, Serbia
[2] National Sport Academy "Vassil Levski", Sofiia, Bulgaria

Introduction

We can understand free time only if we look at it with work and the position of man at work, as an integral part of man's time, which is socially, conditioned and cannot be studied without economic, political, cultural and historical factors.

Free time appears in various forms and should not be seen only as satisfying individual interests, because free time activities can be of social nature, they can be active or passive, take place indoors or outdoors, they can contribute to physical health or to harm, to be useful or harmful to society (Bashir, Bano & Riaz Sajan, 2014).

Activities that people engage in during their free time can significantly affect the quality of life of the individual, as well as society, because social relationships are built, new skills and knowledge are improved and acquired, and positive emotions are experienced (Brajsa Zganec & Kaliterna Lipovcan, 2010).

According to studies conducted in 24 countries belonging to the Organization for Economic Co-operation and Development, with the increase in income (measured by gross domestic product per capita), the number of hours of free time during the week also increases (Veal, 2016).

For students, free time can be seen as the absence of academic obligations. Freedom in the use of free time is important, but the role of education is also important, where it is necessary to enable children to use free time for the development and satisfaction of their needs, and not to "waste" it (Previsic, 2000). Eratay & Audogan (2015) concluded that the opinion about the time spent by students in free time, monetary benefits and benefits of activities varied from student to student and the level of assertiveness and level of education related to the use of free time were not found.

Vrkic Dimic (2005) concludes by examining that students most often spend their free time socializing with friends, partners, neighbours and relatives, then watching TV programs, listening to music, reading books and lastly on sports and recreation. Eratay & Aydogan (2015) reach similar results: that students use their free time mostly listening to music, resting, reading and socializing with peers.

Anic, Roguljic & Svegar (2017) arrive at completely similar results as in the aforementioned research, but there was a difference in students who listed physical activity as their favourite activity for using their free time. Intrinsic motivation among students who practiced sports recreationally is significantly higher compared to students who practiced only as part of physical education subjects.

After research, Karaderi (2021) comes to the conclusion that students mostly prefer passive activities and that it is of great importance for students that the government and local administration enable students to spend their free time in a better way.

Among students, the main factor for not using their free time or playing sports is the lack of time and preoccupation with university duties, which tells us that students have heavy study loads that prevent them from enjoying their free time, which leads to a sedentary lifestyle (Lorenzo Sánchez, et al., 2022).

The goal of this research was to study possible difference in the structure of free time of male and female students, as well as the identification of certain life habits of male and female students, which can have influence on preferences towards sport recreational activities in the frame of free time.

Method

The research had transversal character, with the application of the survey method, carried out in the first semester of the 2022/2023. school year. As a research instrument, a survey questionnaire was used, specially constructed for this research with eight closed questions with the possibility of two or more answers.

The sample of examinees included 175 students divided into two special sub samples – to the criterion of gender: sub sample of 70 male students NSA "Vassil Levski" in Sofia and sub sample of 105 female students at the Faculty of Education in Jagodina. For the determination of the significance of differences between free time of male and female students Pearson's test χ^2 was applied.

Results

Today's students have three hours less free time compared to ten years ago, and therefore spend the least amount of time in passive rest, which is confirmed by research results where we observe that male and female students spend the least amount of free time in activities intended for rest.

Table 1. The most important functions of free time in relation to gender

			What do you think are the most important functions of free time?			
			Activities intended for relaxation	Activities intended for leisure and entertainment	Activities intended for personality development	In total
Sex	Male	*f*	15	18	37	70
		%	21.4	25.7	52.9	100.0
	Female	*f*	22	51	32	105
		%	21.0	48,5	30.5	100.0
In total		*f*	37	69	69	175
		%	21.2	39.4	39.4	100.0

χ^2=10.905, *df*=2, *p*=0.004

The most important functions of free time for students with 52.9% are activities intended for personality development, and for female students with 48.5% are activities intended for leisure and entertainment, which caused statistically significant difference between male and female

students in relation to the most important functions of free time with a level of statistical significance of p=0.004 (Table 1).

Table 2. The most important type of free time in relation to creative values

			What type of free time is most important for a person in relation to creative values?			
			Mutual connection of man with other people	Play and free time	free time through the prism of art	In total
Sex	Male	*f*	38	27	5	70
		%	54.2	38.6	7.2	100.0
	Female	*f*	62	26	17	105
		%	59.0	24.8	16.2	100.0
In total		*f*	100	53	22	175
		%	57.1	30.3	12.6	100.0

χ^2=5.546, *df*=2, *p*=0.062

Looking at Table 2. we can conclude that the mutual connection of a person with other people is the most important type of free time in relation to creative values, which did not cause a statistically significant difference between male and female students with a level of statistical significance of p=0.062.

Mass media are increasingly suppressing cultural institutions such as libraries, theatres and museums, and the value of educational institutions is declining. Mostly students spend time on the Internet, which becomes an instrument in socialization.

Table 3. The concept of free time in relation to gender

			What do you think free time is in relation to the claims offered?			
			Time freed from organized work	Requirement for recreation and active rest	free time as a function of self-evaluation and self-identification	In total
Sex	Male	*f*	12	25	33	70
		%	17.1	35,7	47.2	100.0
	Female	*f*	49	38	18	105
		%	46.7	36,2	17.1	100.0
In total		*f*	61	63	51	175
		%	34.9	36.0	29.1	100.0

χ^2=23.476, *df*=2, *p*=0.000

Male students with 35.7% and female students with 36.2% point out that free time should be used for recreation and active rest. The majority of male students point out that free time for them is a function of self-evaluation and self-identification, while for the largest number of female students it is free time, time freed from organized work. The difference in the perception of free time between male and female students resulted in a statistically significant difference with a level of statistical significance of p=0.000 (Table 3).

Table 4. Activity performed in free time in relation to gender

			In relation to your lifestyle, which activity prevails in your free time?			In total
			Physical-recreational activities	Cultural-aesthetic activities	Educational activities	
Sex	Male	*f*	49	9	12	70
		%	70.0	12.9	17.1	100.0
	Female	*f*	68	23	14	105
		%	64.8	21.9	13.3	100.0
In total		*f*	117	32	26	175
		%	66.9	18.3	14.8	100.0

χ^2=2.463 , *df*=2, *p*=0.292

Among male students, the smallest percentage (12.9%) engages in cultural and aesthetic activities in their free time and the smallest percentage of female students engage in educational activities (13.3%). In second place for male students are educational activities, and for female students, cultural and aesthetic activities. Physical-recreational activities (walks, excursions, trips, sports activities, etc.) prevail among male students with 70%, and among female students with 64.8%. There is no statistically significant difference between male and female students in relation to the chosen activity during free time since the level of statistical significance is p=0.292 (Table 4).

Table 5. Factors by level of organization in enabling the implementation of various forms of free time

			Which of the above factors by level of organization enables spending different forms of free time?				In total
			Educational institutions	Family and local environment	Social organizations	Means of mass communication	
Sex	Male	*f*	17	35	11	7	70
		%	24.3	50.0	15.7	10.0	100.0
	Female	*f*	24	53	15	13	105
		%	22.8	50.5	14.3	12.4	100.0
In total		*f*	41	88	26	20	175
		%	23.4	50.3	14.9	11.4	100.0

χ^2=0.035 , *df*=3, *p*=0.959

According to the understanding of male and female students, the family and the local environment have the greatest influence on the organization and implementation of various forms of free time. They also agreed that after the family and the local environment, the organization and implementation of various forms of free time are most influenced by educational institutions, then children's, youth, and other social organizations, and lastly by means of mass communication such as the press, radio, television, and the movie.

The attitudes of male and female students in relation to the most organized factors in enabling the implementation of various forms of free time did not cause a statistically significant difference p=0.959 (Table 5).

Table 6. Character of sports and recreational activities

			If sports and recreational activities prevail, are they?		
			Recreational in character	Professional in character	In total
Sex	Male	*f*	42	28	70
		%	60.0	40.0	100.0
	Female	*f*	101	4	105
		%	96.2	3.8	100.0
In total		*f*	143	32	175
		%	81.7	18.3	100.0

χ^2=36.815, df=1, p=0.000

The data in Table 6. indicate that 96.2% of female students are engaged in sports and recreational activities of a recreational nature, while the percentage of male students is lower and amounts to 60.0%. Only 3.8% of female students play sports professionally, while the situation is different for male students and 40.0% of students play sports professionally. The obtained results indicate that there is a statistically significant difference between male and female students in relation to the character of sports and recreational activities with a level of statistical significance of p=0.000.

The most common sports and recreational activity among students is field hockey, followed by running, basketball, football, volleyball, and walking, and what is surprising is that the smallest percentage exercises in the gym. For female students, the picture is completely different, and walking is the most common, followed by exercise in the gym, followed by running, field hockey, volleyball, basketball, and the smallest percentage plays soccer in their free time. The dispersion of the results caused a statistically significant difference between male and female students in relation to the most frequent sports-recreational activity with a level of statistical significance of p=0.000 (Table 7).

Table 7. The most frequent sports and recreational activity

			What sports and recreational activity do you most often practice in your free time?							
			Basketball	Running	Volleyball	Walking	Football	Gym	Field Hockey	In total
Sex	Male	*f*	12	15	5	5	6	4	23	70
		%	17.1	21.4	7.1	7.1	8.6	5.7	33.0	100.0
	Female	*f*	3	10	4	65	2	15	6	105
		%	2.9	9.5	3.8	61.9	1.9	14.3	5.7	100.0
In total		*f*	15	25	9	70	8	19	29	175
		%	8.5	14.3	5.1	40.0	4.6	10.9	16.6	100.0

χ^2=71.160, df=6, p=0.000

Looking at Table 8. we can state that only 2.9% of male students and 38.1% of female students do not exercise at all. 5.7% of male students and 36.2% of female students exercise once or twice a week. 40.0% of male students and 21% of female students exercise three to four times a week. 25.7% of male students exercise five to six times a week, and 3.8% of female students. 25.7% of male students and 10.9% of female students exercise daily. The differences between male and female students are more than pronounced. The largest percentage of male students exercise three to four times a week, while the situation is quite different for female students, since the largest number do not exercise or exercise once or twice a week, which caused a statistically significant difference between male and female students in relation to the number of exercises per week with a level of statistical significance of p=0.000.

Table 8. Number of weekly exercises

			How many times a week do you exercise?					
			I don't exercise	1-2 times a week	3-4 times a week	5-6 times a week	I exercise every day	In total
Sex	Male	*f*	2	4	28	18	18	70
		%	2.9	5.7	40.0	25.7	25.7	100.0
	Female	*f*	40	38	22	4	1	105
		%	38.1	36.2	21.0	3.8	10.9	100.0
In total		*f*	42	42	50	22	19	175
		%	24.0	24.0	28.6	12.5	10.9	100.0

χ^2=83.067, df=4, p=0.000

Discussion

The most important functions of free time for male students are activities intended for personality development, and for female students, activities intended for leisure and entertainment.

The mutual connection of a man with other people is the most important type of free time in relation to the creative values of male and female students, while in the research of Markovic & Milanovic (2015), male students especially emphasized the importance of free time for play, and female students for the mutual connection of a man with other people.

In Serbia, Mrdja (2011) states that 83.0% of students do not go to museums, and about 70.0% of them very rarely visit galleries, cultural-historical monuments, archaeological sites, theatre performances, literary evenings, cinema. The absence of cultural habits and lack of interest in visiting museums is also stated by Tesin et al. (2019), but indicate that with certain investments and effort, museums can become places for the socialization of young people. For the largest number of male students, free time is a function of self-evaluation and self-identification, while for the largest number of female students; it is free time, time freed from organized work.

In relation to lifestyle, sports and recreational activities prevail over cultural, aesthetic, and educational ones. Identifying factors that influence adults to opt for physical activity are numerous and may be related to value attitudes, social environment, structural and cultural barriers (Brett et al., 2002). According to research by the Centres for Disease Control and Prevention (1997), male

and female students have different interests in certain activities, have different beliefs, perceptions, and have different motives and barriers regarding physical activity. Students are more interested in competitions, while girls primarily see their physical engagement as a function of regulating their body mass

According to the level of organization, the family, and the local environment, according to the understanding of male and female students, have the greatest influence on the organization and implementation of various forms of free time. Sports and recreational activities are of an amateur nature, while the percentage of active athletes among students is significantly higher. A very small percentage of professional athletes among female students of the Faculty of Pedagogical Sciences was found in research by Markovic & Ignjatovic (2009) and Markovic & Milanovic (2015).

Female students do not participate in high-risk sports and are more interested in individual physical activities, such as walking, aerobics or dancing. What attracts attention is a choice of activities that does not entail material costs for students. Walking and running in nature, as basic natural forms of movement, can be practiced individually, in pairs or in smaller groups. They do not require special material and spatial conditions, organization, dates, etc. They can be done anytime and anywhere in the fresh air.

The largest percentage of male students exercise three to four times a week, while the situation is quite different for female students, since the largest number do not exercise or exercise once or twice a week. Obligations at the Faculty with morning and afternoon lectures, trips, consultations, and other obligations do not allow more free time to practice your favourite sports and recreational activity. Research shows that the age group of 15-19 years exercises more, especially boys, to look physically as beautiful as possible. One of the main reasons for bad lifestyle habits in most countries is recognized as the poor quality of school physical education. The data indicated that since 1990, the marginalization of physical education has been carried out and students are susceptible to withdrawing from physical activity, with the consequence that they do not practice it even later, because neither the skills nor the habits necessary for regular physical activity during the lifetime have been adopted (Hardman, 2008).

Conclusion

The results of research at the Faculty of Pedagogical Sciences in Jagodina and NSA "Vassil Levski" in Sofia reflect the average student population in Serbia, as well as in European and American countries. There is a statistically significant difference between male and female students in five of the eight variables, a statistically significant difference was not found when it comes to: the most important type of free time in relation to creative values, the type of activity that prevails in free time in relation to lifestyle and the most organized factors that enable different forms of free time.

The general conclusion is that physical education, which was abolished back in 1996 at most universities in the Republic of Serbia, should be returned to students as soon as possible in order to build, improve, and preserve their bio-psycho-social characteristics.

Note: *This research was funded by the Ministry of Science, Technological Development and Innovation (Contract No. 451-03-47/2023-01/ 200140).*

References

Anić, P., Roguljić, D., & Švegar, D. (2017). What do students do in their free time and why?. *Polish Psychological Bulletin, 48*(4) 504–515

Bashir, R., Bano, H., & Riaz Sajan, H. M. (2014). Leisure Time Activities of Students with Visual Impairment. *Academic Research International*, *5*(5), 186–196.

Brajsa Zganec, A., & Kaliterna Lipovcan, Lj. (2010). Quality of life, life satisfaction and happiness of people who professionally help others. *Social Research*, *15*(4-5), 84–85.

Veal, A. J. (2016). Leisure. income inequality and the Veblen effect: Cross-national analysis of leisure time and sport and cultural activity. *Leisure Studies, 35*(2), 215–240.

Vrkic Dimic, J. (2015). Actual and desired activities of students in their free time. *Pedagogical research*, *2*(2), 313–326.

Eratay, E., & Aydogan, Y. (2015). Study Of The Relationship Between Leisure Time Activities And Assertiveness Levels Of Students Of Abant Izzet Baysal University. *Procedia - Social and Behavioral Sciences*, *191*(2015), 2213–2218.

Karaderi, B. (2021). Leisure Time Spending Tendencies of University Students: The Case of TRNC. *Asian Journal of University Education*, *17*(3), 41–50.

Lorenzo Sánchez, O., Sánchez Gómez, M. C., Martín Cilleros, M. V., Martín Sevillano, R., Cabanillas García, J. L., & Verdugo Castro S. (2022). Perception about leisure and free time and how it has affected university students. *Investigação Qualitativa em Educação: Avanços e Desafios, 12*(2022), 1–12.

Markovic, Z., & Ignjatovic, A. (2009). Assessment of physical ability as a criterion of selection of students of pedagogy and teacher training faculty. U S. Divljan (ed.), International Conference ''Promoting Teachers Education – from intake system to teaching practice'' 19-20.05.2009, 1(8/1), (r.r. 323–336). Jagodina: Facultu of Education in Jagodina.

Markovic, Z, & Milanovic, S. (2015). Free Time of the Students of Pedagogical Sciences at the University of Kragujevac. U. V. Vujevic (ed*), Compilation of Works from the Scientific Meeting "Science and Freedom*", 6-8. June 2014, (page 764–782). Pale: University at Istocno Sarajevo, Faculty of Philosophy, Pale.

Previsic, V. (2000). Free time between pedagogical theory and educational practice. *Progress*, *141*(4), 403–410.

Tesin, A., Kovacic, S., & Bozovic, T. (2019). Preferences of young people in Serbia towards different types of interpretation in museums. Pale: Faculty of Economics, University of East Sarajevo.

Hardman, K. (2008), Physical education in schools: a global perspective. *Kinesiology, 40*(1), 5–28.

Centers for Disease Control and Prevention. Guidelines for school and community programs to promote lifelong physical activity among young people 1997: Morbidity and Mortality Weekly Report, 46 (RR6), 1–36.

SLOBODNO VREME STUDENATA

Živorad Marković[1], Antonio Antonov[2], Jelena Jančić[1]

[1] Univerziteta u Kragujevcu, Fakultet pedagoških nauka, , Jagodina, Srbija
[2] Nacionalna Sportska Akademija "Vassil Levski", Sofija, Bugarska

Uvod

Slobodno vreme možemo shvatiti samo ako ga posmatramo sa radom i položajem čoveka u radu, kao integralni deo čovekovog vremena, koji je društveno uslovljen i ne može se izučavati bez ekonomskih, političkih, kulturnih i istorijskih činilaca. Ono se javlja u raznim oblicima i ne sme se gledati samo kao zadovoljavanje individualnih interesa jer aktivnosti slobodnog vremena mogu biti i društvenog karaktera, mogu biti aktivne i pasivne, da se odvijaju u zatvorenom ili na otvorenom prostoru, one mogu da doprinose fizičkom zdravlju ili da štete, da budu korisne ili štetne za društvo (Bashir, Bano & Riaz Sajan, 2014). Aktivnosti kojima se ljudi bave u slobodno vreme mogu značajno da utiču na kvalitet života samog pojedinca, kao i društva jer se grade socijalni odnosi, poboljšavaju i usvajaju nove veštine, znanja i doživljavaju pozitivne emocije (Brajša Žganec & Kaliterna Lipovčan, 2010).

Prema studijama sprovedenim u 24 zemlje koje pripadaju Organizaciji za ekonomsku saradnju i razvoj, uz rast prihoda (merenog bruto domaćeg proizvoda po glavi stanovnika), raste i broj sati slobodnog vremena tokom nedelje (Veal, 2016). Kod studenata slobodno vreme može da se posmatra kao odsustvo akademskih obaveza. Sloboda u korišćenju slobodnog vremena je važna, ali je takođe važna i uloga vaspitanja gde je potrebno osposobiti decu da slobodno vreme iskoriste za razvoj i zadovoljenje svojih potreba, a ne da ga „troše" (Previšić, 2000). Eratay & Audogan (2015) zaključuju da mišljenje o vremenu koje studenti provode u slobodno vreme, novčane povlastice i koristi od aktivnosti varirale su od studenta do studenta i nije pronađen nivo asertivnosti i nivo obrazovanja u vezi sa korišćenjem slobodnog vremena. Vrkić Dimić (2005) ispitivanjem zaključuje da studenti slobodno vreme najčešće „troše" na druženje sa prijateljima, partnerom, komšijama i rođacima, zatim na praćenje TV programa, slušanje muzike, čitanje knjiga i na poslednjem mestu bavljenje sportom i rekreaciju. Eratay & Aydogan (2015) dolaze do sličnih rezultata: da studenti svoje slobodno vreme najviše koriste slušajući muziku, odmarajući se, čitajući i družeći se sa vršnjacima. Anić, Roguljić & Švegar (2017) dolaze do potpuno sličnih rezultata kao i u prethodno navedenim istraživanjima, ali je postojala razlika kod studenata koji su fizičku aktivnost naveli kao omiljenu aktivnost za korišćenje slobodnog vremena. Intrinzična motivacija kod studenata koji su se sportom bavili rekreativno je znatno veća u poređenju sa studentima koji su vežbali samo u okviru predmeta fizičkog vaspitanja. Karaderi (2021) nakon istraživanja dolazi do zaključka da studenti uglavnom preferiraju pasivne aktivnosti te da je od velikog značaja za studente da vlada i lokalna administracija studentima omogući da na kvalitetniji način provode svoje slobodno vreme.

Kod studenata glavni faktor nekorišćenje slobodnog vremena ili bavljenje sportom je nedostatak vremena i preokupiranost obavezama na fakultetu, što nam govori da studenti imaju velika opterećenja studiranjem koja ih sprečavaju da uživaju u slobodnom vremenu, što dovodi do sedećeg načina života (Lorenzo Sánchez, et al., 2022).

Cilj istraživanja je bio da se utvrdi eventualna razlika u strukturi slobodnog vremena studenata, kao i identifikacija pojedinih životnih navika studenata koje mogu imati uticaja na opredeljenja prema upražnjavanju sportsko-rekreativnih aktivnosti u okviru slobodnog vremena.

Metod rada

Istraživanje je bilo transverzalnog karaktera, uz primenu Survay metoda realizovano u prvom semestru školske 2022/2023. Kao instrument istraživanja primenjen je anketni upitnik, posebno konstruisan za ovo istraživanje sa osam pitanja zatvorenog tipa sa mogućnošću na dva i više odgovora.

Uzorak ispitanika obuhvatio je 175 studenata podeljenih u dva posebna subuzorka - prema kriterijumu pola i to: subuzorak od 70 studenata NSA „Vassil Levski" u Sofiji i subuzorak od 105 studentkinja Fakulteta pedagoških nauka u Jagodini. U obradi podataka dobijenih empirijskim istraživanjem pored postupaka deskriptivne statistike za utvrđivanje značajnosti razlika između slobodnog vremena studenata i studentkinja primenjen je Pearsonov χ^2 test.

Rezultati

Sadašnji studenti imaju tri sata manje slobodnog vremena u odnosu na studente od pre deset godina i zato najmanje vremena i provode u pasivnom odmoru, što potvrđuju rezultati istraživanja gde uočavamo da studenti i studentkinje najmanje slobodnog vremena provode u aktivnostima namenjene odmaranju.

Tabela 1. Najbitnije funkcije slobodnog vremena u odnosu na pol

			Koje su po Vama najbitnije funkcije slobodnog vremena?			
			Aktivnosti namenjene odmaranju	Aktivnosti namenjene razonodi i zabavi	Aktivnosti namenjene razvitku ličnosti	Ukupno
Pol	Muški	*f*	15	18	37	70
		%	21.4	25.7	52.9	100.0
	Ženski	*f*	22	51	32	105
		%	21.0	48.5	30.5	100.0
Ukupno		*f*	37	69	69	175
		%	21.2	39.4	39.4	100.0

χ^2=10.905, *df*=2, *p*=0.004

Najbitnije funkcije slobodnog vremena kod studenata sa 52.9% su aktivnosti koje su namenjene razvitku ličnosti, a kod studentkinja sa 48.5% su aktivnosti namenjene razonodi i zabavi što je i uslovilo statističku značajnu razliku između studenata i studentkinja u odnosu na najbitnije funkcije slobodnog vremena sa nivoom statističke značajnosti od p=0.004 (Tabela 1).

Tabela 2. Najbitniji tip slobodnog vremena u odnosu na kreativne vrednosti

			Koji je tip slobodnog vremena najbitniji za čoveka u odnosu na kreativne vrednosti?			
			Uzajamna povezanost čoveka sa drugim ljudima	Igra i slobodno vreme	Slobodno vreme kroz prizmu umetnosti	Ukupno
Pol	Muški	*f*	38	27	5	70
		%	54.2	38.6	7.2	100.0
	Ženski	*f*	62	26	17	105
		%	59.0	24,8	16.2	100.0
Ukupno		*f*	100	53	22	175
		%	57.1	30.3	12.6	100.0

χ^2=5.546, *df*=2, *p*=0.062

Uvidom u Tabelu 2. možemo konstatovati da je uzajamna povezanost čoveka sa drugim ljudima najbitniji tip slobodnog vremena u odnosu na kreativne vrednosti što nije uslovilo statističku značajnu razliku između studenata i studentkinja sa nivoom statističke značajnosti od p=0.062.

Mas-mediji sve više potiskuju kulturne institucije kao što su biblioteke, pozorišta i muzeji, a opada i vrednost obrazovnih institucija. Uglavnom studenti provode vreme na internetu koji postaje instrument u socijalizaciji.

Tabela 3. Pojam slobodno vreme u odnosu na pol

			Šta je po Vama slobodno vreme u odnosu na ponuđene tvrdnje?			
			Vreme oslobođeno od organizovanog rada	Uslov za rekreaciju i aktivan odmor	Slobodno vreme u funkciji samovrednovanja i samoidentifikacije	Ukupno
Pol	Muški	*f*	12	25	33	70
		%	17.1	35.7	47.2	100.0
	Ženski	*f*	49	38	18	105
		%	46.7	36.2	17.1	100.0
Ukupno		*f*	61	63	51	175
		%	34.9	36.0	29.1	100.0

χ^2=23.476, *df*=2, *p*=0.000

Studenti sa 35.7% i studentkinje sa 36.2% ističu da slobodno vreme treba iskoristiti za rekreaciju i aktivni odmor. Najveći broj studenata ističe da je slobodno vreme za njih u funkciji samovrednovanja i samoidentfikacije, dok je za najveći broj studentkinja slobodno vreme, vreme oslobođeno od organizovanog rada. Razlika u poimanju slobodnog vremena između studenata i studentkinja uslovila je statistički značajnu razliku sa nivoom statističke značajnosti od p=0.000 (Tabela 3).

Tabela 4. Upražnjavana aktivnost u slobodnom vremenu u odnosu na pol

			U odnosu na stil življenja koja aktivnost preovladava u slobodnom vremenu kod Vas?			
			Fizičko-rekreativne aktivnosti	Kulturno-estetske aktivnosti	Obrazovne aktivnosti	Ukupno
Pol	Muški	*f*	49	9	12	70
		%	70.0	12.9	17.1	100.0
	Ženski	*f*	68	23	14	105
		%	64.8	21.9	13.3	100.0
Ukupno		*f*	117	32	26	175
		%	66.9	18.3	14.8	100.0

χ^2=2.463 , *df*=2, *p*=0.292

Kod studenata najmanji procenat (12.9%) u slobodnom vremenu se bavi kulturno-estetskim aktivnostima, a najmanji procenat studentkinja upražnjava obrazovne aktivnosti (13.3%). Na drugom mestu kod studenata su obrazovne aktivnosti, a kod studentkinja kulturno-estetske aktivnosti. Fizičko-rekreativne aktivnosti (šetnje, izleti, putovanja, sportske aktivnosti i sl.) preovladavaju kod studenata sa 70.0%, a kod studentkinja sa 64.8%. Između studenata i studentkinja ne postoji statistički značajna razlika u odnosu na izabranu upražnjavanu aktivnost u toku slobodnog vremena, pošto je nivo statističke značajnosti p=0.292 (Tabela 4).

Tabela 5. Faktori po nivou organizovanosti u omogućavanju provođenja različitih oblika slobodnog vremena

			Koji od navedenih faktora po nivou organizovanosti omogućava provođenje različitih oblika slobodnog vremena:				
			Vaspitno-obrazovne institucije	Porodica i lokalna sredina	Društvene organizacije	Sredstva masovne komunikacije	Ukupno
Pol	Muški	*f*	17	35	11	7	70
		%	24.3	50.0	15.7	10.0	100.0
	Ženski	*f*	24	53	15	13	105
		%	22.8	50.5	14.3	12.4	100.0
Ukupno		*f*	41	88	26	20	175
		%	23.4	50.3	14.9	11.4	100.0

χ^2=0.035 , *df*=3, *p*=0.959

Po shvatanju studenata i studentkinja, porodica i lokalna sredina najviše utiču na organizaciju i realizaciju različitih oblika slobodnog vremena. Oni su bili saglasni i da nakon porodice i lokalne sredine, na organizaciju i realizaciju različitih oblika slobodnog vremena najviše utiču vaspitno-obrazovne ustanove, zatim dečije, omladinske i druge društvene organizacije i na poslednjem mestu sredstva masovne komunikacije kao što su štampa, radio, televizija i film.

Stavovi studenata i studentkinja u odnosu na najorganizovanije faktore u omogućavanju provođenja različitih oblika slobodnog vremena nisu uslovili statistički značajnu razliku p=0.959 (Tabela 5).

Tabela 6. Karakter sportsko-rekreativnih aktivnosti

			Ukoliko preovladavaju sportsko-rekreativne aktivnosti, da li su one?		Ukupno
			Rekreativnog karaktera	Profesionalnog karaktera	
Pol	Muški	*f*	42	28	70
		%	60.0	40.0	100.0
	Ženski	*f*	101	4	105
		%	96.2	3.8	100.0
Ukupno		*f*	143	32	175
		%	81.7	18.3	100.0

χ^2=36.815, df=1, p=0.000

Podaci u Tabeli 6. upućuju da su kod 96.2% studentkinja sportsko-rekreativne aktivnosti rekreativnog karaktera, a kod studenata je taj procenat niži i iznosi 60.0%. Samo se 3.8% studentkinja profesionalno bavi sportom, dok je kod studenata drugačija situacija i profesionalno sportom se bavi 40.0% studenata. Dobijeni rezultati ukazuju da između studenata i studentkinja postoji značajna razlika u odnosu na karakter sportsko-rekreativnih aktivnosti sa nivoom statističke značajnosti od p=0.000.

Najučestalija sportsko-rekreativna aktivnost kod studenata je hokej na travi, zatim sledi trčanje, košarka, fudbal, odbojka i šetnja i ono što iznenađuje je da najmanji procenat vežba u teretani. Kod studentkinja slika je sasvim drugačija i šetnja je najučestalija, na drugom mestu je vežbanje u teretani, sledi trčanje, hokej na travi, odbojka, košarka i najmanji procenat se bavi fudbalom u slobodnom vremenu. Raspršenost rezultata je uslovila statističku značajnu razliku između studenata i studentkinja u odnosu na najučestalije sportsko-rekreativne aktivnost sa nivoom statističke značajnosti od p=0.000 (Tabela 7).

Tabela 7. Najučestalija sportsko-rekreativna aktivnost

			Koju sportsko-rekreativnu aktivnost najčešće upražnjavate u slobodnom vremenu?							
			Košarka	Trčanje	Odbojka	Šetnja	Fudbal	Teretana	Hokej na travi	Ukupno
Pol	Muški	*f*	12	15	5	5	6	4	23	70
		%	17.1	21.4	7.1	7.1	8.6	5.7	33.0	100.0
	Ženski	*f*	3	10	4	65	2	15	6	105
		%	2.9	9.5	3.8	61.9	1.9	14.3	5.7	100.0
Ukupno		*f*	15	25	9	70	8	19	29	17
		%	8.5	14.3	5.1	40.0	4.6	10.9	16.6	100.0

χ^2=71.160, df=6, p=0.000

Uvidom u Tabelu 8. možemo konstatovati da samo 2.9% studenata i 38.1% studentkinja uopšte ne vežba. Nedeljno jednom do dva puta vežba 5.7% studenata, a 36.2% studentkinja. Tri do četiri puta nedeljno vežba 40.0% studenata, a 21.0% studentkinja. Pet do šest puta nedeljno vežba 25.7%, studenata, a 3.8% studentkinja. Svakodnevno vežba 25.7% studenata i 10.9% studentkinja. Razlike između studenata i studentkinja su i više nego izražene. Najveći procenat studenata vežba

od tri do četiri puta nedeljno, dok je kod studentkinja situacija sasvim drugačija, pošto najveći broj ne vežba ili vežba jednom do dva puta nedeljno što je i uslovilo statističku značajnu razliku između studenata i studentkinja u odnosu na broj vežbanja u toku nedelje sa nivoom statističke značajnosti od p=0.000.

Tabela 8. Broj nedeljnih vežbanja

			Koliko puta nedeljno vežbate?					
			Ne vežbam	1-2 puta nedeljno	3-4 puta nedeljno	5-6 puta nedeljno	Vežbam svakog dana	Ukupno
Pol	Muški	*f*	2	4	28	18	18	70
		%	2.9	5.7	40.0	25.7	25.7	100.0
	Ženski	*f*	40	38	22	4	1	105
		%	38.1	36.2	21.0	3,8	10.9	100.0
Ukupno		*f*	42	42	50	22	19	175
		%	24.0	24.0	28.6	12.5	10.9	100.0

χ^2=83.067, df=4, p=0.000

Diskusija

Najbitnije funkcije slobodnog vremena kod studenata su aktivnosti namenjene razvitku ličnosti, a kod studentkinja aktivnosti namenjene razonodi i zabavi.

Uzajamna povezanost čoveka sa drugim ljudima je najbitniji tip slobodnog vremena u odnosu na kreativne vrednosti kod studenata i studentkinja, dok su u istraživanju Marković & Milanović (2015) studenti posebno isticali značaj slobodnog vremena za igru, a studentkinje za uzajamnu povezanost čoveka sa drugim ljudima.

U Srbiji Mrđa (2011) konstatuje da 83.0% studenata ne odlazi u muzeje, a oko 70.0% njih veoma retko posećuje galerije, kulturno-istorijske spomenike, arheološka nalazišta, pozorišne predstave, književne večeri, bioskop. Odsustvo kulturne navike i nezainteresovanost za posećivanje muzeja, takođe, konstatuje Tešin i sar. (2019), ali ukazuju da uz određena ulaganja i napor, muzeji mogu da postanu mesta za socijalizaciju mladih. Za najveći broj studenata slobodno vreme je u funkciji samovrednovanja i samoidentifikacije, dok je za najveći broj studentkinja slobodno vreme, vreme oslobođeno od organizovanog rada.

U odnosu na stil življenja sportsko-rekreativne aktivnosti preovlađuju u odnosu na kulturno-estetske i obrazovne. Indentifikovanje faktora koji utiču na odrasle da se opredele za fizičku aktivnost su mnogobrojni i mogu biti u vezi sa vrednosnim stavovima, socijalnim okruženjem, strukturalnim i kulturnim barijerama (Brett et al., 2002). Prema istraživanju Centers for Disease Control and Prevention (1997) studenti i studentkinje imaju drugačija interesovanja za određene aktivnosti, različitih su uverenja, percepcija, imaju drugačije motive i barijere u vezi sa fizičkom aktivnošću. Studenti su više zainteresovani za takmičenja, dok devojke svoje fizičko angažovanje prevashodno vide u funkciji regulisanja telesne mase.

Po nivou organizovanosti, porodica i lokalna sredina, po shvatanju studenata i studentkinja, najviše utiču na organizaciju i realizaciju različitih oblika slobodnog vremena. Sportsko-rekreativne aktivnosti su amaterskog karaktera, dok je u znatno većem procentu zastupljenost aktivnih sportista kod studenata. Veoma mali procenat profesionalnih sportista među studentkinjama

Fakulteta pedagoških nauka je konstatovan u istraživanju Marković & Ignjatović (2009) i Marković & Milanović (2015).

Studentkinje ne učestvuju u visokorizičnim sportovima i više su zainteresovane za individualne fizičke aktivnosti, kao što su šetnja, aerobik ili ples. Ono što privlači pažnju je takav izbor aktivnosti koji ne povlači za sobom materijalne troškove studenata. Hodanje i trčanje u prirodi, kao osnovni prirodni oblici kretanja mogu se upražnjavati individualno, u paru ili manjim grupama. Ne zahtevaju posebne materijalno-prostorne uslove, organizaciju, termine i dr. Mogu da se upražnjavaju bilo kada i bilo gde na svežem vazduhu.

Najveći procenat studenata vežba od tri do četiri puta nedeljno, dok je kod studentkinja situacija sasvim drugačija, pošto najveći broj ne vežba ili vežba jednom do dva puta nedeljno. Obaveze na Fakultetu sa prepodnevnim i popodnevnim predavanjima, vežbama, konsultacijama i drugim obavezama ne dozvoljavaju više slobodnog vremena za upražnjavanje omiljene sportsko-rekreativne aktivnosti. Istraživanja ukazuju da uzrast od 15 do 19 godina više vežba i to posebno dečaci u želji da u tom periodu fizički što lepše izgledaju. Jedan od osnovnih razloga loših životnih navika u većini zemalja prepoznat je u lošem kvalitetu školskog fizičkog vaspitanja. Podaci su ukazali da se od 1990. godine vrši marginalizacija fizičkog vaspitanja i učenici su podložni istupanju od fizičke aktivnosti, sa posledicom da je ne upražnjavaju ni kasnije, jer nisu usvojene ni veštine ni navike neophodne za redovno bavljenje fizičkom aktivnošću tokom životnog veka (Hardman, 2008).

Zaključak

Rezultati istraživanja na Fakultetu pedagoških nauka u Jagodini i NSA „Vassil Levski“ u Sofiji odslikavaju prosečnu studentsku populaciju u Srbiji, a i u zemljama Evrope. Između studenata i studentkinja postoji značajna razlika u pet od osam varijabli, statistički značajna razlika nije konstatovana kada je u pitanju: najbitniji tip slobodnog vremena u odnosu na kreativne vrednosti, vrsta aktivnosti koja preovladava u slobodnom vremenu u odnosu na stil življenja i najorganizovaniji faktori koji omogućavaju različite oblike slobodnog vremena.

Opšta konstatacija je da fizičko vaspitanje koje je 1996 godine ukinuto na većini Univerziteta u Srbiji treba u što skorije vreme vratiti studentima u cilju izgrađivanja, unapređenja i očuvanja njihovih bio-psiho-socijalnih karakteristika.

Napomena: *Realizaciju ovog istraživanja finansiralo je Ministarstvo nauke, tehnološkog razvoja i inovacija Republike Srbije (br. Ugovora 451-03-47/2023-01/ 200140).*

Literatura

Anić, P., Roguljić, D., & Švegar, D. (2017). What do students do in their free time and why?. *Polish Psychological Bulletin, 48*(4) 504–515

Bashir, R., Bano, H., & Riaz Sajan, H. M. (2014). Leisure Time Activities of Students with Visual Impairment. *Academic Research International*, *5*(5), 186–196.

Brajša Žganec, A., & Kaliterna Lipovčan, Lj. (2010). Kvaliteta življenja, životno zadovoljstvo i sreća osoba koje profesionalno pomažu drugima. *Društvena istraživanja*, *15*(4-5), 84–85.

Veal, A. J. (2016). Leisure. income inequality and the Veblen effect: Cross-national analysis of leisure time and sport and cultural activity. *Leisure Studies, 35*(2), 215–240.

Vrkić Dimić, J. (2015). Stvarne i željne aktivnosti studenata u slobodnom vremenu. *Pedagogijska istraživanja, 2*(2), 313–326.
Eratay, E., & Aydogan, Y. (2015). Study Of The Relationship Between Leisure Time Activities And Assertiveness Levels Of Students Of Abant Izzet Baysal University. *Procedia - Social and Behavioral Sciences*, *191*(2015), 2213–2218.
Karaderi, B. (2021). Leisure Time Spending Tendencies of University Students: The Case of TRNC. *Asian Journal of University Education*, *17*(3), 41–50.
Lorenzo Sánchez, O., Sánchez Gómez, M. C., Martín Cilleros, M. V., Martín Sevillano, R., Cabanillas García, J. L., & Verdugo Castro S. (2022). Perception about leisure and free time and how it has affected university students. *Investigação Qualitativa em Educação: Avanços e Desafios, 12*(2022), 1–12.
Markovic, Z., & Ignjatovic, A. (2009). Assessment of physical ability as a criterion of selection of students of pedagogy and teacher training faculty. U S. Divljan (ed.), International Conference ''Promoting Teachers Education – from intake system to teaching practice'' 19-20.05.2009, 1(8/1), (r.r. 323–336). Jagodina: Facultu of Education in Jagodina.
Markovic, Z, & Milanovic, S. (2015). Free Time of the Students of Pedagogical Sciences at the University of Kragujevac. U. V. Vujevic (ed*), Compilation of Works from the Scientific Meeting "Science and Freedom*", 6-8. June 2014, (page 764–782). Pale: University at Istocno Sarajevo, Faculty of Philosophy, Pale.
Previšić, V. (2000). Slobodno vrijeme između pedagogijske teorije i odgojne prakse. *Napredak*, *141*(4), 403–410.
Tešin, A., Kovačić, S., & Božović, T. (2019). *Preferencije mladih u Srbiji prema različitim tipovima interpretacije u muzejima*. Pale: Ekonomski fakultet Univerzitet u Istočnom Sarajevu.
Hardman, K. (2008), Physical education in schools: a global perspective. *Kinesiology, 40*(1), 5-28.
Centers for Disease Control and Prevention. Guidelines for school and community programs to promote lifelong physical activity among young people 1997: Morbidity and Mortality Weekly Report, 46 (RR6), 1–36.

A THREE-YEAR FOLLOW UP STUDY ON THE BASIC MORPHOLOGICAL CHARACTERISTICS AND FITNESS LEVEL AT THE UNIVERSITY OF CRIMINAL INVESTIGATION AND POLICE STUDIES STUDENTS

Radivoje Janković[1]
[1] University of Criminal Investigation and Police Studies, Belgrade, Serbia

Introduction

In various critical situations, police officers (POs) have to react urgently and directly, inasmuch as citizens' safety and property needs to be protected. One of the POs work features is the possibility to arrest criminals, physically separate people having an altercation, or control masses at public gatherings and sports events (Strating et al., 2010; Vučković et al., 2011). Likewise, in the occurrence of different natural disasters, traffic accidents, or any other incidents where human life or health is threatened, POs are obliged to assist citizens (Bonkiewicz & Ruback, 2012). In these extremely challenging situations, one of the predictors of work efficiency is the level of physical abilities (Lockie et al., 2018). In order for the adequate level of professional abilities to be obtained, physical abilities are assessed throughout the selection process, whereas the curriculum for their further development and evaluation is realized during cadets' education, as well as throughout POs' work career (Lockie et al., 2020; Janković & Dopsaj, 2022).

The singularity of police work conditions a particular manner of education in the areas considered relevant for work efficiency in policing. The University of Criminal Investigation and Police Studies (UCIPS) is specialized for educating police personnel in Serbia. By means of the accredited teaching curricula, students acquire theoretical and practical knowledge, through various general, criminalistic, legal and police teaching contents (Milojević et al., 2014). The development and evaluation of physical abilities is conducted within a teaching discipline called Specialized Physical Education (SPE). The goal of SPE is to positively impact the development of general fitness abilities (GPA) and specific physical abilities (SPA), whereby aiming to contribute to faster situational response, a more immediate solution finding, and a more efficient performance of police tasks. In other words, one of the crucial SPE objectives is gaining professional competences which enable efficient use of force (Vučković et al., 2011; Amanović et al., 2015). Furthermore, SPE should influence an overall healthier lifestyle, and hence have a long-term positive impact on suitable morphological characteristics, health improvement and maintenance, acquisition of positive attitudes and habits with a continuous physical exercise throughout life, while keeping focus on the phychological health as well (Blagojević et al., 2019).

The education within SPE at UCIPS is conducted via three related segments: basic training, advanced training and situational training (Amanović et al., 2015). In order to keep track of the effects of SPE program, after each segment of education, standardized batteries of tests are used to assess the level of GPA. What is more, students are obligated to meet the predefined minimal norms of each separate test within the battery, so as to move on to the next level of SPE (Janković & Dopsaj, 2022). The selection process eliminates the candidates below the 33rd percentile in comparison to the national population. SPE curriculum is designed in such a manner as to help students improve their physical abilities to the level above the 66th percentile, compared to the

national population's average (Dopsaj et al., 2007). Apart from GPA, the morphological characteristics also have an eliminatory property, and are viewed as the relation between body height and body mass. The requirement for male students is the minimum body height of 170 cm. Body mass must be within the range of body height – 100 ± 10 kg (Janković et al., 2021).

Throughout the studies, the development of abilities and skills required for a successful conduct of police work occurs. In order to determine the effectiveness of the program itself, many law enforcement agencies in the world organize final assessments of physical abilities (Lockie et al., 2021). At UCIPS, SPE teaching program's effectiveness is ascertained after each level of education, with gradual elevation of the required norms from the basic to the situational level (Janković & Dimitrijević, 2012). Since the founding of UCIPS, the SPE programs have been altered several times. Although these changes have pertained to the decrease of the number of lessons as well, the goal and objectives of the subject have remained the same. However, despite the aim and objectives not having changed, the generations with a significantly lower number of lessons have shown weaker results in certain GPA (Dimitrijević, et al., 2014). This paper aims at determining the alterations in the basic morphological characteristics and general physical abilities of UCIPS students from the entrance exam until the end of the third year of undergraduate academic studies.

Methods

For the purpose of determining the changes in the basic morphological characteristics and GPA, two tests were conducted. The first, initial testing took place during the entrance exam. The second, final testing was performed after three years spent at UCIPS; i.e., at the end of the situational level of SPE that students attend in the third year of undergraduate academic studies.

Subjects

The research analyzed the results of 134 respondents who, at the time of the entrance exam, were on average 19.6±0.7 years old. All of the respondents successfully passed the medical examination and psychological testing, thereby showing that they were of suitable health condition, as well as that they possess adequate cognitive abilities defined as a prerequisite for UCIPS entrance exam. The results of their entrance exam enabled them to enrol the undergraduate academic studies of criminalistics.

Basic morphological characteristics

In order to determine the basic morphological characteristics at the entrance exam, as well as at the end of the third year of studies, the following aspects were observed: body height (BH), body weight (BW), and body mass index (BMI), all measured by means of the standard procedures (Dopsaj & Vuković, 2015).

Assessment of general fitness abilities

This research used six out of seven tests for the assessment of the level of basic physical abilities (BPA) at UCIPS entrance exam. All the tests were conducted according to the standard procedures (Koropanovski et al., 2020). For determination of the muscle force, maximal isometric force of the back extensors ($F_{max}BE$) test was used. Lower-body power in the horizontal plane was assessed indirectly by a standing long jump test (SLJ), whereas Abalakow vertical jump test (ABL)

was used to evaluate lower-body power in the vertical plane. The muscular endurance of abdominal and hip flexors was assessed using sit-up (SU) test, performed within 30 seconds. The repetitive power of the arm extensors was ascertained with the number of push-ups performed within 10 seconds (PU). The last test was the 12-minute Cooper running test (RUN), conducted to evaluate general aerobic endurance. This analysis did not include the test for assessing motor educability (contraction and stretching test), as the students had been familiar with it from the entrance exam, as well as since its objective is to estimate the participants' ability to comprehend and learn complex motor tasks (Kolarević et al., 2014). With the exception of RUN, where the respondents only had a single attempt, each test was performed twice, and the better result was taken for the analysis. All of the tests were conducted at UCIPS, in the Laboratory for assessing the basic physical abilities.

Statistics

All data were analyzed using the descriptive statistics to calculate the basic parameters of central tendency: the arithmetic mean (mean) and standard deviation (SD). Regularity of results distribution was defined by skewness (skew.), and kurtosis (kurt.). The existence of a general difference of variability between two tests was determined by paired sample t-test. Statistical significance was defined at 95 percent probability, i.e. at the level of 0.05 (Hair et al., 1998).

Results

Table 1 shows the results of descriptive statistics referring to the basic morphological characteristics and general physical abilities achieved at the initial testing (Entrance exam) and final testing (Third year). The differences in results between the initial and final measurements, determined by means of *paired sample* t-test, were shown in Table 2.

Table 1. Results of descriptive statistics of initial and final testing

Variable	Entrance exam			Third year		
	Mean ± SD	**Min.**	**Max.**	**Mean ± SD**	**Min.**	**Max.**
BH (cm)	182.5 ± 6.0	170	197	182.5 ± 6.1	168.9	197.3
BM (kg)	79.0 ± 7.2	63	97	82.2 ± 8.8	62.7	109.6
BMI (kg/m2)	23.7 ± 1.6	20.5	27.1	24.6 ± 2.1	20.5	30.0
F_{max}BE (DaN)	153.1 ± 21.3	111.5	222.4	156.9 ± 15.6	111.7	216.3
SLJ (cm)	231.0 ± 18.2	175	280	233.0 ± 15.6	190	277
ABL (cm)	44.1 ± 5.7	30.2	60.0	43.7 ± 5.8	32.9	63.5
SU (no)	26.6 ± 2.9	19	35	26.3 ± 2.3	19	33
PU (no)	12.0 ± 1.6	6	15	11.9 ±1.1	9	14
RUN (m)	2743.9 ±225.6	2170	3225	2685.2 ± 169.9	2280	3205

Legend: BH - body height; BW - body weight; BMI - body mass index; F_{max}BE - maximal isometric force of the back; extensors; SLJ - lower-body power in the horizontal plane; ABL - lower-body power in the vertical plane; SU - muscular endurance of abdominal and hip flexors; PU - repetitive power of the arm extensors; RUN - general aerobic endurance

Table 2. Results of paired sample t-test

Variable	Absolute	relatively (%)	95% Confidence Interval of the Difference			
			Lower	Upper	t	p
BH_e - BH_3	-0.01	/	-0.1409	0.1260	-0.111	0.912
BM_e - BM_3	-3.15	-3.9	-3.9565	-2.3629	-7.844	**0.000**
BMI_e - BMI_3	-0.94	-3.7	-1.1823	-0.7000	-7.719	**0.000**
$F_{max}BE_e$ - $F_{max}BE_3$	-3.86	-2.4	-6.7766	-0.9503	-2.623	**0.010**
SLJ_e - SLJ_3	-2.00	-0.8	-4.462	0.462	-1.607	0.110
ABL_e - ABL_3	0.42	0.9	-0.3798	1.2201	1.039	0.301
SU_e - SU_3	0.32	1.1	-0.128	0.770	1.415	0.160
PU_e - PU_3	0.03	0.8	-0.229	0.289	0.228	0.820
RUN_e - RUN_3	58.77	2.2	27.598	89.940	3.729	**0.000**

Legend: subscript e – entrance examination; subscript 3 – third year ; BH - body height; BW - body weight; BMI - body mass index; $F_{max}BE$ - maximal isometric force of the back; extensors; SLJ - lower-body power in the horizontal plane; ABL - lower-body power in the vertical plane; SU - muscular endurance of abdominal and hip flexors; PU - repetitive power of the arm extensors; RUN - general aerobic endurance

Discussion

The results of this research show that, throughout the course of the three-year studies, a statistically significant increase in BM by 3.9% ($t = 7.844$, $p < 0.05$) and BMI by 3.7% ($t = 7.719$, $p < 0.05$) took place. Considering that the tested population was biologically mature, with the process of growth and development fully completed (the average age at the initial testing was 19.6±0.7), an alteration in BH had not been expected. As far as the observed motor abilities are concerned, an increase in maximal isometric force of the back extensors was noted, by 2.4% ($t = 2.623$, $p < 0.01$), as well as a decrease in aerobic endurance by 2.2% ($t = 3.729$, $p < 0.05$). As for other observed variables, no statistically significant alterations occurred throughout the course of the three-year studies (Table 2)

One of the SPE objectives pertains to the positive effect on the morphological characteristics of UCIPS students, as well as to the development of physical abilities (Blagojević et al., 2019). Accordingly, based on the obtained results, the realized curriculum appears not to have achieved the expected goals. Above all else, the reason for it might be sought in the decrease of the number of SPE lessons by approximately 80% compared to the first generation. The lower number of lessons that include solely the martial arts training, without any additional content (such as aerobic running training, swimming, skiing training and practical field training) could be the cause of the lower level of GPA development (Dimitrijević et al., 2014). Moreover, discontinuity in training may be yet another cause, considering that SPE is studied in the second, third, and fifth semester (Janković & Dimitrujević, 2012). During an eight-month break from organized physical training, from the entrance exam, until the beginning of SPE lessons in the second semester, the following variables altered statistically significantly: BMI increased by 2.53%, the results in Abalakov test decreased by 4.27%, whereas standing long jump test results also decreased by 2.83% (Mitrović et al., 2016). Not only could the determined increase in BM lead to better $F_{max}BE$ results (Marković & Jarić, 2004), but it could also negatively impact the results of RUN, especially if it occurred at the expense of the increase of mass component of body composition (Jackson and Wilson, 2013).

Apart from the number of SPE leassons, yet another significant factor potentially affecting morphological characteristics and physical abilities of students are life habits, which, in modern lifestyle, are characterized by hypokinesis and increased intake of high calorie foods (Djordjevic-Nikic, M., Dopsaj, 2013). In the period between the age of 18 and 20 (when academic life starts), life environment and social surroundings change, followed by a decrease in physical activities (Irwin, 2004). This pertains to UCIPS students as well, since moving forward from high school to university educational system may include changing places of residence, moving away from one's family, more comprehensive curriculum and more responsibilites, which could result in potentially negative alterations of life habits (Dimitrijević, 2016). Presumably, the determined changes are partly caused by students' life habits, mostly considering diet and physical activities, particularly in the periods when no SPE lessons took place.

The results of this research could be explained not only by the decreased number of SPE lessons and life habits of UCIPS students, but also by the predefined norms within the battery of tests used to assess GPA. Namely, in comparison with the average values, most students met the required (minimal) SPE norms (Janković & Dimitrijević, 2012). Similarly, the research conducted among Military Academy cadets (Marić et al., 2013) showed that physical education program was satisfactory compared to the set standards, while simultaneously being insufficient for achieving maximum results. The reasons for it, apart from genetic predisposition, could be lower training engagement in the final two years of studying, and / or lower motivation of the cadets. As far as the results of UCIPS students are concerned, regardless of the fact that throughout the course of three-year studies no improvement of the majority of observed physical abilities occurred (whereby one of SPE goals was not achieved), students largely managed to meet the required standards (Blagojević et al., 2019). In other words, most students' goal could be assumed to have been meeting the minimal norms that would enable them to complete their pre-exam requirements, and not achieving results that enable them to have high grades in SPE.

Conclusion

This research ascertained that BM and BMI in UCIPS students statistically significantly increased throughout the course of three-year studies. When observing GPA, the improvement of isometric force of back extensors was noted, accompanied by a decrease in aerobic endurance. Leg muscle speed strength, as well as the repetitive strength of arm extensors and trunk flexors remained at a similar level as in the entrance exam. The primary reasons behind the achieved results could be the decrease in the number of SPE lessons and the discontinuity in their realization, together with possible changes in students' life habits. Likewise, taking into account that the average values of the results were in close proximity to, or above the predefined norms, one could presume that the results were also affected by the students' lowered motivation to achieve higher grades.

References

Amanović, Dj., Mašić, Z., Kostovski, Ž., Ljubisavljević, M. (2015). Special physical education in police: model of education and training *Acta Kinesiologica,* 9 (2), 51-57.

Blagojević, M., Koropanovski, N., Vičković, G., & Dopsaj, M. (2019). *Specijalno fizičko obrazovanje 1 – osnovni nivo*. Kriminalističko-Policijski Univerzitet, Beograd.

Bonkiewicz, L., Ruback, R. B. (2012). The Role of the Police in Evacuations: Responding to the Social Impact of a Disaster. *Police Quarterly*, 15(2), 137–156.

Dimitrijević, R. (2016). *Modelne karakteristike motoričkih sposobnosti, morfoloških karakteristika i životnih navika studentkinja kriminalističko-policijske akademije* Doktorska disertacija, Fakultet sporta i fizičkog vaspitanja Univerziteta u Beogradu.

Dimitrijević, R., Koropanovski, N., Dopsaj, M., Vucković, G., Janković, R. (2014). The influence of different physical education programs on police students' physical abilities. *Policing: An International Journal of Police Strategies & Management*. 37(4), 794-808.

Djordjevic-Nikic, M., Dopsaj, M. (2013). Characteristics of eating habits and physical activity in relation to body mass index among adolescents. *Journal of the American College of Nutrition*, 32(4), 222-231.

Dopsaj, M., Blagojević, M., & Vučković, G. (2007). Normativno-selekcioni kriterijum za procenu bazično motoričkog statusa kandidata za prijem na studije Kriminalističko-policijske akademije u Beogradu. *Bezbednost*, *49(4)*, 166-183.

Dopsaj, M., Vučković, G., Blagojević, M. (2007). Normativno-selekcioni kriterijum za procenu bazično motoričkog statusa kandidata za prijem na studije Kriminalističko-policijske akademije u Beogradu. *Bezbednost*, Beograd, 49(4), 166–183.

Dopsaj, M., Vuković, M. (2015). Prevalenca indeksa telesne mase (BMI) kod pripadnika MUP-a Republike Srbije - pilot istraživanje. *Bezbednost*, 57(3), 28-48.

Hair J., Anderson R., Tatham R., Black W. (1998). *Multivariate Data Analysis* (Fifth Ed.). USA : Prentice – Hall, Inc.

Irwin, J.D. (2004). Prevalence of university students' sufficient physical activity: a systematic review. *Perceptual and Motor Skills*, 98(3), 927-943.

Jackson, C. A., Wilson, D. (2013). The Gender-Neutral Timed Obstacle Course: a valid test of police fitness?. *Occupational Medicine*, *63*(7), 479-484.

Janković, R., Dimitrijević, R. (2012). Stanje i mogućnosti unapređenja načina procene motoričkih sposobnosti u sistemu Ministarstva unutrašnjih poslova Republike Srbije. *Kultura polisa*, 9(1), 419-435.

Janković, R., & Dopsaj, M. (2022). Sprint running, agility and anaerobic endurance: Standards for the students at the University of Criminal Investigation and Police Studies. *NBP. Nauka, bezbednost, policija,* 27(2), 45-58.

Janković, R., Koropanovski, N., Kukić, F. (2021). Changes in the morphological characteristics throughout the three-year studying at the University of criminal investigation and police studies. *XX international scientific conference contemporary challenges in sport, physical exercising & active lifestyle. Edt. Stojiljković,S., Mandić ,R., Majstorović, N.* (pp. 235-241). University of Belgrade - Faculty of Sport and Physical Education.

Kolarević, D., Dimitrijević, R., Vučković, G., Koropanovski, N., Dopsaj, M. (2014). Relations between psychological characteristics and physical abilities in a sample of female police candidates. *Open Sports Sciences Journal*, 7(1), 22-28.

Koropanovski, N., Kukić, F., Janković, R., Dimitrijević, R., Dawes, J., Lockie, R., Dopsaj, M. (2020). Impact of physical fitness on recruitment and its association to study outcomes of police students. *South African Journal for Research in Sport, Physical Education and Recreation,* 42(1), 23 – 34.

Lockie, R.G., Dawes, J.J., Orr, R.M., & Dulla, J.M. (2020). Recruit fitness standards from a large law enforcement agency: between-class comparisons, percentile rankings, and implications for physical training. *The Journal of Strength and Conditioning Research, 34(4)*, 1-7.

Lockie, R.G., Moreno, M.R., Rodas, K.A., Dulla, J.M., Orr, R.M., Dawes, J.J. (2021).With great power comes great ability: Extendingresearch on fitness characteristics that influence Work Sample Test Battery performance in law enforcement recruits. *Work*, 68(4), 1069–1080.

Marić, L., Krsmanović, B., Mraović, T., Gogić, A., Sente, J., & Smajić, M. (2013). The effectiveness of physical education of the Military Academy cadets during a 4-year study. *Vojnosanitetski pregled*, *70*(1), 16-20.

Marković, G., Jarić, S. (2004). Movement performance and body size: the relationship for different groups of tests. *European Journal of Applied Physiology,* 92, 139–149.

Milojević, S., Janković, B., Cvetković, V. (2015). Prediction model of effective studies at the academy of criminalistic and police studies. *NBP – Journal of Criminalistics and Law*, 20(1), 135-149.

Mitrović, B., Janković, R., Dopsaj, M., Vučković, G., Milojević, S., Pantelić, S., Nurkić, M. (2016). How an eight-month period without specialized physical education classes affects the morphological characteristics and motor abilities of students of the Academy of criminalistic and police studies. *Facta Universitatis – series: Physical Education and Sport,* 14(2), 167–178.

Strating, M., Bakker, R., Dijkstra, G., Lemmink, K., Groothoff, J.W. (2010). A job-related fitness test for the Dutch police. *Occupational Medicine*, 60(4), 255–260.

Vučković, G., Subošić, D., Kekić, D. (2011). Physical abilities of police officers as prerequisite for suppressing violence at sporting events in the Republic of Serbia. *Facta universitatis – series: Physical Education and Sport*, 9(4), 385–397.

PROMENE OSNOVNIH MORFOLOŠKIH KARATERISTIKA I MOTORIČKIH SPOSOBNOSTI STUDENATA KRIMINALISTIČKO-POLICIJSKOG UNIVERZITETA TOKOM TRI GODINE STUDIJA

Radivoje Janković[1]
[1] Kriminalističko policijski univerzitet, Beograd, Srbija

Uvod

U različitim kritičnim situacijama policijski službenici (PS) moraju hitno, neposredno i konkretno da reaguju kako bi, u slučaju da je neophodno, zaštitili bezbednost građana i njihove imovine. Jedna od specifičnosti posla PS jeste mogućnost, da kada čuvaju bezbednost građana i sprečavaju nasilje, mogu da uhapse kriminalce, fizički razdvoje ljude koje se sukobljavaju ili kontrolišu mase na javnim okupljanjima i sportskim manifestacijama (Strating et al., 2010; Vučković et al., 2011). Takođe, kada se dese različite prirodne katastrofe, saobraćajne nesreće ili bilo koje druge situacije u kojima može da bude ugroženo zdravlje ili ljudski život, PS su dužni da pruže pomoć građanima (Bonkiewicz & Ruback, 2012). U ovim izuzetno izazovnim situacijama, jedan od prediktora radne efikasnosti jeste nivo razvijenosti fizičkih sposobnosti (Lockie et al., 2018). Kako bi posedovali adekvatan profesionalni nivo, procena fizičkih sposobnosti vrši se tokom selekcionog procesa, dok se programi za njihov razvoj i evaluacija realizuju za vreme edukacije kadeta kao i tokom radne karijere PS (Lockie et al., 2020; Janković & Dopsaj, 2022).

Specifičnosti policijskih poslova uslovljavaju poseban način edukacije u oblastima za koje se smatra da su bitne za radnu efikasnost. Kriminalističko policijski univerzitet (KPU) je specijalizovana visokoškolska ustanova za školovanje policijskog kadra u Republici Srbiji. Realizacijom akreditovanih nastavnih planova, studenti stiču teorijska i praktična znanja kroz raznovrsne opšteobrazovne, kriminalističke, pravne i policijske nastavne sadržaje (Milojević et al., 2014). Razvoj i evaluacija fizičkih sposobnosti odvija se u okviru nastavno naučne discipline koja se naziva specijalno fizičko obrazovanje (SFO). Cilj programske aktivnosti SFO je pozitivan uticaj na razvoj bazičnih motoričkih sposobnosti (BMS) i specifičnih fizičkih sposobnosti (SFS), čime bi trebalo da se doprinese adekvatnim i brzim reakcijama, odnosno efikasnom rešavanju problemskih situacija. Drugim rečima, jedan od dominantnih zadataka SFO jeste sticanje profesionalnih kompetencija koje omogućavaju efikasnu upotrebu sredstava prinude (Vučković et al., 2011; Amanović et al., 2015). Osim toga, SFO treba da utiče na usvajanje i praktikovanje zdravog načina života i time permanentno omogući održanje odgovarajućih morfoloških karakteristika, poboljšanje i održavanje zdravstvenog statusa, razvoj pozitivnih stavova i navika za kontinuiranim fizičkim vežbanjem tokom života i optimizaciju psihološkog statusa (Blagojević et al., 2019).

Edukacija u okviru SFO na KPU se sprovodi kroz povezana tri segmenta: osnovni, usmereni i situacioni nivo (Amanović et al., 2015). U cilju praćenja efekata programa SFO, nakon svakog segmenta edukacije, standardizovanim baterijama testova procenjuje se nivo BMS. Osim toga, studenti su u obavezi da ispune definisane minimalne norme svakog pojedinačnog testa u okviru baterije, kako bi prešli na sledeći nivo SFO (Janković & Dopsaj, 2022). Selekcionim procesom

eliminišu se kandidati koji su ispod 33 percentila u odnosu na nacionalnu populaciju. Nastava SFO osmišljena je tako da studenti na kraju školovanja unaprede fizičke sposobnosti na nivo iznad 66 percentila u odnosu na prosek nacionalne populacije (Dopsaj et al., 2007). Osim BMS i morfološke karakteristike imaju eliminacioni karakter i posmatraju se kao odnos telesne visine i telesne mase. Uslov za kandidate muškog pola je najmanja moguća telesna visina od 170 cm. Opseg telesne mase mora biti u rasponu (telesna visina – 100) ± 10 kg (Janković et al., 2021).

Tokom studiranja razvijaju se sposobnosti i veštine koje su potrebne za uspešno obavljanje policijskog posla, a kako bi mogao da se utvrdi efekat programa, mnoge agencije za sprovođenje zakona u svetu organizuju završne provere fizičkih veština (Lockie et al., 2021). Na KPU praćenje efekata SFO realizuje se nakon svakog nivoa edukacije uz postepeno podizanje normativa od osnovnog, preko usmerenog do situacionog nivoa (Janković & Dimitrijević, 2012). U periodu od osnivanja KPU više puta su se menjali programi SFO. Iako su se promene odnosile i na smanjenje broja časova, cilj i zadaci predmeta su ostali isti, a utvrđeno je da su generacije koje su imale značajno manji broj časova pokazale i slabije rezultate određenih BMS (Dimitrijević, et al., 2014). Cilj ovog rada je utvrđivanje promena osnovnih morfoloških karakteristika i bazičnih motoričkih sposobnosti studenata KPU tokom tri godine, tj. od prijemnog ispita do kraja treće godine osnovnih akademskih studija.

Metode

Kako bi se utvrdilo postojanje promena osnovnih morfoloških karakteristika i BMS realizovana su dva testiranja. Prvo, inicijalno testiranje sprovedeno je tokom prijemnog ispita. Drugo, finalno testiranja sprovedeno je nakon tri godine provedenih na KPU, odnosno na kraju edukacije u okviru situacionog nivoa SFO koji se izučava na trećoj godini osnovnih akademskih studija.

Uzorak ispitanika

U istraživanju su analizirani rezultati 134 ispitanika koji su u trenutku prijemnog ispita imali u proseku 19.6±0.7 godina. Svi ispitanici su uspešno prošli lekarski pregled i psihološka testiranja, čime je utvrđeno adekvatno zdravstveno stanje i nivo kognitivnih sposobnosti definisanih kao preduslov da bi se pristupilo prijemnom ispitu na KPU. Rezultat koji su ostvarili na prijemnom ispitu omogućio im je da se upišu i studiraju po programu osnovnih akademskih studija kriminalistike.

Procena morfoloških karakteristika

Za utvrđivanje osnovnih morfoloških karakteristika na prijemnom ispitu i na kraju treće godine studija posmatrane su: telesna visina (TV), telesna masa (TM) i indeks mase tela (BMI) koji su izmereni standardnim procedurama (Dopsaj & Vuković, 2015).

Procena bazičnih motoričkih sposbnosti

U ovom istraživanju korišćeno je šest od sedam testova za procenu nivoa bazičnih motoričkih sposobnosti koji se koriste na prijemnom ispitu KPU. Svi testovi su izvedeni u skladu sa standardnim procedurama (Koropanovski et al., 2020). Posmatrani su maksimalna sila opružača leđa (FmaxBE), brzinska snaga mišića opružača nogu u horizontalnom smeru (SLJ), brzinska snaga

mišića opružača nogu u vertikalnom smeru (ABL), repetitivna snaga mišića pregibača trupa (SU), repetitivna snaga mišića opružača ruku (PU), aerobne izdržljivosti (RUN). Test za procenu motoričke edukatibilnosti (grčenje i opružanje), koji je sastavni deo prijemnog ispita, već je bio poznat ispitanicima i nije korišćen u ovoj analizi s obzirom na to da je njegov cilj da proceniti sposobnost da se razume i nauči složeni motorički zadatak (Kolarević et al., 2014). U svakom testiranju (inicijalnom i finalnom) ispitanici su izvodili test dva puta, a bolji rezultat je uzet za analizu (osim RUN za koji su ispitanici imali samo jedan pokušaj). Svi testovi su sprovedeni na KPU u laboratoriji za procenu BMS.

Statističke procedure

Svi podaci su predstavljeni osnovnim parametrima deskriptivne statistike: aritmetičkom sredinom (Mean) i standardnom devijacijom (SD). Homogenost skupa određena je simetričnošću distribucije rezultata pomoću skjunisa (Skew) i njenom ispupčenošću koja je određena kurtozisom (Kurt). Razlike svih posmatranih varijabli utvrđene su korišćenjem t-testa za nezavisne uzorke, a statistička značajnost definisana je na 95%, odnosno $p < 0.05$

Rezultati

U Tabeli 1 prikazani su rezultati deskriptivne statistike osnovnih morfoloških karakteristika i bazičnih motoričkih sposobnosti ostvareni na inicijalnom testiranju (Prijemni ispit) i finalnom testiranju (Treća godina). Razlike rezultata između inicijalnog i finalnog merenja koje su utvrđene pomoću t-testa za nezavisne uzorke prikazane su na Tabeli 2.

Tabela 1. Rezultati deskriptivne statistike inicijalnog i finalnog testiranja

Varijable	Prijemni ispit			Treća godina		
	Mean ± SD	Min.	Max.	Mean ± SD	Min.	Max.
TV (cm)	182.5 ± 6.0	170	197	182.5 ± 6.1	168.9	197.3
BM (kg)	79.0 ± 7.2	63	97	82.2 ± 8.8	62.7	109.6
BMI (kg/m2)	23.7 ± 1.6	20.5	27.1	24.6 ± 2.1	20.5	30.0
F_{max}BE (DaN)	153.1 ± 21.3	111.5	222.4	156.9 ± 15.6	111.7	216.3
SLJ (cm)	231.0 ± 18.2	175	280	233.0 ± 15.6	190	277
ABL (cm)	44.1 ± 5.7	30.2	60.0	43.7 ± 5.8	32.9	63.5
SU (no)	26.6 ± 2.9	19	35	26.3 ± 2.3	19	33
PU (no)	12.0 ± 1.6	6	15	11.9 ±1.1	9	14
RUN (m)	2743.9 ±225.6	2170	3225	2685.2 ± 169.9	2280	3205

Legenda: TV – telesna visina; TM – telesna masa; BMI – indeks mase tela; F_{max}BE – maksimalna sila opružača leđa; SLJ - brzinska snaga mišića opružača nogu u horizontalnom smeru; ABL - brzinska snaga mišića opružača nogu u vertikalnom smeru; SU - repetitivna snaga mišića pregibača trupa; PU - repetitivna snaga mišića opružača ruku; RUN - aerobne izdržljivost

Tabela 2. Rezultati t-testa za nezavisne uzorke

Varijable	Apsolutna razlika	Relativna razlika(%)	95% interval poverenja donji	gornji	t	p
TV_e - TV_3	-0.01	/	-0.1409	0.1260	-0.111	0.912
BM_e - BM_3	-3.15	-3.9	-3.9565	-2.3629	-7.844	**0.000**
BMI_e - BMI_3	-0.94	-3.7	-1.1823	-0.7000	-7.719	**0.000**
$F_{max}BE_e$ - $F_{max}BE_3$	-3.86	-2.4	-6.7766	-0.9503	-2.623	**0.010**
SLJ_e - SLJ_3	-2.00	-0.8	-4.462	0.462	-1.607	0.110
ABL_e - ABL_3	0.42	0.9	-0.3798	1.2201	1.039	0.301
SU_e - SU_3	0.32	1.1	-0.128	0.770	1.415	0.160
PU_e - PU_3	0.03	0.8	-0.229	0.289	0.228	0.820
RUN_e - RUN_3	58.77	2.2	27.598	89.940	3.729	**0.000**

Legenda: indeks e – prijemni ispit; indeks 3 – treća godina; TV – telesna visina; TM – telesna masa; BMI – indeks mase tela; $F_{max}BE$ – maksimalna sila opružača leđa; SLJ - brzinska snaga mišića opružača nogu u horizontalnom smeru; ABL - brzinska snaga mišića opružača nogu u vertikalnom smeru; SU - repetitivna snaga mišića pregibača trupa; PU - repetitivna snaga mišića opružača ruku; RUN - aerobne izdržljivost

Diskusija

Rezultati ovog istraživanja ukazuju da tokom tri godine studija dolazi do statistički značajnog povećanja BM 3.9% ($t = 7.844$, $p < 0.05$) i BMI za 3.7% ($t = 7.719$, $p < 0.05$). S obzirom na to da je testirana biološki zrela populacija kod koje je proces rasta završen (prosek godina na inicijalnom merenju 19.6±0.7 godina) bilo je očekivano da se neće uočiti promena TV. Kada su u pitanju posmatrane motoričke sposobnosti, uočeno je povećanje maksimalne izometrijske sile opružača leđa za 2.4% ($t = 2.623$, $p < 0.01$), ali i smanjenje aerobne izdržljivosti za 2.2% ($t = 3.729$, $p < 0.05$). Kod ostalih posmatranih varijabli (SLJ, ABL, SU i PU) tokom tri godine studija nije došlo da statistički značajnih promena (Tabela 2).

Deo ciljeva SFO odnosi na pozitivan uticaj na morfološke karakteristike studenata KPU, kao i na razvoj fizičkih sposobnosti (Blagojević et al., 2019). U skladu s tim, a na osnovu dobijenih rezultata, može se konstatovati da realizovani plan i program nije ostvario projektovane ciljeve. Prvenstveno, razlog za to može se tražiti u smanjenju broja časova SFO za oko 80% u odnosu na prvu generaciju. Utvrđeno je da manji broj časova SPE koji uključuju samo elemente borilačkih veština, bez dodatnih sadržaja (kao što su aerobni treninzi, plivanje, skijanje itd) može biti razlog nižeg nivoa razvijenosti BMS (Dimitrijević et al., 2014). Osim toga, drugi razlog može biti i diskontinuitet vežbanja, s obzirom na to da se SFO izučava u drugom, trećem i petom semestru (Janković & Dimitrujević, 2012). U ranijim istraživanjima je utvrđeno da je tokom osam meseci pauze, u kojoj nakon prijemnog ispita nije bilo organizovanog fizičkog vežbanja do početaka nastave SFO u drugom semestru, došlo do statistički značajnog povećanja BMI za 2.53 % uz statistički značajno smanjenje rezultata Abalakovog teta za 4.27 % i skoka udalj iz mesta za 2.83 % (Mitrović et al., 2016). Takođe, povećanje mase tela moglo bi da uslovi bolje rezultate $F_{max}BE$ (Marković & Jarić, 2004), ali i da ujedno negativno utiče na rezultat RUN, posebno ukoliko je veća TM prouzrokovana uvećanjem masne komponente telesnog sastava (Jackson and Wilson, 2013).

Osim broja i načina realizacije časova SFO, značajan faktor koji takođe ima uticaja na morfološke karakteristike i fizičke sposobnosti studenata jesu životne navike, koje u savremenom način života karakterišu hipokinezija i povećani unos visoko kalorične hrane (Djordjevic-Nikic, M.,

Dopsaj, 2013). Takođe, u periodu između 18. i 20. godine života (periodu započinjanja akademskog života) dolazi do promene životne sredine i socijalnog okruženja, što prati smanjenje fizičkih aktivnosti (Irwin, 2004). Ovo se odnosi i na studente KPU, jer prelazak iz srednjoškolskog na fakultetski sistem uključuje i promena mesta boravka, odvajanje od porodice, varijabilnu i obimniju nastavu i veći broj obaveza. Sve navedeno dodatno može dovesti do narušavanja dotadašnjih životnih navika i posledičnog uvećanja TM (Dimitrijević, 2016). Može se pretpostaviti da su utvrđene promene delimično uzrokovane i životnim navikama studenata, prvenstveno s aspekta načina ishrane i upražnjavanja fizičkih aktivnosti posebno u periodima studiranja kada nije organizovana nastava SFO.

Prezentovani rezultati ovog istraživanja, s jedne strane mogu se objasniti smanjenim brojem časova SFO i životnim navikama studenata KPU, ali sa druge strane i definisanim normativima u testova za procenu BMS. Naime, u odnosu na prosečne vrednosti rezultata testova, utvrđeno je da je većina studenata ispunila tražene (minimalne) normative SFO (Janković & Dimitrijević, 2012). Slično tome, u istraživanju sprovedenom na kadetima Vojne akademije (Marić et al., 2013) utvrđeno je da je program fizičkog obrazovanja zadovoljavajući u odnosu na postavljene standarde, ali je nedovoljan za postizanje maksimalnih rezultata. Razlog za to, osim individualnih predispozicija, može biti manji angažman u treningu u poslednje dve godine studija i/ili manja motivisanost kadeta. Kada se posmatraju rezultati studenata KPU, uprkos tome što tokom tri godine studija nije došlo do unapređenja većine posmatranih fizičkih sposobnosti (čime nije ispunjen jedan od ciljeva SFO) studenti su u najvećoj meri ispunili tražene standarde (Blagojević et al., 2019). Drugim rečima, može se pretpostaviti da je cilj većine studenata bilo ispunjenje minimalnih normativa koje omogućava ostvarivanje predispitnih obaveza ali ne i postizanje rezultata koji omogućavaju visoke ocene u okviru predmeta SFO.

Zaključak

U ovom istraživanju utvrđeno ja da je tokom tri godine studija kod studenata KPU utvrđeno statistički značajno povećanje BM i BMI. Kada se posmatraju BMS, uočava se unapređenje izometrijske sile opružača leđa, ali i smanjenje aerobne izdržljivosti. Brzinska snaga mišića nogu, kao i repetitivna snaga mišića opružača ruku i mišića pregibača trupa ostale su na sličnom nivou kao što su bile i na prijemnom ispitu. Osnovni razlozi koji mogu da objasne dobijene rezultate odnose se na smanjenje broja časova SFO i diskontinuitet njihove realizacije, kao i na moguće promene životnih navika studenta. Takođe, s obzirom na to da su prosečne vrednosti rezultata blizu ili iznad definisanih normi, može se pretpostaviti da je na ovako dobijene rezultate uticala i niža motivisanost studenata da ostvare rezultate koji omogućavaju dobijanje viših ocena.

Literatura

Amanović, Dj., Mašić, Z., Kostovski, Ž., Ljubisavljević, M. (2015). Special physical education in police: model of education and training *Acta Kinesiologica,* 9 (2), 51-57.

Blagojević, M., Koropanovski, N., Vičković, G., & Dopsaj, M. (2019). *Specijalno fizičko obrazovanje 1 – osnovni nivo*. Kriminalističko-Policijski Univerzitet, Beograd.

Bonkiewicz, L., Ruback, R. B. (2012). The Role of the Police in Evacuations: Responding to the Social Impact of a Disaster. *Police Quarterly*, 15(2), 137–156.

Dimitrijević, R. (2016). *Modelne karakteristike motoričkih sposobnosti, morfoloških karakteristika i životnih navika studentkinja kriminalističko-policijske akademije* Doktorska disertacija, Fakultet sporta i fizičkog vaspitanja Univerziteta u Beogradu.

Dimitrijević, R., Koropanovski, N., Dopsaj, M., Vucković, G., Janković, R. (2014). The influence of different physical education programs on police students' physical abilities. *Policing: An International Journal of Police Strategies & Management*. 37(4), 794-808.

Djordjevic-Nikic, M., Dopsaj, M. (2013). Characteristics of eating habits and physical activity in relation to body mass index among adolescents. *Journal of the American College of Nutrition*, 32(4), 222-231.

Dopsaj, M., Blagojević, M., & Vučković, G. (2007). Normativno-selekcioni kriterijum za procenu bazično motoričkog statusa kandidata za prijem na studije Kriminalističko-policijske akademije u Beogradu. *Bezbednost*, *49(4)*, 166-183.

Dopsaj, M., Vučković, G., Blagojević, M. (2007). Normativno-selekcioni kriterijum za procenu bazično motoričkog statusa kandidata za prijem na studije Kriminalističko-policijske akademije u Beogradu. *Bezbednost*, Beograd, 49(4), 166–183.

Dopsaj, M., Vuković, M. (2015). Prevalenca indeksa telesne mase (BMI) kod pripadnika MUP-a Republike Srbije - pilot istraživanje. *Bezbednost*, 57(3), 28-48.

Hair J., Anderson R., Tatham R., Black W. (1998). *Multivariate Data Analysis* (Fifth Ed.). USA : Prentice – Hall, Inc.

Irwin, J.D. (2004). Prevalence of university students' sufficient physical activity: a systematic review. *Perceptual and Motor Skills*, 98(3), 927-943.

Jackson, C. A., Wilson, D. (2013). The Gender-Neutral Timed Obstacle Course: a valid test of police fitness?. *Occupational Medicine*, *63*(7), 479-484.

Janković, R., Dimitrijević, R. (2012). Stanje i mogućnosti unapređenja načina procene motoričkih sposobnosti u sistemu Ministarstva unutrašnjih poslova Republike Srbije. *Kultura polisa*, 9(1), 419-435.

Janković, R., & Dopsaj, M. (2022). Sprint running, agility and anaerobic endurance: Standards for the students at the University of Criminal Investigation and Police Studies. *NBP. Nauka, bezbednost, policija,* 27(2), 45-58.

Janković, R., Koropanovski, N., Kukić, F. (2021). Changes in the morphological characteristics throughout the three-year studying at the University of criminal investigation and police studies. *XX international scientific conference contemporary challenges in sport, physical exercising & active lifestyle. Edt. Stojiljković,S., Mandić ,R., Majstorović, N.* (pp. 235-241). University of Belgrade - Faculty of Sport and Physical Education.

Kolarević, D., Dimitrijević, R., Vučković, G., Koropanovski, N., Dopsaj, M. (2014). Relations between psychological characteristics and physical abilities in a sample of female police candidates. *Open Sports Sciences Journal*, 7(1), 22-28.

Koropanovski, N., Kukić, F., Janković, R., Dimitrijević, R., Dawes, J., Lockie, R., Dopsaj, M. (2020). Impact of physical fitness on recruitment and its association to study outcomes of police students. *South African Journal for Research in Sport, Physical Education and Recreation,* 42(1), 23 – 34.

Lockie, R.G., Dawes, J.J., Orr, R.M., & Dulla, J.M. (2020). Recruit fitness standards from a large law enforcement agency: between-class comparisons, percentile rankings, and implications for physical training. *The Journal of Strength and Conditioning Research, 34(4)*, 1-7.

Lockie, R.G., Moreno, M.R., Rodas, K.A., Dulla, J.M., Orr, R.M., Dawes, J.J. (2021).With great power comes great ability: Extendingresearch on fitness characteristics that influence Work Sample Test Battery performance in law enforcement recruits. *Work*, 68(4), 1069–1080.

Marić, L., Krsmanović, B., Mraović, T., Gogić, A., Sente, J., & Smajić, M. (2013). The effectiveness of physical education of the Military Academy cadets during a 4-year study. *Vojnosanitetski pregled*, *70*(1), 16-20.

Marković, G., Jarić, S. (2004). Movement performance and body size: the relationship for different groups of tests. *European Journal of Applied Physiology,* 92, 139–149.

Milojević, S., Janković, B., Cvetković, V. (2015). Prediction model of effective studies at the academy of criminalistic and police studies. *NBP – Journal of Criminalistics and Law*, 20(1), 135-149.

Mitrović, B., Janković, R., Dopsaj, M., Vučković, G., Milojević, S., Pantelić, S., Nurkić, M. (2016). How an eight-month period without specialized physical education classes affects the morphological characteristics and motor abilities of students of the Academy of criminalistic and police studies. *Facta Universitatis – series: Physical Education and Sport,* 14(2), 167–178.

Strating, M., Bakker, R., Dijkstra, G., Lemmink, K., Groothoff, J.W. (2010). A job-related fitness test for the Dutch police. *Occupational Medicine*, 60(4), 255–260.

Vučković, G., Subošić, D., Kekić, D. (2011). Physical abilities of police officers as prerequisite for suppressing violence at sporting events in the Republic of Serbia. *Facta universitatis – series: Physical Education and Sport*, 9(4), 385–397.

THE RELATIONSHIP BETWEEN THE LEVEL OF PHYSICAL ACTIVITY OF PARENTS AND THE LEVEL OF PHYSICAL ACTIVITY OF CHILDREN

Marin Marinović[1], Marija Dragojević[1], Zvonimir Tomac[1]
[1] University of Osijek, Faculty of Kinesiology, Osijek, Hrvatska

Introduction

Insufficient physical activity (PA) and reduced stimulation of the movement system negatively affect the function of all organs. The human body is designed for movement, so it falls due to its lack. Thus, numerous organs such as the heart and blood vessels, respiratory organs, bone-joint, and muscular systems for movement, responsible for maintaining the motor and functional abilities of the organism, are threatened by a lack of PA. Maintaining and improving these abilities is only possible through the application of appropriate PA, physical effort, and movement (Andrijašević, 2010). In modern living conditions, all PAs are practically reduced to a minimum. At the same time, in the modern world, it is extremely important to be healthy, to look good physically, to live creatively, with a high standard of living, and to have enough free time for personal creative and recreational activities. But that modern man cannot fully function without appropriate PA, which is one of the most important means to create and maintain health and beauty (Sindik, 2008). Today, for the majority of adults, PA in all segments of everyday life is extremely reduced. The time spent sitting in front of the TV, at the computer, or in the car increases. Thanks to technology, even the need to go to shops, banks, and the like are reduced. Numerous well-argued studies associate such a way of life with a low functional capacity of the organism already in adolescents and young adults, and especially in adults and the elderly (Mišigoj – Duraković et al., 2018). According to Jurakić and Heimer (2012), PA is categorized according to the level of intensity, from low to moderate to vigorous, i.e. high intensity. The level of PA varies widely in the population concerning age, gender, level of education, socioeconomic and health status, and biological and cultural heritage (Mišigoj - Duraković et al., 2018 according to Mišigoj - Duraković et al., 2000; Hoed et al., 2013). This is precisely why the World Health Organization (WHO) published the recommended level of PA for children aged 5 to 17 years. Children of that age should have at least 60 minutes of moderate to high-intensity PA per day. PA lasting more than 60 minutes a day will provide additional health benefits. PA should include activities that strengthen muscles and bones, at least 3 times a week. Jurakić and Andrijašević (2008) state that the choice of method of measuring PA mostly depends on the goal of the research, so PA can be measured for several main goals:

1. measuring PA with the aim of monitoring and supervising PA levels at the level of a particular population (e.g. the population of a country),
2. measuring PA in epidemiological research conducted to understand the connection between the level of PA and physical and mental health,
3. measuring PA to understand the determinants of PA within individual groups, i.e. to explain the reasons for the patterns of PA of different groups,
4. measuring PA to determine the effects of intervention programs for improving health.

The results of some previous research obtained on a representative sample of participants of different ages, genders, and work statuses from all over Croatia show that about 60% of the

population is physically inactive, and only a smaller number, about 15% of them, exercise regularly, 2-3 times a week as part of organized forms of recreational exercise or programmed physical activity, while the remaining individuals exercise unsystematically, irregularly and only occasionally (Barić, 2012). Based on data from the Global Health Monitor (WHO, year!), 26.7% of adults in Croatia are insufficiently active. The prevalence of insufficient activity is slightly higher in men (27.8%) than in women (25.6%) (Jurakić and Heimer, 2012).

People with a lower level of education and lower income often perform more physically demanding jobs and probably do not have enough time and financial resources for physical activities in their free time. On the other hand, people with a higher level of education have jobs with prolonged sitting and tend to be more physically active in their free time, probably due to a greater need for physical activity and greater knowledge about its positive effects on health (Jurakić, Pedišić, Andrijašević, 2008). The World Health Organization (WHO) estimates that 5 to 10% of mortality in developed countries of the world can be attributed to physical inactivity. Physical inactivity ranks fourth among risk factors for total mortality in the world. Today, it is estimated that physically inactive people (who do not meet the minimum daily moderate TA lasting at least 30 min) have an even 20 to 30% higher risk of mortality (Mišigoj – Duraković et al., 2018). The prevalence of insufficient activity in the first grade of elementary school was 71.7% among female students and 54.0% among male students, in the eighth grade 78.3% among female students and 49.9% among male students, and in the third grade of secondary school 86.2% among female students and 66.8% among male students (Jurakić and Heimer, 2012). It is estimated that the global prevalence of insufficient activity among adults is 31%. In almost all research, a higher prevalence of insufficient activity has been found in women than in men, so it is 34% in women and 28% in men on a global level (Jurakić and Heimer, 2012). The research aims to determine the connection between physically active parents and the level of PA of their children and to determine possible differences in the level of PA according to the age and education of the parents.

Methods

Subjects

The data were collected in 2018, in two elementary schools in the area of Osijek. All necessary institutions approved the implementation of the research. The sample of respondents consisted of 46 children with an average age of 9.8 years (SD =,68) and 46 parents of the same children, who were divided into the following groups:

Table 1. Frequencies of parents by age

Age	N	%
18-20	0	0,00
21-29	0	0,00
30-35	7	15,22
36-49	38	82,61
50+	1	2,17

Table 2. Frequencies of parents according to their' level of education

Parents' level of education	N	%
four-year vocational high school	0	0,00
gymnasium	0	0,00
bachelor	7	15,22
master	38	82,61
postgraduate	1	2,17

Table 3. Parental involvement in sports

Parental involvement	N	%
Involment in sports	13	28,26
Non involment in sports	32	69,57

Measuring instruments

The measuring instruments used in the research were questionnaires, IPAQ-SF for parents, and PAQ-C for male and female students (Ajman, Dapić Striga & Novak, 2015; Pedisic et al, 2011). According to Pedišić et al. (2011), the process of translation and cultural adaptation of the IPAQ is standardized and well-defined. However, any change to the original version can cause a slight semantic difference in the questions and explanations, which can directly affect the reliability and validity of the questionnaire.

Statistics

The basic descriptive parameters were calculated in all variables of morphological characteristics and PA questionnaire in both children and parents. The Pearson correlation coefficient was used to determine the relationship between children's and parents' PA. Kruskall-Walis ANOVA was used to determine the differences between active and inactive children with regard to the activity of their parents. Kruskall-Waliss ANOVA was also used to determine differences in morphological characteristics between children. Analisys of variance (ANOVA) is used for analize differences in the morphological characteristics of children with regard to the level of education of the parents.

Results

The average body mass index (BMI) of the subjects is 17.07 ± 2.85. The table shows that the majority of students are malnourished and normally nourished.

Table 4. Basic descriptive parameters of morphological characteristics of children

Variables	N	M	SD	Min	Max
BH	46	1,40	0,06	1,29	1,54
BW	46	33,55	6,90	23,00	55,00
BMI	46	17,07	2,85	12,28	26,90

Legend: N – number; M – mean; SD – standard deviation; Min – minimum; Max – maximum

Table 5. Level of physical activity of children

Variables	N	M	SD	Min	Max
Activity during Physical and Health Culture	46	4,52	0,75	2,00	5,00
Lunchtime activity	46	2,96	1,25	1,00	5,00
Activity right after school	46	2,93	1,12	1,00	5,00
Activity during the evening	46	3,35	1,61	1,00	5,00
Activity during the last weekend	46	3,09	1,36	1,00	5,00
Activity	46	3,52	1,30	1,00	5,00
What describes you?	46	2,98	1,34	1,00	5,00
How often you had PA on Monday?	46	3,52	1,21	1,00	5,00
How often you had PA on Tuesday?	46	3,46	1,19	1,00	5,00
How often you had PA on Wednesday?	46	3,54	1,22	1,00	5,00
How often you had PA on Thursday?	46	3,76	1,10	1,00	5,00
How often you had PA on Friday?	46	3,76	1,18	1,00	5,00
How often you had PA on Saturday?	46	3,74	1,27	1,00	5,00
How often you had PA on Sunday?	46	3,41	1,38	1,00	5,00
Average per week	46	3,60	0,90	1,29	5,00
Average activity level	46	3,24	0,69	1,65	4,57

Legend: N – number; M – mean; SD – standard deviation; Min – minimum; Max – maximum

Table 6. Differences in the morphological characteristics of children concerning playing sports

Variables	M sport	M nonsport	t-value	p
BH	1,40	1,40	-0,01	1,00
BW	32,74	35,80	-1,35	0,18
BMI	16,62	18,27	-1,79	0,08
PA level	3,28	3,06	0,98	0,33

Legend: BH – body height ; BW- body weight; BMI – body mass index; PA- physical activity; M-mean

Table 7. Differences in the physical activity of parents concerning the level of education(ANOVA)

	SS	df	MS	SS	df	MS	F	p
Physical activity level	1,38	4,00	0,34	20,14	41,00	0,49	0,70	0,60

Table 8. Percentage of parents according to the level of PA

Level of PA	N	%
low	18	39,13
moderate	19	41,30
vigorous	9	19,57

Table 9. Percentage of children according to the level of PA

Level of PA	N	%
low	17	36,96
moderate	23	50,00
vigorous	6	13,04

Tables 8 and 9 show that both children and parents are moderately physically active, i.e. 50% of the examined children and 41.30% of the parents are moderately physically active. Also, differences in the morphological characteristics of children with regard to the level of education of the parents were not observed or were not statistically significant (ATV – F= 0.61; p = 0.66; ATT – F = 0.31; p= 0.87; BMI – F = 0.40; p=0.81).

Table 10. Correlation matrix of the level of physical activity of children and parents

Var	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
1	1,00*	0,21	0,21	0,13	0,17	0,33*	0,30*	0,28	0,38*	0,32*	0,35*	0,22	0,28	0,42*	0,48*	0,48	0,50	0,11	-0,01	0,14	0,11
2	0,21	1,00*	0,07	-0,01	0,10	0,06	0,26	0,17	0,16	0,20	0,07	0,07	0,19	0,45*	0,37*	0,30*	0,33*	-0,22	-0,17	-0,11	-0,20
3	0,21	0,07	1,00*	0,74*	-0,09	0,20	0,14	0,20	0,25	0,09	0,09	0,22	0,24	0,24	0,08	0,23	0,49*	-0,08	-0,14	0,01	-0,08
4	0,13	-0,01	0,74*	1,00*	0,01	0,21	0,15	0,43*	0,16	0,19	0,14	0,20	0,21	0,13	-0,03	0,19	0,54*	-0,14	-0,23	-0,11	-0,17
5	0,17	0,10	-0,09	0,01	1,00*	0,24	0,52*	0,43*	0,29	0,44*	0,36*	0,39*	0,37*	0,35*	0,27	0,47*	0,59*	-0,15	-0,01	0,17	-0,03
6	0,33*	0,06	0,20	0,21	0,24	1,00*	0,35*	0,55*	0,39*	0,30*	0,40*	0,37*	0,32*	0,38*	0,17	0,45*	0,65*	-0,18	-0,25	0,05	-0,15
7	0,30*	0,26	0,14	0,15	0,52*	0,35*	1,00*	0,45*	0,39*	0,41*	0,34*	0,39*	0,49*	0,50*	0,26	0,53*	0,71*	0,05	0,04	0,24	0,12
8	0,28	0,17	0,20	0,43*	0,43*	0,55*	0,45*	1,00*	0,31*	0,48*	0,56*	0,31*	0,33*	0,15	0,07	0,42*	0,77*	-0,17	-0,06	0,07	-0,09
9	0,38*	0,16	0,25	0,16	0,29	0,39*	0,39*	0,31*	1,00*	0,47*	0,68*	0,60*	0,32*	0,57*	0,28	0,75*	0,55*	0,04	0,10	0,21	0,11
10	0,32*	0,20	0,09	0,19	0,44*	0,30*	0,41*	0,48*	0,47*	1,00*	0,64*	0,58*	0,62*	0,45*	0,30*	0,77*	0,59*	-0,21	-0,04	0,09	-0,10
11	0,35*	0,07	0,09	0,14	0,36*	0,40*	0,34*	0,56*	0,68*	0,64*	1,00*	0,54*	0,49*	0,38*	0,25	0,76*	0,57*	0,02	0,19	0,24	0,14
12	0,22	0,07	0,22	0,20	0,39*	0,37*	0,39*	0,31*	0,60*	0,58*	0,54*	1,00*	0,42*	0,45*	0,32*	0,74*	0,55*	-0,06	0,06	0,23	0,06
13	0,28	0,19	0,24	0,21	0,37*	0,32*	0,49*	0,33*	0,32*	0,62*	0,49*	0,42*	1,00*	0,61*	0,39*	0,74*	0,58*	-0,06	-0,06	0,10	-0,02
14	0,42*	0,45*	0,24	0,13	0,35*	0,38*	0,50*	0,15	0,57*	0,45*	0,38*	0,45*	0,61*	1,00*	0,67*	0,80*	0,60*	0,05	-0,05	0,16	0,07
15	0,48*	0,37*	0,08	-0,03	0,27	0,17	0,26	0,07	0,28	0,30*	0,25	0,32*	0,39*	0,67*	1,00*	0,64*	0,37*	0,24	0,11	0,10	0,20
16	0,48*	0,30*	0,23	0,19	0,47*	0,45*	0,53*	0,42*	0,75*	0,77*	0,76*	0,74*	0,74*	0,80*	0,64*	1,00*	0,73*	0,01	0,06	0,21	0,09
17	0,50*	0,33*	0,49*	0,54*	0,59*	0,65*	0,71*	0,77*	0,55*	0,59*	0,57*	0,55*	0,58*	0,60*	0,37*	0,73*	1,00*	-0,16	-0,15	0,13	-0,08
18	0,11	-0,22	-0,08	-0,14	-0,15	-0,18	0,05	-0,17	0,04	-0,21	0,02	-0,06	-0,06	0,05	0,24	0,01	-0,16	1,00*	0,76*	0,56*	0,94*
19	-0,01	-0,17	-0,14	-0,23	-0,01	-0,25	0,04	-0,06	0,10	-0,04	0,19	0,06	-0,06	-0,05	0,11	0,06	-0,15	0,76*	1,00**	0,54*	0,86*
20	0,14	-0,11	0,01	-0,11	0,17	0,05	0,24	0,07	0,21	0,09	0,24	0,23	0,10	0,16	0,10	0,21	0,13	0,56*	0,54**	1,00*	0,78*
21	0,11	-0,20	-0,08	-0,17	-0,03	-0,15	0,12	-0,09	0,11	-0,10	0,14	0,06	-0,02	0,07	0,20	0,09	-0,08	0,94*	0,86*	0,78*	1,00*

Legend: Variables 1-17 refer to children, while variables 18-21 refer to parents. Variable 1 = Physical Activity in your free time: Did you do any of these activities in the past 7 days (last week)? If so, how many times? Variable 2 = In the past 7 days, at the Physical and Health Education class, how active were you (running, jumping, throwing, playing)? Variable 3 = In the past 7 days, what did you do during your short break? Variable 4 = In the past 7 days, what did you usually do during a long break (apart from eating a snack)? Variable 5 = In the past 7 days, how many days, right after school, did you play sports, dance, or play games in which you were very active? Variable 6 = In the past 7 days, how many days in the evening did you play sports, dance, or play games in which you were very active? Variable 7 = Last weekend, how many times did you play sports, dance, or play games in which you were very active? Variable 8 = For the past week, which of these sentences best describes you? Read all 5 and choose only one answer. Variable 9 = Mark how often you had physical activity (such as playing sports, dancing, playing games, or something else) for each day last week: Monday Variable 10 = Mark how often you had physical activity (such as playing sports, dancing, playing games, or something else) for each day last week: Tuesday Variable 11 = Mark how often you had physical activity (such as playing sports, dancing, playing games, or something else) for each day last week: Wednesday Variable 12 = Mark how often you had physical activity (such as playing sports, dancing, playing games, or something else) for each day last week: Thursday Variable 13 = Mark how often you had physical activity (such as playing sports, dancing, playing games, or something else) for each day last week: Friday Variable 14 = Mark how often you had physical activity (such as playing sports, dancing, playing games, or something else) for each day last week: Saturday Variable 15 = Mark how often you had physical activity (such as playing sports, dancing, playing games, or something else) for each day last week

Discussion

The obtained results show that of the total number of parents in the research, 39.13% are not sufficiently active, 41.30% are moderately active, and 19.57% are sufficiently active. On the other hand, of the total number of children in the study, 36.96% are not sufficiently active, 50.00% are moderately active, and 13.04% are sufficiently active. Differences in the physical activity of parents concerning the level of education (F= 0.70; p= 0.60). Observing the results, the question arises whether a larger sample would better describe the phenomenon, as well as the age of the parents of the research participants since 82.61% of the parents belong to the age group of 36-49 years. Although the research results show that both parents and children are moderately physically active, there is still no correlation (perhaps the parents of different children are active and vice versa). However, the interaction between both samples was not obtained. There is also no difference with regard to age, sport and education in morphology and level of physical activity. It is interesting to note that the children, although moderately active, were not obese, and the average BMI of the subjects was 17.07 ± 2.85 (malnutrition and normal nutrition). Although at this age it needs to be defined according to other indicators, and therefore the results need to be interpreted with caution. Considering the approximate percentage of active, moderately active and insufficiently active children and parents, it is possible that the pattern of parents' behavior is not a criterion that will influence children's activity, but other endogenous and exogenous factors also influence it. Mišigoj – Duraković et al. (2018) stated that the biggest shortcoming of the questionnaire as a method for assessing PA is the reliance on the subjective interpretation of questions and the respondent's perception of physical activity, which often leads to underestimation or overestimation of the respondent's physical activity. Furthermore, social factors, for example, the desirability of a certain behavior, are the cause of overestimation of the amount of activity, but also of underestimation of sedentary behavior in the self-assessment of the level of PA (this deficiency is particularly pronounced in obese people). Since the instruments of the research were questionnaires, PAQ-C and IPAQ-SF, it turned out that incorrect filling of the questionnaire can also be a disadvantage and have an impact on the final results of the research. A possible reason for such results can be found in the loss of research participants, i.e. drop out of the sample of respondents (parent questionnaires) since more than half of the questionnaires had to be omitted due to incomplete filling. As shown in the results of the research, differences between children regarding playing sports were not obtained either in body height body mass as well as in the BMI.

Conclusion

The most important results of this research are not in accordance with common assumptions, considering that it turns out that physically active parents do not have more physically active children, since there is no correlation between the physical activity of parents and the physical activity of children, there is also no difference between the level of physical activity of parents and the level children's physical activities, because, although both parents and children are moderately physically active, there is no correlation between these two variables. There are also no differences in the morphological characteristics of children concerning playing sports, and there is no connection between the level of education of parents and their playing sports. Physical inactivity is a phenomenon of today's society and a feature of the age in which we live. Given the numerous

benefits that PA provides to human health, from the earliest age to old age, it is important to inform society to move from theory to practice. The level of PA can be increased by everyday little things that become a habit. For example, walking the stairs instead of taking the elevator, getting off the public transport station earlier or cycling to work can have multiple health benefits for adults. On the other hand, spending your free time physically active sets a good example for children. Since parents are models that children look up to and whose patterns of behavior they imitate, even the youngest must be informed about the benefits of PA, playing sports and spending time in nature. Everything starts in the family, continues at school and results in one's own choice of spending one's free time. Especially if PA is chosen that the child will enjoy, make new friends, and work on self-confidence and the well-being of the whole body. Since parents are models that children look up to and whose patterns of behavior they imitate, even the youngest must be informed about the benefits of physical activity, playing sports and spending time in nature. Everything starts in the family, continues at school and results in one's own choice of spending one's free time. Especially if PA is chosen that the child will enjoy, make new friends, work on self-confidence and the well-being of the whole body. The level of PA can be increased by including children in various sports clubs, extracurricular sports activities, etc., all to create a working habit of exercise and positive attitudes towards sports and take care of one's health. In conclusion, taking care of your health should be the rule, not the exception.

Considering the approximate percentage of active, moderately active and insufficiently active children and parents, it is possible that the pattern of parents' behavior is not a criterion that will influence children's activity, but that it is influenced by other endogenous and exogenous factors.

References

Ajman, H., Đapić Štriga, S. i Novak, D. (2015). Pouzdanost kratke verzije međunarodnog upitnika tjelesne aktivnosti za Hrvatsku. *Hrvatski športskomedicinski vjesnik, 30 (2)*, 87-90.

Andrijašević, M. (2010). *Kineziološka rekreacija.* Zagreb: Kineziološki fakultet Sveučilišta u Zagrebu

Barić, R. (2012). Motivacija i prepreke za tjelesno vježbanje. *Arhiv za higijenu rada i toksikologiju,63(Supplement 3)*, 47-57.

Jurakić, D., Andrijašević, M. (2008). Mjerenje tjelesne aktivnosti kao sastavnicaizrade strategija za unapređenje zdravlja. U V. Findak (ur.) *Zbornik radova 17. ljetne škole kineziologa Republike Hrvatske: Stanje i perspektiva razvoja u područjima edukacije, sporta, sportske rekreacije i kineziterapije.* Poreč, str. 296-303. Zagreb: Hrvatski kineziološki savez.

Jurakić, D., Heimer, S. (2012). *Prevalencija nedovoljne tjelesne aktivnosti u Hrvatskoj i u svijetu: pregled istraživanja.* Zagreb: Kineziološki fakultet Sveučilišta u Zagrebu, str. 3-12.

Jurakić, D., Pedišić, Ž, Andrijašević, M. (2009). Physical activity of Croatian population: cross-sectional study using International Physical Activity Questionnaire. *Croat Med J.* 50:165–173.

Mišigoj – Duraković, M. (2008). *Kinantropologija: Biološki aspekti tjelesnog vježbanja.* Zagreb: Kineziološki fakultet Sveučilišta u Zagrebu

Mišigoj – Duraković, M. i sur. (2018). *Tjelesno vježbanje i zdravlje*. Zagreb: Znanje

Pedišić, Ž., Jurakić, D., Rakovac, M., Hodak, D. i Dizdar, D. (2011). Reliability of the croatian long version of the international physical activity questionnaire. *Kinesiology, 43 (2),* 185-191.

Sindik, J. (2008). *Sport za svako dijete: Kako odabrati pravi sport, brinuti se o zdravlju i osigurati pozitivno iskustvo od samog početka.* Buševec: Ostvarenje d.o.o.

World Health Organization (WHO). *Global Strategy on Diet, Physical Activity and Health*

World Health Organization (WHO). *Global Strategy on Diet, Physical Activity and Health, Physical activity and young people*.

World Health Organization (WHO). *Media centre, Physical Activity*.

DIFFERENCES IN EXERCISE MOTIVATION BETWEEN KINESIOLOGY STUDENTS AND RECREATIONAL SPORT PARTICIPANTS

Karla Vojedilov[1], Klara Findrik[1], Josip Cvenić[1]
[1] Kineziološki fakultet Osijek, Osijek, Hrvatska

Introduction

A sedentary lifestyle is one of the biggest problems of modern society (Šimunić and Barić, 2011). With a change in people's lifestyles and contemporary culture, there has been a decrease in physical activity. If we want to change this and encourage people to embrace an active lifestyle, we must investigate why people exercise. For a long time, motivation has been seen as a crucial factor to take into account when figuring out why people choose to engage in a certain recreational or physical activity (Havitz et al., 2013). But in order for anything to be effective and meaningful for someone, the drive must come from within - intrinsic motivation - just like it does for any other activity of a person (Tušak, 1997). Despite the numerous obvious advantages of living an active lifestyle, inactivity is a serious health issue among college students (Kilpatrick et al., 2005). According to the study, approximately half of all college students say their level of physical activity drops after they graduate (Calfas et al., 1994). Physical exercise is planned and programmed (Bungić & Barić, 2009) and recreational activities are the ones that a person chooses outside of professional activities (Relac & Bartoluci, 1987). According to some previous studies, people participate in sports with a variety of achievement goals and it is logical to assume that achieving these goals contributes to overall satisfaction (Whitehead, 1990). But it is impossible to have a complete picture of motivational structure if we do not explore the motivation of those who exercise a lot and study kinesiology and those who exercise only temporarily and irregularly.

Methods

The study has been conducted on a sample of 274 respondents, of which 124 were kinesiology students and 123 recreational athletes aged 15 to 50. The research included recreational athletes from all over Croatia who are involved in some physical activity and kinesiology students from Osijek, Zagreb and Split. The condition for completing the survey was that the person engages in physical activity.

The research used a questionnaire of socio-demographic data that examined: age, sex, the main reason for training (positive health, body shape, challenge and enjoyment, hanging out with friends, competition, strength, mobility, others (stress management, increasing power, and endurance, etc.)), use of vitamin or nutritional supplements. This questionnaire was not standardized, most of main motives were chosen from the Croatian version of EMI-2 (Vlašić et al., 2002).

Data were processed using the Statistica software package, version 10. A frequency table and Chi-Square test was created for all kinesiology students, all recreational athletes, kinesiology students, female kinesiology students, male recreational athletes and female recreational athletes.

Results

Data were collected on a sample of 247 young adults comprising of 124 kinesiology students (68 male and 56 female) and 123 recreational athletes (43 male and 80 female). The use of supplements among male kinesiology students is more common where 38 (55.88%) male kinesiology students use supplements, and 30 (44.12%) male kinesiology students do not. For female kinesiology students, the situation is reversed, where 24 (42.86%) female kinesiology students use supplements, and 32 (57.14%) female kinesiology students do not use supplements. Furthermore, the situation is similar for recreational athletes, where 33 (76.75%) male recreational athletes use supplements, and 10 (23.26%) male recreational athletes do not use supplements, while 37 (46.25%) female recreational athletes use supplements, and 43 (53.75%) female recreational athletes do not use supplements.

The percentage of motivation for exercise among all kinesiology students, all recreational athletes, male kinesiology students, female kinesiology students, male recreational athletes and female recreational athletes are shown (Table 1).

Table 1. The percentage of motives among participants

MOTIVES FOR EXERCISE	ALL KINESIOLOGY STUDENTS		ALL RECREATIONAL ATHLETES		MALE KINESIOLOGY STUDENTS		FEMALE KINESIOLOGY STUDENTS		MALE RECREATIONAL ATHLETES		FEMALE RECREATIONAL ATHLETES	
	N	%	N	%	N	%	N	%	N	%	N	%
CHALLENGE AND ENJOYMENT	33	26,6	24	19,5	15	22,4	18	31,6	8	19,0	16	19,8
COMPETITION	21	16,9	7	5,7	17	25,4	4	7,0	6	14,3	1	1,2
OTHERS	19	15,3	18	14,6	7	10,4	12	21,1	3	7,1	15	18,5
BODY SHAPE	17	13,7	25	20,3	10	14,9	7	12,3	7	16,7	18	22,2
POSITIVE HEALTH	32	25,8	33	26,8	16	23,9	16	28,1	13	30,9	20	24,7
STRENGTH	2	1,6	6	4,9	2	2,9	0	0	3	7,1	3	3,7
HANGING OUT WITH FRIENDS	0	0	4	3,3	0	0	0	0	0	0	4	4,9
MOBILITY	0	0	6	4,9	0	0	0	0	2	4,8	4	4,9

Legend: number of responses(N), percentage (%).

The main motive for exercise among male kinesiology students is competition which makes 25.4%. The second main motive for exercise is positive health and it includes 23,9% of students, while the third motive is challenge and enjoyment and it amounts 22,4%. The least important motives for exercise are hanging out with friends, mobility and strength. This population of male kinesiology students enjoy to compete because they are inspired to work hard. During their university education they are introduce with lots of information from wide variety of sports. A student may be pushed to work much harder on getting better with their techniques because of the social pressure of competing against peers than they otherwise would feel motivated to do.

The main motive for exercise among female kinesiology students is challenge and enjoyment which makes 31.6%. Positive health is second motive and it includes 28.1%, while the third motive is others (stress management, increasing power, endurance etc.) and it amounts 21.1%. Strength, hanging out with friends and mobility did not appeared as a main motives for exercise among female kinesiology students. Female kinesiology students like to trying out different sports activities until they find the one which suits them. They enjoy it because through

playing sports they are lifting up their confidence and self-esteem. . Between male and female kinesiology students, the Chi-Square test results are x^2=46.12; p=0.00 so we can conclude that the results are statistically significantly different.(*Figure 1.)*

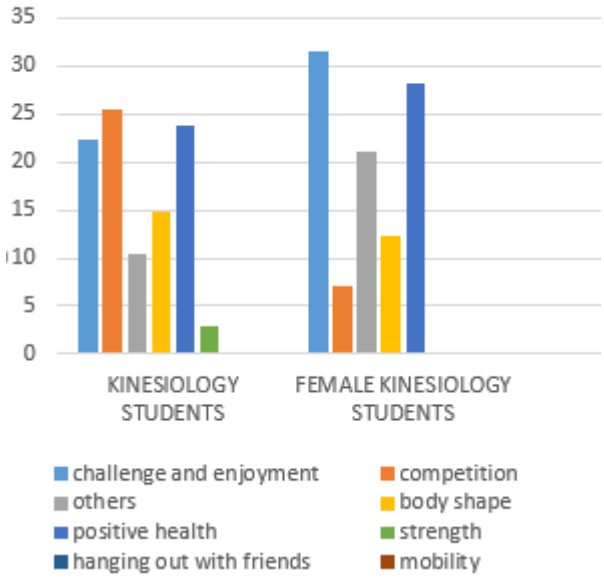


Figure 1. Reasons for exercising male and female kinesiology students

Positive health is the main motive for exercise among male recreational athletes which makes 30.9%. Second motive for exercise is challenge and enjoyment and it includes 19.0%, while the body shape is the third main motive for exercise and it amounts 16.7%. Hanging out with friends, mobility and strength are the least important motives for exercise among recreational athletes. We are all aware of the health benefits of living an active lifestyle. After the end of sport career, men continue to engage in different kind of recreational activities to preserve their good health. Some benefits are: reducing risk of becoming overweight, reducing risk of developing diabetes, better bone and muscle development etc.

The main motive for exercise among female recreational athletes is positive health which makes 24.7%. Body shape includes 22.2% and it is the second motive for exercise. The third one is challenge and enjoyment, this motive includes 19.8%. Among female recreational athletes, strength, hanging out with friends and mobility are the least present motives for exercise. Although there are some barriers to participation in recreational activities but there are much more powerful evidences that any kind of physical activity can improve health status of women. Chi-Square test between male recreational athletes and female recreational athletes is x^2=52.77; p=0.00 and we can conclude that the results are statistically significantly different.(*Figure 2.)*

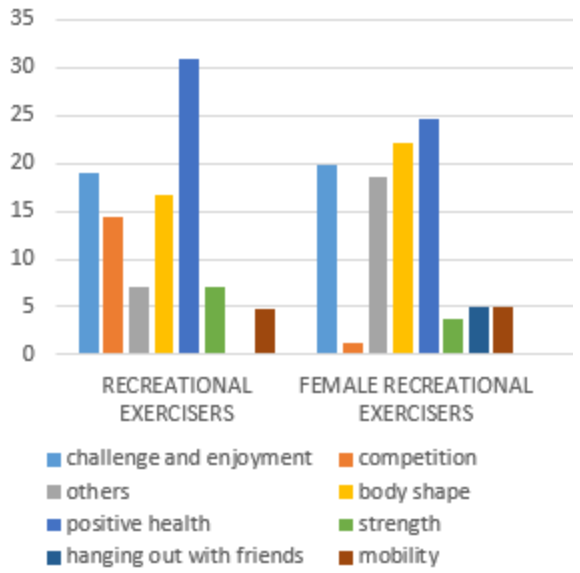


Figure 2. Reasons for exercising male and female recreational athletes

If all students are taken into account regardless of gender, the main motivation for exercise is challenge and enjoyment in the amount of 26.6%. Positive health is the most important motive for exercise among male recreational athletes and female recreational athletes in the amount of 26.8%. The Chi-Square test is x^2=45.69; p=0.00 and we can conclude that the results between all kinesiology students and all recreational athletes are statistically significantly different. Positive health as a motive was equally chosen on both side, mainly because regular exercise has benefits for overall health, for mood, and for maintaining a healthy weight. The biggest difference between these two samples can be seen in the selection of competition motive, mainly due to the fact that the majority of kinesiology students still train and compete during their studies, and have a strong desire to compete, while in the case of recreational athletes, their sports careers are mostly over and most of them are only engaged in recreational activities (Figure 3).

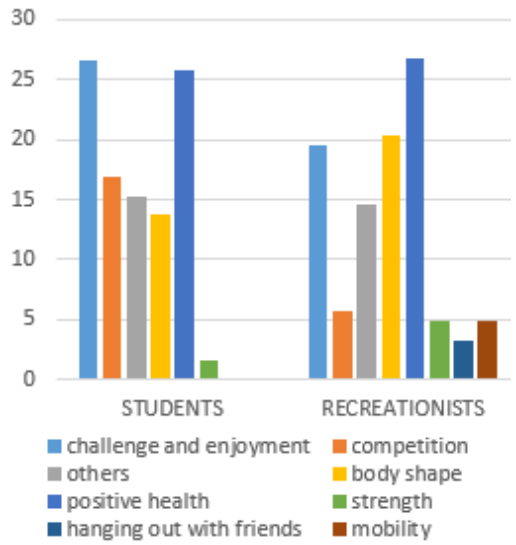


Figure 3. Reasons for exercising all kinesiology students and all recreational athletes

Discussion

Our study came up with results that female kinesiology students exercise because of challenge and enjoyment and health; their most irrelevant reasons are nimbleness, strength, and hanging out with friends. We found the similar data where active female students decided to participate in activities because they thought they were essential to achieve their goals, like weight loss or to have better health (Snyder et al., 2017). Another example where we found the connection with our research is that female students chose a certain activity (table tennis) to fulfill their desire to travel and that can be one of the factors for enjoyment (Furjan-Mandić et al., 2010). Based on our results, we realised that recreational females exercise because of health and body shape; competition is the least important reason for them. Some research discovered that women regularly work out for their health, agility and weight control, while competitiveness and social recognition are of less importance to them (Šimunić and Barić, 2011).

The most frequent answer is that male kinesiology students exercise because of challenge, fun and positive health and the least important reasons for them are hanging out with friends and nimbleness (no answer). Male students of kinesiology from Ljubljana are also motivated to exercise because of excitement (Sindik et al., 2013). The opposite results that are mentioned in another study, when we talk about men who are physically active, are that strength achievement, health and nimbleness are the three factors that inspire them the most (Šimunić and Barić, 2011).

We got interesting results when we talk about male recreational athletes. The most important motivations for them included positive health, challenge and enjoyment, and body shape. According to the study, recreational male college students were more driven by external motives (such as wanting to look good) than by inborn, intrinsic motivations (e.g., enjoyment) (Snyder et al., 2017). The results showed that for male recreational athletes the least important reasons for exercising are hanging out with friends, strength and mobility.

But on the other hand, recreational swimmers place a high importance on social motivational elements when selecting to engage in this activity (Anderson and William, 2018).

Our results showed that recreational females exercise because of health (24 %) and body shape and that competition is the least important reason for them (1,2 %). Another study showed that women regularly work out for their health, agility and weight control, while competitiveness and social recognition are of less importance to them (Šimunić and Barić, 2011). In a research that was related with goals of coming to the recreation center, women explained that physical activity is important to them because it will help them achieve the goal of reducing excess weight (Protrka, 2021.)

Conclusion

This research was conducted to find out motives that could be potential triggers for including people who exercise (kinesiology students) or only occasionally exercise (recreational athletes). The goal was to identify the motivational structure of such exercisers and athletes and investigate differences in motivation regarding the subsample and gender.

The results of the present study revealed that various motives of exercise are differentially presented in different groups. Furthermore, in the motivational profile of a regular male exerciser, competition is main motive for exercise (25,4%). Positive health is the main motive for exercise among recreational athletes which makes 30.9%. All this relation between kinesiology student and recreational athletes was significant different (p=0.00).

Regular physical activity can offer numerous physical, psychological, and social benefits. Physical activity is a great way to deal with everyday stress that harms the functioning of the human body and the quality of life itself.

References

Anderson, A. R., & Ramos, W. D. (2018). Social motivation and health in college club swimming. *Journal of American College Health*, *66*(8), 783-789.

Calfas, K. J., Sallis, J. F., Lovato, C. Y., & Campbell, J. (1994). Physical activity and its determinants before and after college graduation. *Medicine, Exercise, Nutrition, and Health*, *3*(323-334).

Furjan-Mandić, G., Kondrič, M., Tušak, M., Rausavljević, N., & Kondrič, L. (2010). Sports students' motivation for participating in table tennis at the faculty of kinesiology in Zagreb. *International journal of table tennis sciences*, *6*, 44-47.

Havitz, M. E., Kaczynski, A. T., & Mannell, R. C. (2013). Exploring relationships between physical activity, leisure involvement, self-efficacy, and motivation via participant segmentation. *Leisure Sciences*, *35*(1), 45-62.

Kilpatrick, M., Hebert, E., & Bartholomew, J. (2005). College students' motivation for physical activity: differentiating men's and women's motives for sport participation and exercise. *Journal of American college health*, *54*(2), 87-94.

Protrka, M. (2021). Profil rekreativaca vježbača u Splitu. *Doctoral dissertation, University of Split. Faculty of Kinesiology.*

Relac, M., Bartoluci, M., & Pavičić, M. (1987). Turizam i sportska rekreacija: organizacija i ekonomika sportsko-rekreacijskih sadržaja u turizmu. *Informator.*

Sindik, J., Mandić, G. F., Schiefler, B., & Kondrič, M. (2013). Differences in the structure of motivation for participation in sport activities among sport students in three countries. *Kinesiologia Slovenica*, *19*(1).

Snyder, K., Lee, J. M., Bjornsen, A., & Dinkel, D. (2017). What gets them moving? College students' motivation for exercise: An exploratory study. *Recreational Sports Journal*, *41*(2), 111-124.

Šimunić, V., & Barić, R. (2011). Motivacija za vježbanje povremenih rekreativnih vježbača: spolne razlike. *Hrvatski športskomedicinski vjesnik*, *26*(1), 19-25.

Tušak, M. (1997). Razvoj motivacijskega sistema v športu [The development of motivational system in sport]. *Unpublished doctoral dissertation. Ljubljana: University of Ljubljana*.

Whitehead, J. (1990). Motivation and sport persistence in children and adolescents. *Research report to the National Coaching Foundation.* Leeds, England.

ANTHROPOMETRIC CHARACTERISTICS ARE NOT SIGNIFICANT PREDICTORS OF SWIMMING SUCCESS AMONG KINESIOLOGY STUDENTS

Karla Šitić[1,2], Klara Šiljeg[3], Igor Jelaska[1]
[1] University of Split, Faculty of Kinesiology, Split, Croatia
[2] Aspira College, Split, Croatia
[3] University of Zagreb, Faculty of Kinesiology, Zagreb, Croatia

Introduction

In sports, the question often arises to what extent we can predict success and what it is conditioned by. Success in swimming is determined by several factors: anthropological, functional, and metabolic characteristics, efficient biomechanical execution of movements in water, conative and cognitive characteristics, and a legitimate plan and program that respects the laws of growth and development (Šiljeg, Zoretić, Leko, 2009). Therefore, one of the important factors of swimming success is certainly the anthropological status of the swimmer. Banerjee et al. (2019) examined the relationship of anthropometric variables in adolescents (thigh circumference, calf circumference, foot length and foot width) with swimming performance in short sections. The results showed that there is a significant relationship between swimming performance and thigh circumference and calf circumference, and that anthropometry is another factor that affects swimming performance and helps predict swimming performance. Latt et al. (2010) analyzed the relationships between swimming success in the 100 m crawl technique and anthropometric characteristics such as body height, arm span and body mass in adolescent boys. They concluded that anthropometric factors largely determine swimming success. Furthermore, Moura et al., (2014) examined the relationship between anthropometric variables (body height and mass, sitting height, arm span, arm muscle area and body composition and body composition) and propulsive force in adolescent swimmers. Body fat and height were identified as significant predictors of propulsive force. The aim of the research by Zampagni et al., (2008) was, among other things, to determine whether it is possible to use anthropometric variables to predict the performance time of the freestyle on sections of 50, 100, 200, 400 and 800 m, and at the same time to determine the existence of differences in elite swimmers of both genders. Body height was a predictor of performance, while gender differences were not found in the 50 m event but were present in all other events. Moreover, result of Geladas et al. (2005) indicated that the performance in the 100 m freestyle can be partially explained by anthropometry in young swimmers and that the contribution of these factors to the performance of sprint swimming is different in boys and girls. It was shown that the length of upper limbs is correlated with swimming performance in male swimmers, while height, length of upper limbs and arm length are correlated with swimming performance in female swimmers. The aim of this research was to examine whether there is a statistically significant relationship between anthropometric characteristics and swimming speed in kinesiology students.

Methods

The sample of respondents consisted of 98 male second-year undergraduate kinesiology students in Zagreb. The sample of variables consisted of 8 swimming disciplines at 25 and 50 meters (butterfly, backstroke, breaststroke, crawl) and 7 anthropometric measures (body height, body mass, upper arm volume, arm length, shoulder width, hip width and foot length).

Prior to the calculations, all variables were examined on reliability. So, Cronbach Alpha (Cα) and average inter item correlation (IIR) were calculated. All calculations were done using Software package Statistica 14.0. Type I error was set at α=5%. Kolmogorov Smirnov test was used to examine normality. All variables were subjected to standard descriptive procedures to determine basic statistical parameters. Canonical correlation analysis was used to determine the relationship between variables.

Results

All reliability indicators show moderate to high values (Cα ranged 0,87-0,95; IIR ranged 0,72-0,91). Table 1 shows the results of descriptive statistics for all variables (motor skills – swimming speed at 25 and 50 meters and morphological characteristics).

Table 1. *Results of descriptive statistics for all variables: arithmetic mean ± standard deviation (Mean± SD), minimum (Min), maximum (Max), skewness (Skew), kurtosis (Kurt), Kolmogorov Smirnov test (K-S p).*

	Mean± SD	Min	Max	Skew	Kurt	K-S p
BH	180,15±6,93	165,60	194,80	-0,06	-0,70	p>0,20
BM	80,11±9,09	58,50	105,70	0,25	0,48	p>0,20
UAV	35,27±2,80	28,80	43,50	0,34	0,33	p>0,20
AL	79,36±3,80	71,50	87,70	0,07	-0,44	p>0,20
SW	40,55±2,25	29,25	45,75	-1,39	5,72	p>0,20
HW	27,19±1,66	23,00	32,00	0,22	0,19	p>0,20
FL	26,90±1,35	24,30	30,70	0,33	0,07	p>0,20
25FR	17,81±4,23	13,13	48,68	4,50	29,64	p<0,05
25BC	24,75±5,65	17,73	57,53	2,68	11,57	p>0,10
25BR	25,27±4,27	18,98	36,68	0,96	0,42	p<0,15
25BT	22,39±4,20	15,28	40,48	1,35	3,01	p<0,15
50FR	41,39±7,37	22,09	69,47	1,03	1,99	p<0,20
50BC	56,04±9,06	24,47	79,68	0,02	0,58	p>0,20
50BR	55,66±9,35	26,09	82,81	0,52	1,34	p>0,20
50BT	51,83±10,07	37,68	97,83	1,50	3,84	p<0,15

Legend: BH- body height; BM- body mass; UAV- upper arm volume; AL- arm length; SW- shoulder width; HW- hip width; FL- foot length; 25FR- 25m freestyle; 25BC- 25m backstroke; 25BR- 25m breaststroke; 25FR- 25m butterfly; 50FR- 50m freestyle; 50BC- 50m backstroke; 50BR- 50m breaststroke; 50FR- 50m butterfly.

By looking at table 1, all observed parameters confirm the normal distribution of data for all mentioned variables. Table 2 shows the results of the canonical correlation analysis for all variables, where a set of morphological variables and a set of motor variables were observed.

Table 2. *Testing the significance of the canonical model: the number of canonical pairs eliminated from the model (RR; Eng. root removed), canonical correlation coefficient (CanR), Chi-square test (χ^2), degrees of freedom (df), level of significance (p).*

RR	CanR	CanR²	χ^2	df	p
0	0,48	0,23	58,84	56	0,37
1	0,41	0,17	35,40	42	0,75
2	0,31	0,10	18,83	30	0,94
3	0,24	0,06	9,54	20	0,98
4	0,19	0,04	4,27	12	0,98
5	0,10	0,01	0,90	6	0,99
6	0,01	0,00	0,00	2	1,00

From Table 2, we can conclude that no canonical pair is statistically significant, that is, no significant connection has been identified. Therefore, not a single anthropometric variable is statistically significant for success in this discipline. Table 3 shows the results of the correlation analysis, to establish a significant connection between morphological characteristics and motor skills.

Table 3. *Canonical correlation analysis. Factor structure (set of morphological and motor variables).*

	Root 1	Root 2	Root 3	Root 4	Root 5	Root 6	Root 7
BH	0,20	0,36	0,46	0,04	-0,69	0,11	-0,36
BM	-0,04	-0,41	0,15	0,12	-0,83	0,13	-0,31
UAV	-0,25	-0,32	-0,21	0,55	-0,48	0,50	-0,09
AL	0,20	0,28	0,28	-0,14	-0,34	0,21	-0,79
SW	0,36	0,27	-0,42	0,19	-0,68	-0,10	-0,34
HW	-0,50	0,18	-0,03	0,05	-0,58	-0,35	-0,50
FL	0,24	-0,04	0,48	0,32	-0,28	-0,19	-0,70
	Root 1	**Root 2**	**Root 3**	**Root 4**	**Root 5**	**Root 6**	**Root 7**
25FR	0,30	-0,01	-0,21	0,53	0,47	-0,16	-0,35
25BC	0,18	-0,48	0,02	0,29	0,69	-0,02	0,20
25BR	-0,10	-0,28	-0,82	0,03	0,36	0,24	0,03
25BT	0,17	-0,19	-0,28	-0,41	0,66	0,04	-0,50
50FR	0,28	-0,04	-0,23	-0,03	0,59	0,52	-0,26
50BC	-0,29	0,14	-0,08	-0,14	0,80	-0,04	-0,06
50BR	-0,22	-0,63	-0,63	0,02	0,30	0,13	-0,17
50BT	0,35	-0,22	-0,46	-0,28	0,62	-0,14	-0,32

Legend: BH- body height; BM- body mass; UAV- upper arm volume; AL- arm length; SW- shoulder width; HW- hip width; FL- foot length; 25FR- 25m freestyle; 25BC- 25m backstroke; 25BR- 25m breaststroke; 25FR- 25m butterfly.; 50FR- 50m freestyle; 50BC- 50m backstroke; 50BR- 50m breaststroke; 50FR- 50m butterfly.

Considering that the first root in the morphological set is not statistically significant, which can be seen from the coefficients which are relatively low, the results indicate that in principle it could be a transversal dimensionality factor that is related to the butterfly swimming speed factor

and also to the freestyle speed on 50m (table 3). Certainly, there is no statistically significant connection between morphological characteristics and success in swimming on this population.

Discussion

The results of this research can be identified with the conclusions of some other research, while some similar studies have shown different outcomes. Thus, the research by Ozkadi et al. (2022) observed the association between anthropometric characteristics and results at 50 meters for all four competitive styles. Body height, arm and foot length can be taken as predictive variables for breaststroke and backstroke styles in female swimmers. In accordance with the results of this research, no predictor variables were proven in our research for crawling and backstroke swimming styles in swimmers. The sample of this research were students, not professional swimmers as it was the case in the above-mentioned research. It can be assumed that students do not know how to swim the given section of 50 m with maximum speed, neither how to us their technique to perform swimming the best, which means that anthropometrical measures taken on student population is not a relevant indicator to predict swimming success. Hip width was a positive predictor variable for the score on the 50-meter butterfly, which is somewhat indicated by our results. Research by Bielec and Jurak (2019) observed the connection between some anthropometric characteristics and results in the 50 free and 200-meter medley. A significant correlation was found between body height, arm span and hand length according to freestyle results. In contrast to these results, the canonical correlation analysis of the association of various anthropometric parameters with the results of 25 and 50 meters in this work did not prove any significant association. This also applies to the already mentioned problem related to the sample that was used in this research. Also, contrary to that, the research of Yarar et al. (2021) led to the conclusion that anthropometric characteristics such as stature, arm length, arm span, leg length, lower leg length are very important for sprint swimming with the crawl technique, especially at 50 m, and that anthropometric tests could be used to identify talented swimmer. We cannot refer to these findings since the sample is not a professional swimmer, who nevertheless knows how to determine the maximum in swimming a certain section.

Considering all the above, attention should still be paid to the sample of respondents in the research. The sample of this study was made up of students of the Faculty of Kinesiology, while the samples of other studies were made up of professional swimmers of different ages.

Conclusion

From all the above, we can conclude that there is no statistically significant connection between morphological and motor measures in the observed sample. The obtained results are certainly useful because they show that measurements on students do not give significant results in terms of predicting success in sports, considering that it is precisely a motley sample and equally below-average results in the motor skills of swimming speed. Therefore, the observed sample should be emphasized as a limitation of this research, while for future research it is desirable to select a wider range of variables, and in the context of predicting success in a particular sport.

References

Banerjee, M., & Bag, S. (2019). Relationship of selected anthropometric variables with short distance swimming performance. *International Journal of Physiology, Nutrition and Physical Education*, *4*(2), 413-7.

Bielec, G., & Jurak, D. (2019). The relation between selected anthropometric variables and the sports results of early pubescent swimmers. *Baltic Journal of Health and Physical Activity*, *11*(1), 13.

Geladas, N. D., Nassis, G. P., & Pavlicevic, S. (2005). Somatic and physical traits affecting sprint swimming performance in young swimmers. *International journal of sports medicine*, *26*(2), 139–144.

Lätt, E., Jürimäe, J., Mäestu, J., Purge, P., Rämson, R., Haljaste, K., Keskinen, K. L., Rodriguez, F. A., & Jürimäe, T. (2010). Physiological, biomechanical and anthropometrical predictors of sprint swimming performance in adolescent swimmers. *Journal of sports science & medicine*, *9*(3), 398–404.

Moura, T., Costa, M., Oliveira, S., Júnior, M. B., Ritti-Dias, R., & Santos, M. (2014). Height and body composition determine arm propulsive force in youth swimmers independent of a maturation stage. *Journal of human kinetics*, *42*, 277–284.

Özkadı, T., Demirkan, E., Can, S., Alagöz, I., & Demir, E. (2022). Contribution of motoric and anthropometric components to the fifty-meter four swimming styles: Model approaches. *Science & Sports*, *37*(4), 316-e1.

Šiljeg, K., Leko, G., & Zoretić, D. (2009). Razlike između plivača kadeta i mlađih juniora u nekim antropometrijskim karakteristikama i motoričkim sposobnostima. *Hrvatski športskomedicinski vjesnik*, *24*(2), 113-118.

Yarar, H., Baruğ, D., Bostan, A., Kaya, A., & Aydin, E. M. (2021). Influence of Physical and Anthropometric Properties on Sprint Swimming Performance. *Pakistan Journal Of Medical & Health Sciences*.

Zampagni, M. L., Casino, D., Benelli, P., Visani, A., Marcacci, M., & De Vito, G. (2008). Anthropometric and strength variables to predict freestyle performance times in elite master swimmers. *Journal of strength and conditioning research*, *22*(4), 1298–1307.

COMPARATIVE ANALYSIS OF THE APPLIED CONTENTS FROM THE ARTISTIC GYMNASTICS CURRICULUM ON PHYSICAL EDUCATION CLASSES OVER A 15 – YEAR PERIOD

Marko Erak[1], Milinko Dabović[1], Sonja Kocić Paijć[1], Božidar Marović[2]
[1] University of Belgrade, Faculty of Sports and Physical Education, Belgrade, Serbia
[2] Falcon club „Partizan", Kostolac, Serbia

Introduction

Gymnastics is a branch of sports that includes exercises which require a high level of certain motor skills like: power, agility, coordination and flexibility (Bacciotti, 2017; Jemni, 2011). Gymnastics has been developed since the 19. century in the Swedish and German exercising systems. The roots of the gymnastics that we know today, date back to the exercises that were performed in the Middle Ages as well as in the Antic Greece (mounting and dismounting from horses, vaulting over bulls, etc). In Egypt, acrobatic exercises were performed for ceremonial purposes, while exercises, that resemble artistic gymnastics, were performed for health improving purposes in China. In Ancient Greece, these exercises were performed in educational as well as military purposes (Athens and Sparta) (Caine, 2013). Today, artistic gymnastics as a competitive activity, represents activities which include exercising and competing on apparatuses that are: parallel bars, uneven bars, balance beam, floor, pommel horse, high bar and vault. Some of these activities are separate for men's and women's artistic gymnastics (www.fig-gymnastics.com). Researches that have been done so far, have shown that the contents from the elementary and high school artistic gymnastics curriculum, are conducted only to a certain level of planned contents (Kocić Pajić, et al, 2018). Curriculum revisions and reforms over the years, have brought a change in the number of classes that are assigned for physical education as well the contents on those classes. Also, some of the contents have been changed to accommodate to the modern way of life, which as a consequence, has less physical activity of elementary and high school students in their day to day life. Third year students on Faculty of Sports and Physical Education, at the start of their artistic gymnastic classes, fill a questionnaire which gives insight into contents that were conducted in their elementary and high school physical education classes. One of the problems that arise on artistic gymnastics classes on the subject Theory and methodology of artistic gymnastics, is the mentioned low level of realisation of artistic gymnastics curriculum contents on physical education classes in their former education. Students come to artistic gymnastics classes semi or completely unprepared, because the contents that were planned by the curriculum, were not conducted by their teachers or were avoided by the students. Avoiding the contents planned by the curriculum poses a threat not only to students of Faculty of Sports and Physical Education, but for the health of the whole nation as well, because these contents are considered fundamental for development of motor skills and have a great incentive especially in their critical and sensitive periods of development. These problems introduce the subject as well as the goal of this research.

The subject of this research, are the contents from elementary and high school curriculum of the Republic of Serbia.

The goal of this research, is to determine possible changes in the level of conducted artistic gymnastics contents, that might have occurred in the span of 15 years (from 2006 to 2021).

Method

This research has a qualitative character of descriptive type. Data were gathered with a specifically designed questionnaire with 20 questions, that covered certain contents on the floor, vault, balance beam, high bar (uneven bars for women), parallel bars and on the pommel horse. Results from the 2006 and 2021 questionnaires, were analysed by standard statistical procedures as well as percentage representation of answers. The data were analysed by SPSS 20.0 statistical package.

Respondents were comprised of 87 students that enrolled on their third year on Faculty of Sports and Physical Education in 2006 and 87 students that enrolled on their third year on Faculty of Sports and Physical Education in 2021. All of the respondents voluntarily agreed to fill in the anonymous questionnaire.

Results

Percentage representation of positive and negative answers to the question „Did you conduct contents on the floor and which ones?" from the 2006 questionnaire can be seen in table 1. Table 2, gives percentage representation to the same question from the 2021 questionnaire.

Table 1. Percentage of answers to the question „Did you conduct contents on the floor and which ones?" from 2006 questionnaire

2006	Forward roll – over	Backward roll – over	Handstand	Cartwheel
Sprovodili	89,66%	72,41%	57,47%	74,71%
Nisu sprovodili	10,34%	27,59%	42,53%	25,29%

Table 2. Percentage of answers to the question „Did you conduct contents on the floor and which ones?" from 2021 questionnaire.

2021	Forward roll – over	Backward roll – over	Handstand	Cartwheel
Sprovodili	96,55%	89,66%	64,37%	83,91%
Nisu sprovodili	3,45%	10,34%	35,36%	16,09%

Tables 3 and 4, give insight into percentual representation of answers to the question „Did you conduct contents on the vault – split vault?" from the 2006 and 2021 respectively.

Table 3. Percentage of answers to the question „Did you conduct contents on the vault – split vault?" from the 2006 questionnaire

2006	Vault – split vault
Conducted	82,76%
Did not conduct	17,24%

Table 4. Percentage of answers to the question „Did you conduct contents on the vault – split vault?“ from the 2021 questionnaire

2021	Vault – split vault
Conducted	59,77%
Did not conduct	40,23%

Tables 5 and 6, show the answers and their percentual representation to the question „Did you conduct contents on the balance beam?“ from the 2006 and 2021 questionnaires respectively.

Table 5. Percentage of answers to the question „Did you conduct contents on the balance beam?“ from the 2006 questionnaire

2006	Balance beam
Conducted	74,71%
Did not conduct	25,29%

Table 6. Percentage of answers to the question „Did you conduct contents on the balance beam?“ from the 2021 questionnaire

2021	Balance beam
Conducted	75,86%
Did not conduct	24,14%

Answers and their percentual representation for the question „Did you conduct the contents on the high bar or uneven bars – lift up?“ from the 2006 and 2021 questionnaire, can be seen in the tables 7 and 8 respectively.

Table 7. Percentage of answers to the question „Did you conduct the contents on the high bar or uneven bars – lift up?“ from the 2006 questionnaire

2006	High bar / Uneven bars – lift up
Conducted	21,84%
Did not conduct	78,16%

Table 8. Percentage of answers to the question „Did you conduct the contents on the high bar or uneven bars – lift up?“ from the 2021 questionnaire

2021	High bar / Uneven bars – lift up
Conducted	43,68%
Did not conduct	56,32%

In tables 9 and 10, are the percentual representaion of answers to the question „Did you conduct contents on parallel bars – support swing?“ from the 2006 and 2021 questionnaires respectively.

Table 9. Percentage of answers to the question „Did you conduct the contents on the parallel bars – support swing?“ from the 2006 questionnaire

2006	Parallel bars – support swing
Conducted	26,44%
Did not conduct	73,56%

Table 10. Percentage of answers to the question „Did you conduct the contents on the parallel bars – support swing?“ from the 2021 questionnaire

2021	Parallel bars – support swing
Conducted	34,48%
Did not conduct	65,52%

Tables 11 and 12, show percenutal represention of answers to the question „Did you conduct contents on the pommel horse – swings?“ from 2006 and 2021 questionnare respectively.

Tabela 11. Percentage of answers to the question „Did you conduct the contents on the pommel horse – swings?“ from the 2006 questionnaire

2006	Pommel horse – swings
Conducted	8,05%
Did not conduct	91,95%

Tabela 12. Percentage of answers to the question „Did you conduct the contents on the pommel horse – swings?“ from the 2021 questionnaire

2021	Pommel horse – swings
Conducted	18,39%
Did not conduct	81,61%

Discussion

Based on the analysis of percentual representation of positive and negative answers from the 2006 and 2021 questionnaires, it can be concluded that there are certain changes in the percentage of the conducted contents in a positive as well as in a negative way in the period of 15 years. Certain contents are conducted in a measure that is close to its determined value by the curriculum, such as forward roll – over on the floor. On the other hand, some of the contents are not conducted to the extent that is near their determined value (such as the pommel horse).

Significate changes can be seen in the percentual representation of positive answers to the questions that are related to the contents on the floor (especially for backward roll – over). These changes are significant because they show a positive change in all of the contents on the floor.

Changes that are related to the percentual representation of answers to the questions related to vault (split vault), are significant but in a negative way. Namely, in the span of 15 years, percentual representation of answers to this question has dropped by 22.29%. Reasons for this change are not familiar but it can be assumed that it occurred due to negative change in the way of life of younger generations as well as in the coming of younger teachers, where a certain dosage of fear for conducting the split vault, is present in both the students and the younger teachers.

Positive changes can be seen on the other apparatuses like the balance beam (a slight increase in the percentage of realisation, that is not statistically significant), swings on the pommel horse with an increase just above 10%. The biggest increase in the span of 15 years (based on the questionnaire analysis), can be seen on the high bar or uneven bars for women. Namely, there is a 21.84% increase, which represents a statistically significant difference in regards to the conduction percentage of this apparatus from the 2006 questionnaire.

Conclusion

The goal of this research was to determine eventual changes that have occurred in the rate of the conducted artistic gymnastics contents in the span of 15 years (2006 – 2021).

The sample was comprised of students of Faculty of Sports and Physical Education, that have enrolled on their third year of studies in the year 2006 as well as 2021. 87 students, both male and female, from each generation have voluntarily filled questionnaires that was anonymous. Giving out these questionnaires, is a year's long practice from professors and assistants on the subject of Theory and methodology of artistic gymnastics, so that they can get an insight into personal anamnesis of conducted artistic gymnastics contents in the goal of better preparation and realisation of practical classes on the subject.

Determined elementary and high school curriculum of the Republic of Serbia, contains certain artistic gymnastics contents that are conducted in more or less determined extent on physical education classes. By analysing the answers that respondents have given, it can be concluded there are certain reasons for not conducting the given contents to their determined extent.

Based on the analysis of the results of the questionnaires, it can be concluded that in the span of 15 years (2006 – 2021), contents on the floor are conducted to a degree that is relative to their determined values. Also, it can be concluded that positive changes have occurred in the sense of conduction rate, of which some have reached the 96.55% conduction rate after this span of 15 years.

The biggest positive changes have the contents that are conducted on high bar or uneven bars. Lift up as a basic exercise on these apparatuses, has an increase of 21.84%. One of the reasons for this increase, can be a higher number of apparatuses that schools have gained via donations or improvisations by the teachers (doing this exercise on one bar of parallel bars).

On the other hand, certain contents have a negative shift, like the split vault. This exercise had a decrease of 22.99%. Assumption is that this change has occurred due to the change in the way of life of younger generations, namely less physical activity that helps develop the central nervous system as well as boldness for executing certain motor tasks.

One of possible reasons for less percentage of conduction of certain contents can be the lack of apparatuses in schools on which these contents can be conducted on. The questionnaires that the respondents have filled, did not include items that were related to this problem. Questionnaire was designed around teaching contents and if they were conducted. For that reason, this research can be used as a foundation on which further research can be based upon, to determine the reasons why certain contents are not conducted to their determined extent.

It can also be concluded that there were certain changes in the conduction rate of artistic gymnastics contents but that not all of them are conducted in their determined extent. Revision and

reformation of the educational curriculum of the Republic of Serbia, could bring an increase in the rate of conduction of the mentioned artistic gymnastics contents. Likewise, equipping school and adequate training of teachers will surely lead to better conduction of the teaching contents on the apparatuses.

This research can be used as a „springboard“ for further analyses of the educational curriculum of the Republic of Serbia, namely the artistic gymnastics contents within it, as well as for research that will help the development of artistic gymnastics as a fundamental sport in physical education and with it, better growth and development of younger generations.

References

Aleksić, D., & Mekić, B. (2010). Examination of effects of arthystic gymnastics teaching of physical education on static strength of 3th & 4th grade pupils of elementary schools. *Sport Mont Journal*, *7*(21-22), 185-191.

Kocić Pajić, S. et al. (2018). Stepen realizacije sadržaja programa sportske gimnastike na časovima fizičkog vaspitanja u osnovnoj školi. Fakultet sporta i fizičkog vaspitanja, Beograd.

Mekić, R., & Mavrić, A. (2016). UTICAJ SPORTSKE GIMNASTIKE NA TRANSFORMACIJU KOORDINACIJE I RAVNOTEŽE. SPORT I ZDRAVLJE, 2(1).

Radisavljvić, S., Milanović, I. (2008) Praktikum za pedagošku praksu studenata III i IV godine. Fakultet sporta i fizičkog vaspitanja, Beograd

Radojević, J. (1998). Za adekvatnu nastavu fizičkog vaspitanja u mlađem školskom uzrastu. Fizička kultura, 52 (2-4), 154-160.

Radojević, J., Vukašinović, V., Grbović, M., Dabović, M. (2011). Teorija i metodika sportske gimnastike II deo: praktična nastava i priprema za rad u školi. Fakultet sporta i fizičkog vaspitanja, Beograd.

Stamatović, M., i Šekeljić, G. (2011). Efikasnost nastave fizičkog vaspitanja u IV razredu osnovne škole i stručna osposobljenost nastavnika. Nastava i vaspitanje, 60 (4), 703-717.

Živčić Marković, K. (2010). Uloga i značaj sportske gimnastike u razrednoj nastavi. *Zbornik radova Međimurskog veleučilišta u Čakovcu, 1(2),* 113-121.

UPOREDNA ANALIZA PRIMENJENIH NASTAVNIH SADRŽAJA IZ PROGRAMA SPORTSKE GIMNASTIKE NA ČASOVIMA FIZIČKOG VASPITANJA U ŠKOLI, U RAZMAKU OD 15 GODINA

Marko Erak[1], Milinko Dabović[1], Sonja Kocić Paijć[1], Božidar Marović[2]
[1] Univezitet u Beogradu, Fakultet sporta i fizičkog vaspitanja, Beograd, Srbija
[2] Sokolsko društvo „Partizan“ Kostolac

Uvod

Gimnastika je sportska grana, koja obuhvata izvođenje vežbi koje zahtevaju visok nivo određenih motoričkih sposobnosti kao što su: snaga, spretnost, koordinacija i gipkost (Bacciotti, 2017; Jemni, 2011). Gimnastika se razvijala kao sportska disciplina još od 19. veka u okviru švedskog i nemačkog sistema vežbanja. Koreni i počeci sportske gimnastike koju poznajemo danas, prepoznaju još u vežbama koje su se primenjivale u srednjem veku, ali i u antičkoj Grčkoj, kao što su uzjahivanje i silaženje sa konja, preskakanje bikova, itd. U Egiptu, akrobatske vežbe su se izvodile su u obredne svrhe, dok su se u Kini vežbe koje podsećaju na sportsku gimnastiku, primenjivale u zdravstvene svrhe u Kini. U antičkoj Grčkoj, ove vežbe su se primenjivale u vaspitno – obrazovne kao i u vojne svrhe (Atina i Sparta) (Caine, 2013). Danas, sportska gimnastika kao takmičarska aktivnost, koja uključuje vežbanje i takmičenje na razboju (paralelni i dvovisinski), gredi, tlu, krugovima, konju sa hvataljakama, vratilu i preskoku, u odvojenim disciplinama muške i ženske sportske gimnastike (www.fig-gymnastics.com). Dosadašnja istraživanja pokazala su da se sadržaji iz sportske gimnastike koji su predviđeni nastavnim planom i programom za osnovnu i srednju školu Republike Srbije, realizuju u određenoj meri, ali ne i u predviđenoj (Kocić Pajić, et al, 2018). Reforme nastavnog plana i programa, tokom godina, dovele su do promena u vidu fonda časova koji su predviđeni za fizičko i zdravstveno vaspitanje kao i sami sadržaji na tim časovima. Takođe, neki od sadržaja su pretrpeli promene kako bi se prilagodili modernom načinu života koji za posledicu ima smanjenu fizičku aktivnost učenika kako osnovnih tako i sredjih škola. Studenti treće godine Fakulteta sporta i fizičkog vaspitanja, na početku nastave na predmetu Teorija i metodika sportske gimnastike, popunjavaju upitnik koji daje uvid u anamnezu primenjenih nastavnih sadržaja iz sportske gimnastike koje su studenti realizovali tokom nastave na časovima fizičkog vaspitanja. Ono što predstavlja problem prilikom izvođenja sadržaja sportske gimnastike na nastavi, na predmetu Teorija i metodika sportke gimnastike, jeste upravo nizak nivo primene nastavnih sadržaja propisanih nastavnim planom i programom za osnovnu i srednju školu. Studenti na nastavu sportske gimnastike dolaze delimično ili potpuno nespremni za ovaj vid nastave, jer su tokom svog školovanja u osnovnoj i srednjoj školi, uglavnom izbegavali ove sadržaje ili uopšte nisu bili primenjivani od strane nastavnika fizičkog i zdravstvenog vaspitanja. Izbegavanje izvođenja nastavnih sadržaja iz sportske gimnastike, predstavlja problem ne samo za studente Fakulteta sporta i fizičkog vaspitanja, već i za celokupnu dobrobit nacije, jer se upravo ovi sadržaji smatraju bazičnim i imaju veliki podsticajni faktor za razvoj motoričkih sposobnosti, pogotovo u njihovim senzitivnim i kritičnim periodima razvoja. Ovi problemi uvode u predmet i cilj ovog rada.

Predmet rada su sadržaji sportske gimnastike iz nastavnog plana i programa Republike Srbije za osnovnu i srednju školu.

Cilj rada je da se utvrde eventualne promene koje su nastale u stepenu primene određenih sadržaja iz sportske gimnastike u školama, u periodu od 15 godina (od 2006 do 2021).

Metode

Primenjeno je kvalitativno istraživanje, deskritivnog tipa. Za prikupljanje podataka korišćen je posebno konstruisan instrument – upitnik, sa 20 pitanja koji su obuhvatili određene sadržaje na parteru, preskoku, gredi, vratilu odnosno dvovisinskom razboju, paralelnom razboju kao i na konju sa hvataljkama. Za analizu odgovora dobijenih korišćenjem upitnika 2006. i upitinika korišćenog 2021. godine, koršićenje su standardne statističke procedure kao i procentualna zastupljenost odgovora. Podaci su analizirani statističkim paketom SPSS 20.0.

Uzorak ispitanika sačinjavaju 87 studenata koji su treću godinu Fakulteta sporta i fizičkog vaspitanja pohađali 2006. godine, i 87 studenata koji su treću godinu Fakulteta sporta i fizičkog vaspitanja pohađali 2021. godine. Svi ispitanici su dobrovoljno pristali na popunjavanje upitnika koji je bio anoniman.

Rezultati

U tabeli 1, mogu se videti procentualni odnosi potvrdnih i odričnih odgovora na pitanje „Da li ste sprovodili sadržaje na parteru i koje?“ sa upitnika iz 2006. godine. U tabeli 2, mogu se videti videti procentualni odnosi potvrdnih i odričnih odgovora na pitanje „Da li ste sprovodili sadržaje na parteru i koje?“ sa upitnika iz 2021. godine.

Tabela 1. Procentualni odgovori na pitanje „Da li ste sprovodili sadržaje na parteru i koje?“ 2006. godine

2006	Kolut napred	Kolut nazad	Stav na šakama	Premet uporom strance
Sprovodili	89,66%	72,41%	57,47%	74,71%
Nisu sprovodili	10,34%	27,59%	42,53%	25,29%

Tabela 2. Procentualni odgovori na pitanje „Da li ste sprovodili sadržaje na parteru i koje?“ 2021. godine

2021	Kolut napred	Kolut nazad	Stav na šakam	Premet uporom strance
Sprovodili	96,55%	89,66%	64,37%	83,91%
Nisu sprovodili	3,45%	10,34%	35,36%	16,09%

Tabele 3 i 4, daju uvid u procentualnu zastupljenost odgovora na pitanje „Da li ste sprovodili sadržaje na preskoku – raznoška?“ sa upitnika 2006. godine i 2021. godine.

Tabela 3. Procentualni odgovori na pitanje „Da li ste sprovodili sadržaje na preskoku – raznoška“ 2006. godine

2006	Preskok – raznoška
Sprovodili	82,76%
Nisu sprovodili	17,24%

Tabela 4. Procentualni odgovori na pitanje „Da li ste sprovodili sadržaje na preskoku – raznoška“ 2021. godine

2021	Preskok – raznoška
Sprovodili	59,77%
Nisu sprovodili	40,23%

Tabela 5 i tabela 6, prikazuju odgovore i procentualnu zastupljenost na pitanje „Da li ste sprovodili sadržaje na gredi?“ sa upitnika iz 2006. kao i 2021. godine.

Tabela 5. Procentualni odgovori na pitanje „Da li ste sprovodili sadržaje na gredi?“ 2006. godine

2006	Greda
Sprovodili	74,71%
Nisu sprovodili	25,29%

Tabela 6. Procentualni odgovori na pitanje „Da li ste sprovodili sadržaje na gredi?“ 2021. godine

2021	Greda
Sprovodili	75,86%
Nisu sprovodili	24,14%

Na tabelama 7 i 8, mogu se videti odgovori na pitanja „Da li ste sprovodili sadržaje na niskom vratilu / dvovisinskom razboju (niža pritka) – uzmak?“ sa uptnika iz 2006. i 2021. godine.

Tabela 7. Procentualni odgovori na pitanje „Da li ste sprovodili sadržaje na niskom vratilu / dvovisinskom razboju (niža pritka) – uzmak?“ 2006. godine

2006	Vratilo / Dvovisnski razboj – uzmak
Sprovodili	21,84%
Nisu sprovodili	78,16%

Tabela 8. Procentualni odgovori na pitanje „Da li ste sprovodili sadržaje na niskom vratilu / dvovisinskom razboju (niža pritka) – uzmak?“ 2021. godine

2021	Vratilo / Dvovisnski razboj – uzmak
Sprovodili	43,68%
Nisu sprovodili	56,32%

U tabelama 9 i 10 nalaze se rezultati pitanja „Da li ste sprovodili sadržaje na paralelnom razboju – njih u uporu?“ sa upitnika iz 2006. i 2021. godine.

Tabela 9. Procentualni odgovori na pitanje „Da li ste sprovodili sadržaje na paralelnom razboju – njih u uporu?“ 2006. godine

2006	Paralelni razboj – njih u uporu
Sprovodili	26,44%
Nisu sprovodili	73,56%

Tabela 10. Procentualni odgovori na pitanje „Da li ste sprovodili sadržaje na paralelnom razboju – njih u uporu?“ 2021. godine

2021	Paralelni razboj – njih u uporu
Sprovodili	34,48%
Nisu sprovodili	65,52%

Tabele 11 i 12, prikazuju procentualnu zastupljenost odgovora na pitanje „Da li ste sprovodili sadržaje na konju sa hvataljkama – premasi?“ sa upitnika iz 2006. i 2021. godine.

Tabela 11. Procentualni odgovori na pitanje „Da li ste sprovodili sadržaje na konju sa hvataljkama – premasi?“ 2006. godine

2006	Konj sa hvataljkama – premasi
Sprovodili	8,05%
Nisu sprovodili	91,95%

Tabela 12. Procentualni odgovori na pitanje „Da li ste sprovodili sadržaje na konju sa hvataljkama – premasi?“ 2021. godine

2021	Konj sa hvataljkama – premasi
Sprovodili	18,39%
Nisu sprovodili	81,61%

Diskusija

Na osnovu analize procentualne zastupljenosti pozitivnih i negativnih odgovora sa upitnika koji su ispitanici popunjavali 2006. i 2021. godine, može se doći do zaključka da postoje izvesne promene u procentu sprovedenih sadržaja kako u pozitivnom tako i u negativnom smislu, u vremenskom razmaku od 15 godina. Određeni sadržaji se realizuju u meri koja je približna onoj koja je propisana nastavnim planom i programom za osnovnu i srednju školu Republike Srbije (kao što je kolut napred na parteru). Sa druge strane, pojedini sadržaji imaju veoma malu procentualnu zastupljenost kada se govorimo o propisanoj meri (kao što je konj sa hvataljkama).

Mogu se uočiti značajne promene u procentualnoj zastupljenosti pozitivnih odgovora na pitanja koja su se odnosila na sadržaje na parteru (naorčito za kolut nazad). Ove promene su značajne jer govore o porastu stepena realizacije predviđenih sadržaja (svi procentualni odnosi imaju pozitivnu promenu).

Promene koje se odnose na procentualnu zastupljenost odgovora na pitanje koje se odnosilo na sadržaje na preskoku, odnosno, raznoške, su značajne ali imaju negativnu notu. Naime, u razmaku od 15 godina, procenutalna zastupljenost odgovora na ovo pitanje, opala je za 22.99%. Razlozi zbog kojeg je došlo do ove promene, nisu poznati ali se može pretpostaviti da je to toga došlo zbog promena načina života mladih kao i smene generacija nastavnika (gde su mladi nastavnici fizičkog vaspitanja zamenili prethodnike) gde se pojavljuje izvesna doza straha za izvođenje preskoka, kako od strane učenika, tako i od strane nastavnika.

Pozitivne promene se mogu uočiti i na ostalim spravama kao što su greda (relativno malo povećanje procenta realizacije sadržaja, nije statistički značajno), premasi na konju sa hvataljkama

sa nešto više od 10% povećanja. Najveći porast sprovođenja sadržaja u razmaku od 15 godina (na osnovu analize rezultata upitnika), može se uočiti na niskom vratilu, odnosno na dvovisinskom razboju (niža pritka). Naime, ovde je uočen porast od 21.84%, što predstavlja statistički značajnu razliku u odnosu na procenat sprovođenja ovog sadržaja u odnosu na odgovore sa upitnika iz 2006. godine.

Zaključak

Cilj ovog istraživanja bio je da se utvrde eventualne promene koje su nastale u vidu sprovedenih sadržaja iz sportske gimnastike u razmaku od 15 godina (2006 – 2021).

Uzorak ispitanika sačinjavali su studenti koji su svoju treću godinu na Fakultetu sporta i fizičkog vaspitanja, Univerziteta u Beogradu, pohađali u 2006. godini kao i u 2021. godini. Po 87 (studenti i studentkinje) ispitanika iz obe generacije studenata su dobrovoljno popunjavale upitnik koji je bio anoniman. Popunjavanje ovog upitnika je dugogodišnja praksa nastavnika i saradnika na predmetu Teorija i metodika sportske gimnastike, kako bi se dobio uvid u svojevrsnu, ličnu gimnastičku anamnezu studenata, radi što bolje pripreme i realizovanja praktične nastave na predmetu.

Predviđeni nastavni plan i program za osnovnu i srednju školu Republike Srbije, sadrži određene sadržaje sportske gimnastike koji se u manjoj ili većoj meri primenjuju na nastvi fizičkog i zdravstvenog vaspitanja. Analiziranjem odgovora koje su ispitanici davali, može se zaključiti da postoje određeni razlozi zbog kojih se ovi sadržaji realizuju u meri u koja je različita od predviđene programom.

Na osnovu analize rezultata upitnika, došlo se do zaključka da su se u razmaku od 15 godina (2006 – 2021), sadržaji na tlu odnosno parteru, realizovali relativno u predviđenoj meri ali da je došlo i do pozitivnih promena u vidu procenta realizacije. Svi sadržaji su imali povećanje procenta sprovođena, a neki čak i 96.55% nakon ovog vremenskog perioda.

Najveću pozitivnu promenu, imaju sadržaji koji se odivjaju na vratilu odnosno dvovisinskom razboju (niža pritka). Uzmak kao osnovni element na ovim spravama, ima porast od 21.84%. Jedan od razloga zbog kojeg je došlo do ovog povećanja, može biti veći broj sprava koje su škole dobijle putem određenih donacija ili improvizaijce od strane nastavnika (izvođenje ovog elementa na jednoj pritki paralelnog razboja).

Sa druge strane, pojedini sadržaji su imali negativni pomak, kao što je izvođenje preskoka raznožno preko kozlića (raznoška). Ovaj nastavni sadržaj imao je pomeraj od negativnih 22.99%. Pretpostavka je da je do ovog smanjenja došlo zbog promena načina života mlađih generacija, odnosno smanjenja kretanja i aktivnosti koje potpomažu razvijanju centralnog nervnog sistema kao i odvažnosti za izvođenje određenih motoričkih zadataka.

Jedan od mogućih razloga manjeg procenta realizacije određenih sadržaja može biti nedostatak sprava u školma na kojima bi se ovi sadržaji sprovodili. U upitniku koji su ispitanici popunjavali nije bilo ajtema koji su se odnosili na ovaj problem. Upitnik se odnosio samo na nastavne sadržaje i da li su oni sprovođeni. Iz tog razloga, ova studija se može koristiti kao osnova na koju se mogu nadovezati dalja istraživanja, kako bi se utvrdili razlozi zbog kojih se određeni sadržaji ne realizuju u predviđenoj meri.

Može se takođe zaključiti da je došlo do određenih promena u procentu sprovedenih sadržaja sportske gimnastike, ali i dalje nisu svi zastupljeni u predviđenoj meri. Reformacija

nastavnog plana i programa Republike Srbije, mogla bi da donese povećenju procenata realizovanih sadržaja. Takođe, opremanje škola i adekvatna obuka nastavnika, sigurno će pomoći realizaciji nastavnih sadržaja na spravama.

Ovo istraživanje može poslužiti kao „odskočna daska“ za dalje analize nastavnog plana i programa Republike Srbije, odnosno sadržaja iz sportske gimnastike u njemu, kao i za istraživanja koja će potpomoći razvoju sportske gimnastike kao bazičnog sporta u nastavi fizičkog vaspitanja, a samim tim i boljem razvoju mlađih generacija.

Literatura

Aleksić, D., & Mekić, B. (2010). Examination of effects of arthystic gymnastics teaching of physical education on static strength of 3th & 4th grade pupils of elementary schools. *Sport Mont Journal*, *7*(21-22), 185-191.

Kocić Pajić, S. et al. (2018). Stepen realizacije sadržaja programa sportske gimnastike na časovima fizičkog vaspitanja u osnovnoj školi. Fakultet sporta i fizičkog vaspitanja, Beograd.

Mekić, R., & Mavrić, A. (2016). UTICAJ SPORTSKE GIMNASTIKE NA TRANSFORMACIJU KOORDINACIJE I RAVNOTEŽE. SPORT I ZDRAVLJE, 2(1).

Radisavljvić, S., Milanović, I. (2008) Praktikum za pedagošku praksu studenata III i IV godine. Fakultet sporta i fizičkog vaspitanja, Beograd

Radojević, J. (1998). Za adekvatnu nastavu fizičkog vaspitanja u mlađem školskom uzrastu. Fizička kultura, 52 (2-4), 154-160.

Radojević, J., Vukašinović, V., Grbović, M., Dabović, M. (2011). Teorija i metodika sportske gimnastike II deo: praktična nastava i priprema za rad u školi. Fakultet sporta i fizičkog vaspitanja, Beograd.

Stamatović, M., i Šekeljić, G. (2011). Efikasnost nastave fizičkog vaspitanja u IV razredu osnovne škole i stručna osposobljenost nastavnika. Nastava i vaspitanje, 60 (4), 703-717.

Živčić Marković, K. (2010). Uloga i značaj sportske gimnastike u razrednoj nastavi. *Zbornik radova Međimurskog veleučilišta u Čakovcu, 1(2),* 113-121.

APPLIED SPORTS SCIENCES

PRIMENJENE SPORTSKE NAUKE

DIFFERENCES IN THE FUNCTIONAL MOBILITY OF KARATE ATHLETES IN RELATION TO GENDER AND SPECIALIZATION

Ognjen Maric[1], Milos Mudric[1]
[1] University of Belgrade, Faculty of Sports and Physical Education, Belgrade, Serbia

Introduction

Karate is a sport with a multidimensional character, in which two competitive disciplines are most represented: kata and kumite. Kata are a presentation of formal offensive and defensive techniques that are performed freely in space in a precisely determined order, that is, they represent a fight against imaginary opponents (Imamura et al., 2002). On the other hand, kumite represent a set of selected offensive and defensive actions performed in relation to the opponent, including a series of techniques and movements that require constant movement of the body in space (Iide et al., 2008). Competitors in kata and kumite in the first phase of training go through a unique training process, so that in the later period there will be spontaneous differentiation under the influence of various factors and orientation towards preferred competitive disciplines (Koropanovski, 2012). Practicing karate for many years can affect the improvement of basic motor skills, especially the development of explosive strength, speed and coordination (Simonovic, 2010). Karate training involves the adaptation of the practitioner to specific, extended positions and movements as a specific environment for the realization of powerful movements (Probst et al. 2007). The manifestation of strength and power is influenced by body dimensions (Jaric, 2003; Jaric et al. 2005; Nedeljkovic et al. 2009), which can play a significant role in the selection of competitors related to the different requirements of sports disciplines in kata and kumite. This is supported by numerous studies that examined the differences between kumite and kata competitors in terms of anthropomotor and physiological characteristics as well as neuromuscular functions (Mudric et al., 2019; Vujkov, 2015; Koropanovski et al., 2011). Therefore, the assessment and evaluation of karatekas and their specific abilities is of great importance for the processes of managing the transformational processes that arise as a result of the training activity of karatekas of both specializations (kata and kumite). On the basis of previous research in the examination of differences between competitors in kata and kumite, in this paper the FMS battery of tests was applied with the aim of obtaining additional knowledge about the existence of possible differences in the area of intra and inter muscular coordination, as well as the mobility and stability of all joints. Using this test, poor movement patterns can be identified that require the interaction of cognitive, perceptual, proprioceptive and motor functions that include muscle strength and endurance, flexibility, mobility, coordination and balance (Vehr et al., 2021). The subject of this research is the differences in the basic patterns of movement that appear in female and male karate athletes who practice kata and kumite. The aim of this research is to analyze the functional mobility of male and female karate athletes who practice the kata and kumite using the FMS battery of tests.

Methods

The research sample consisted of 55 karatekas, who actively compete in the kata and kumite, with an average age of 14.6 years. The total sample was divided into two subsamples, which consisted of 25 boys with an average age of 14.4 years and 30 girls with an average age of 14.6 years. Each subsample was divided into two additional subsamples, i.e. according to the disciplines in which they compete (kata or kumite). With that, we have 4 sub-samples, of which 11 boys and 13 girls are engaged in the discipline of kata and 14 boys and 17 girls are engaged in the discipline of fighting. All respondents were subjected to a test with questions related to personal data, as well as the results they achieved, that is, whether they have had any injuries so far. The testing was done in the afternoon in the period from 17-18 hours, i.e. during daily training. All subjects were healthy. Two experienced examiners with previous experience of performing the FMS battery of tests observed the execution of the movements from two angles, frontal and lateral. Based on their agreement, an adequate rating was given. If there was any doubt, a lower grade was given. Each test has 4 grades, on a scale from 0 to 3, where there is a defined performance standard for each grade. With the use of adequate equipment, the examinee performs the previously demonstrated movement, where in accordance with his capabilities, he tries to perform the movement in the best possible way. Variables for the assessment of functional mobility represent the data obtained by applying the FMS battery of tests. FMS (Functional movement screening) is a battery of 7 tests (deep squat (DS), Inline lunge (IL), Hurdle step (HS), Shoulder mobility (SHM), Active-straight leg raise (ASLR), trunk stability push-up (TSP), rotatory stability (RS)) which assesses functional stability and joint mobility. This research was conducted according to the principle of a transversal study, qualitative and quantitative approaches are represented through observation, description, measurement and testing. The data were processed through descriptive and comparative statistics. Within the descriptive statistics of the number of years, the total score on the FMS test, as well as the results of individual FMS tests, the Median and Interquartile difference were used. The Mann-Whitney test was used to assess differences between subsamples in relation to gender and competitive discipline.

Results

In the analysis of the functional mobility of male and female karateka who practice the discipline of kata and the discipline of fighting, primarily the descriptive indicators of the entire subsample were determined for individual tests as well as for the overall result.

Table 1. shows the overall results as well as the individual results of the FMS battery of tests. The average score is 16.69, which represents a score above the average in relation to respondents of that age.

Table 1. Presentation of the basic descriptive indicators of the entire subsample for individual tests and for the overall result

	Kumite				Kata			
	Female		Male		Female		Male	
	Median	Interquartile difference	Median	Interquartile difference	Median	Interquartile difference	Median	Interquartile difference
DS	2	1	2	1	2	0	3	0.5
HS	2	0	2	1	2	1	3	1
IL	3	0	3	1	3	0	3	0
SHM	3	1	3	0	3	0	3	0
ASLR	3	0	2	1	3	0	3	1
TSP	2	2	2	1	1	1	3	1
RS	2	0	2	0	2	0	2	0
Total	17	2	16	3.75	16.5	2	18	2

Table 2 shows the difference between the boys competing in the kata and the kumite in the individual tests, as well as in the overall test. Statistically significant differences were found in the overall results, as well as in the obstacle crossing test, in favor of examinees practicing the discipline of kata.

Table 2. Presentation of statistically significant differences between boys competing in the kata and kumite in individual tests, as well as in the overall test.

	Kumite male		Kata male			
	Median	Interquartile difference	Median	Interquartile difference	Mann-Whitney U	p
DS	2	1	3	0.5	44	**0.045***
HS	2	1	3	1	58	0.246
IL	3	1	3	0	60.5	0.252
SHM	3	0	3	0	73	0.697
ASLR	2	1	3	1	57	0.22
TSP	2	1	3	1	59	0.278
RS	2	0	2	0	74.5	0.844
Total	16	3.75	18	2	41.5	**0.049***

Table 3 shows the differences that appear between boys and girls in the discipline of kata. More significant differences can be observed in the deep squat test, as well as in the trunk stability test during lifting from handstands in favor of boys.

Table 3. Presentation of statistically significant differences between boys and girls practicing kata

	Kata female		Kata male			
	Median	Interquartile difference	Median	Interquartile difference	Mann-Whitney U	p
DS	2	0	3	0.5	29	**0.005***
HS	3	1	3	1	70.5	0.946
IL	3	0	3	0	64	0.449
SHM	3	0	3	0	61	0.348
ASLR	3	0	3	1	62	0.485
TSP	2	1	3	1	37.5	**0.035***
RS	2	0	2	0	58.5	0.116
Total	17	2	18	2	47	0.15

Table 4 shows the differences between boys and girls in the fighting discipline. Statistically significant differences were found in the line lunge tests, the active leg raise test, and the trunk rotatory stability test in favor of girls.

Table 4. Presentation of statistically significant differences between boys and girls practicing kumite

	Kumite female		Kumite male			
	Median	Interquartile difference	Median	Interquartile difference	Mann-Whitney U	p
DS	2	1	2	1	113	0.812
HS	2	0	2	1	90	0.192
IL	3	0	3	1	84	**0.047***
SHM	3	1	3	0	87	0.106
ASLR	3	0	2	1	67	**0.012***
TSP	2	2	2	1	104	0.525
RS	2	0	2	0	88	**0.034***
Total	17	2	16	3.75	113.5	0.824

Table 5 shows the differences between girls who practice kata, that is, the discipline of kumite. A statistically significant difference was found only in the hurdle test in favor of girls practicing kata.

Table 5. Presentation of statistically significant differences between girls who compete in kata and kumite

	Kumite female		Kata female			
	Median	Interquartile difference	Median	Interquartile difference	Mann-Whitney U	p
DS	2	1	2	0	94.5	0.432
HS	2	0	3	1	54.5	**0.009***
IL	3	0	3	0	109	0.885
SHM	3	1	3	0	94	0.401
ASLR	3	0	3	0	99.5	0.477
TSP	2	2	2	1	100.5	0.656
RS	2	0	2	0	104	0.382
Total	17	2	16.5	2	93	0.455

Table 6 shows the results of all individual tests as well as the total test result of respondents who are involved in the discipline of fighting in relation to whether they had previously actively

competed in the discipline of kata. Statistically significant differences can be seen in the deep squat test and the hurdle test in favor of subjects who have previously competed in the kata discipline.

Table 6. Presentation of statistically significant differences between subjects who are practicing kumite in relation to whether they previously competed in the discipline of kata

	Competed in kata		Didn't compete in kata			
	Median	Interquartile difference	Median	Interquartile difference	Mann-Whitney U	p
DS	2	1	2	0.5	72	**0.870***
HS	2	1	2	0	64	**0.029***
IL	3	0.25	3	0	93.5	0.322
SHM	3	1	3	0.5	107	0.875
ASLR	3	1	3	0	88	0.27
TSP	2	2	2	2	99.5	0.643
RS	2	0	2	0	91	0.178
Total	17	3.25	16	2	86	0.314

Discussion

The average results of all test subjects were 16.7±2.2. According to Abraham (2015), the average score of children of that age is 14.6. From the point of view of the normative values of the results of that age, it can be noted that the results are far above the average. Considering the homogeneity of the groups in this research, the results can be absolutely justified. The better results of subjects who practice karate can be supported by research conducted by Bogusewski et al. (2015), which shows better results of subjects who practice karate, compared to those who do not practice it. Also, Mekic (2020) confirms the high results of karate athletes by comparing them with athletes from other martial sports branches. The results of this research indicate that practicing karate has a positive effect on the functional mobility of the lower extremities. Somewhat weaker results compared to the results obtained in this research were obtained by Yildiz (2018), where the average results were 15.9±2. Weaker results can be explained by the fact that the respondents were older. In this research, the dependence of results on the FMS test with different athletic abilities was compared, where significant correlations were found between high results in the FMS test and trunk stability, as well as the height of the squat jump. The difference between the subjects practicing kata and kumite was observed in all tests, but a statistically significant difference was seen only in the obstacle crossing test as well as in the overall results. The similarity of this result can be compared with the results of the study by Mudric et al. (2019), according to which boys who practice kata have better results in the balance test compared to boys who practice kumite. On the other hand, the dominant presence of the *mae geri* technique (forward kick) in the kata, shows a similar motor pattern with this test. The analysis of the results between subjects who had competed in the kata before and those who had not competed in the kata showed that there were statistically significant differences in the deep squat and hurdle tests. Considering the statistically significant differences that appear in this research in these two tests in favor of boys who practice kata, it can be concluded that kata as a formal form of fighting, which serves as part of training, has a very large role in creating a quality competitor in the kumite. Bodden (2015) also noted in his work a large difference in the functionality of the left and right sides of the body when only specific exercises are practiced in combat sports. Using a program of corrective exercises along with regular training, improvement was seen in the equalization of left and right side strength. Given that the katas are

absolutely symmetrical in terms of performing left and right side techniques as well as movement, they can also be used as a tool for maintaining a good posture and functionality of a competitor who is engaged in kumite.

Conclusion

The main goal of this work was to examine the differences between boys and girls who practice the discipline of kata, i.e. the discipline of kumite in karate. The results of the research showed that boys who practice kata have better results than boys who practice kumite in all tests, while the differences between girls who practice kata compared to girls who practice kumite were only observed in the test crossing an obstacle. Given the different characteristics of competitive disciplines in karate (kata and kumite) in terms of the uniformity of the expression of strength on both sides of the body, it leads to muscle imbalance even at the age of cadets and juniors, so the danger that can follow is the occurrence of injuries. By applying this test, the problems of early specialization, which is increasingly present in this combat sport, can be seen. In this regard, regardless of the competitive commitment towards one of the two competitive disciplines (kata and kumite), kata must be a mandatory part of the training process, especially for karate athletes who choose to compete in the kumite discipline. Based on previous research as well as the results of this research, permanent improvement and reprogramming of training plans is necessary in order to avoid unwanted effects in the entire training.

References

Abraham, A., Sannasi, R., & Nair, R. (2015). Normative values for the functional movement screentm in adolescent school aged children. International journal of sports physical therapy, 10(1), 29.

Bodden, J. G., Needham, R. A., & Chockalingam, N. (2015). The effect of an intervention program on functional movement screen test scores in mixed martial arts athletes. *The Journal of Strength & Conditioning Research*, *29*(1), 219-225.

Boguszewski, D., Jakubowska, K., Adamczyk, J. G., & Białoszewski, D. (2015). The assessment of movement patterns of children practicing karate using the Functional Movement Screen test. *J Combat Sports Martial Arts*, *6*(1), 21-26.

Iide, K., Imamura, H., Yoshimura, Y., Yamashita, A., Miyahara, K., Miyamoto, N., et al. (2008). Physiological responses of simulated karate sparring matches in young men and boys. Journal of Strength and Conditioning Research, 22(3): 839-844.

Imamura, H., Yoshimura, Y., Nishimura, S., Nakazawa, A.T. (2002). Physiological responses during and following karate training in women. Journal of Sports and Medicine Physiological Fitness, 42:431-437.

Jaric, S. (2003). Role of body size in the relation between muscle strength and movement performance. Exercise and Sport Science Reviews, 31(1): 8-12.

Jaric, S., Mirkov, D., Markovic, G. (2005). Normalizing psysical performance tests for body. Zbornik radova, Deveti međunarodni naučni skup FIS komunikacije u sportu, fizičkom vaspitanju i rekreaciji, 489-495. Niš, Fakultet sporta i fizičkog vaspitanja.

Koropanovski, N., Berjan, B., Bozic, P., Pazin, N., Sanader, A., Jovanovic, S., Jaric, S. (2011). Anthropometric and Physical Performance Profiles of Elite Karate Kumite and Kata Competitors. Journal of Human Kinetics, 30:107-114.

Mekic, A., Vrevic, E., Malovic, P., Kapo, S., & Kajmovic, H. (2020). Differences in the Quality of Movement Functionality between Judokas, Karatekas, and Non-Athletes. *Journal of Anthropology of Sport and Physical Education*, *4*(4), 21-26.

Mudric, M., Aleksic, B., Goran, K., Jovanovic, S., & Suzovic, D. (2019). Morphological characteristics and motor skills of junior age karate athletes different specialization. *Godišnjak Fakulteta sporta i fizičkog vaspitanja*, (24), 40-48.

Nedeljkovic, A., Mirkov, D.M., Bozic, P., Jaric, S. (2009). Tests of muscle power output: the role of body size. International Journal of Sports Medicine, 30(2): 100-6.

Probst, M.M., Fletcher, R., Seeling, D.S. (2007). A comparison of lower-body flexibility, strength, and knee stability between karate athletes and active controls. Journal of Strength and Conditioning Research, 21(2):451-455.

Simonović, Z., Kozomora, G., Mujanović, R., Projović, A. (2010) Razlika u morfološkim karakteristikama između nesportista i karatista. u: Zbornik radova, Deveti međunarodni naučni skup FIS komunikacije u sportu, fizičkom vaspitanju i rekreaciji, Niš: Fakultet sporta i fizičkog vaspitanja, 489-495

Vehrs, P. R., Uvacsek, M., & Johnson, A. W. (2021). Assessment of Dysfunctional Movements and Asymmetries in Children and Adolescents Using the Functional Movement Screen—A Narrative Review. *International Journal of Environmental Research and Public Health*, *18*(23), 12501.

Yildiz, S. (2018). Relationship between Functional Movement Screen and Some Athletic Abilities in Karate Athletes. *Journal of Education and Training Studies*, *6*(8), 66-69.

RAZLIKE U FUNKCIONALNOJ POKRETLJIVOSTI KARATISTA U ODNOSU NA POL I SPECIJALIZACIJU

Ognjen Marić[1], Miloš Mudrić[1]
[1] Univerzitet u Beogradu, Fakultet sporta i fizičkog vaspitanja, Beograd, Srbija

Uvod

Karate je sport višedimenzionalnog karaktera, u kome su najzastupljenije dve takmičarske discipline: kate i borbe. Kate predstavljaju prikaz formalnih ofanzivnih i defanzivnih tehnika koje se izvode slobodno u prostoru po tačno utvrđenom redosledu, odnosno predstavljaju borbu protiv zamišljenih protivnika (Imamura i sar., 2002). Sa druge strane, borbe predstavljaju skup izabranih ofanzivnih i defanzivnih akcija koje se izvode u odnosu na protivnika, obuhvatajući niz tehnika i kretanja koje zahtevaju stalno pomeranje tela u prostoru (Iide i sar., 2008). Takmičari u katama i borbama u prvoj fazi obuke prolaze kroz jedinstveni trenažni proces, da bi u kasnijem periodu došlo do spontane diferncijacije pod uticajem raznih faktora i usmeravanje prema preferentnim takmičarskim disciplinama (Koropanovski, 2012). Višegodišnje vežbanje karatea može uticati na poboljšanje osnovnih motoričkih sposobnosti i to najviše na razvoj eksplozivne snage, brzine i koordinacije (Simonović, 2010). Karate trening podrazumeva adaptaciju vežbača na određene, produžene stavove i kretanja kao specifični ambijent za realizaciju snažnih pokreta (Probst i sar. 2007). Na ispoljavanje sile i snage utiču telesne dimenzije (Jarić, 2003; Jarić i sar. 2005; Nedeljković i sar. 2009), koje mogu imati značajnu ulogu u selekciji takmičara povezano sa različitim zahtevima sportskih disciplina u katama i borbama. U prilog tome govore brojna istraživanja koja su se bavila ispitivanjem razlika između takmičara u borbama i katama u pogledu antropomotričkih i fizioloških karakteristika kao i neuromišićnih funkcija (Mudrić i sar., 2019; Vujkov, 2015; Koropanovski i sar., 2011). Stoga je procena i evaluacija karatista i njihovih specifičnih sposobnosti od velikog značaja za procese upravljanja transformacionim procesima koje nastaju kao posledica trenažne aktivosti karatista obe specijalizacije. Na osnovu dosadašnjih istraživanja u ispitivanju razlika između takmičara u katama i borbama, u ovom radu je primenjena FMS baterija testova sa ciljem da se dobiju dodatna saznanja o postojanju eventualnih razlika u prostoru intra i inter mišićne koordinacije, kao i mobilnosti i stabilnosti svih zglobova. Primenom ovog testa mogu se identifikovati loši obrasci pokreta koji zahtevaju uzajamno delovanje kognitivnih, perceptivnih, proprioceptivnih i motornih funkcija koji uključuju mišićnu snagu i izdržljivost, fleksibilnost, mobilnost, koordinaciju i balans (Vehr i sar., 2021). Predmet ovog istraživanja predstavljaju razlike u osnovnim obrascima pokreta koji se pojavljuju kod karatiskinja i karatista koji se bave disciplinom kate i disciplinom borbe. Cilj ovog istraživanja odnosi se na analizu funkcionalne pokretljivosti karatista i karatiskinja koji se bave disciplinom kate i disciplinom borbe primenom FMS baterije testova.

Metode

Ukupan uzorak u ovom istraživanju činilo je 55 ispitanika koji se aktivno takmiče u disciplini kate, odnosno disciplini borbe, prosečne starosti 14.6 godina. Ukupan uzorak je bio raspoređen u dva subuzorka, od kojih je činilo 25 dečaka prosečne starosti 14.4 godina i 30

devojčica prosečne starosti 14.6 godina. Svaki subuzorak je bio podeljen na dva dodatna subuzorka odnosno prema disciplinama u kojima se takmiče (kate ili borbe). Sa tim imamo 4 subuzorka od kojih su 11 dečaka i 13 devojčica koji se bave disciplinom kate i 14 dečaka i 17 devojčica koji se bave disciplinom borbe. Svi ispitanici su bili podvrgnuti testu sa pitanjima vezanim za lične podatke, kao i rezultate koje u postigli, odnosno da li su imali do sada neku povredu. Testiranje je rađeno u popodnevnim časovima u periodu od 17-18 časova, odnosno u vreme svakodnevnih treninga. Svi ispitanici su bili zdravi. Dva iskusna ispitivača sa prethodnim iskustvom izvođenja FMS baterije testova posmatrali su izvođenje pokreta iz dva ugla, čeonog i bočnog. Na osnovu njihovog usaglašavanja, davana je adekavatna ocena. U koliko je postojala nedoumica, davala se niža ocena. Svaki test ima 4 ocene, na skali od 0 do 3, gde za svaku ocenu postoji definisan standard izvođenja. Uz korišćenje adekvatne opreme, ispitanik izvodi prethodno demonstriran pokret, gde u skladu sa svojim mogućnostima, pokušava da izvede pokret na najbolji mogući način. Varijable za procenu funkcionalne pokretljivosti predstavljaju podaci dobijeni primenom FMS baterije testova. FMS (Functional movement screening) predstavlja bateriju od 7 testova (duboki čučanj sa uzručenim rukama (DČ), iskorak u liniji (ISK), prelazak preko prepreke (PPP), mobilnost ramena (RAME), aktivno podizanje opružene noge (ZL), stabilnost trupa tokom izvođenja upora za rukama (SKLEK), rotatorna stabilnost trupa (ST)) koja procenjuje funkcionalnu stabilnost i mobilnost zglobova.
Ovo istraživanje sprovedeno je po principu transverzalne studije, a zastupljeni su kvalitativni i kvantitativni pristupi kroz posmatranje, deskripciju, metode merenja i testiranje.
prikupljeni podaci su obrađeni putem deskriptivne i komparativne statistike. U okviru deskriptivne statistike broja godina, ukupnog rezultata na FMS testu, kao i rezultata pojedinačnih FMS testova korišćene su Medijana i Interkvartilna razlika. Za procenu razlika između subuzoraka u odnosu na pol i takmičarsku disciplinu korišćen je Mann-Witney test.

Rezultati

U analizi funkcionalne pokretljivosti karatista i karatiskinja koji se bave disciplinom kate i disciplinom borbe, prvenstveno su određeni deskriptivni pokazatelji celokupnog subuzorka za pojedinačne testove kao i za ukupan rezultat.

U tabeli 1. prikazani su ukupni rezulati kao i pojedinačni rezultati FMS baterije testova. Prosečan rezultat iznosi 16.69 što predstavlja rezultat iznad proseka u odnosu na ispitanike tog uzrasta.

Tabela 1 . Prikaz osnovih deskriptivnih pokazatelja celokupnog subuzorka za pojedinačne testove i za ukupni rezultat

	Borbe				Kate			
	Devojčice		Dečaci		Devojčice		Dečaci	
	Medijana	Interkvartilna razlika	Medijana	Interkvartilna razlika	Medijana	Interkvartilna razlika	Medijana	Interkvartilna razlika
DČ	2	1	2	1	2	0	3	0.5
PPP	2	0	2	1	2	1	3	1
ISK	3	0	3	1	3	0	3	0
RAME	3	1	3	0	3	0	3	0
ZL	3	0	2	1	3	0	3	1
SKLEK	2	2	2	1	1	1	3	1
ST	2	0	2	0	2	0	2	0
Ukupno	17	2	16	3.75	16.5	2	18	2

U tabeli 2. prikazana je razlika između između dečaka koje se takmiče u disciplini kate i disciplini borbe na pojedinačnim testovima, kao i na ukupnom testu. Statističke značajne razlike pronađene su na ukupnim rezultatima, kao i u testu prelaska preko prepreke u korist ispitnika koji se bave disciplinom kate.

Tabela 2. Prikaz statistički značajnih razlika između dečaka koje se takmiče u disciplini kate i disciplini borbe na pojedinačnim testovima, kao i na ukupnom testu.

	Borbe dečaci		Kate dečaci			
	Medijana	Interkvartilna razlika	Medijana	Interkvartilna razlika	Mann-Whitney U	p
DČ	2	1	3	0.5	44	**0.045***
PPP	2	1	3	1	58	0.246
ISK	3	1	3	0	60.5	0.252
RAME	3	0	3	0	73	0.697
ZL	2	1	3	1	57	0.22
SKLEK	2	1	3	1	59	0.278
ST	2	0	2	0	74.5	0.844
Ukupno	16	3.75	18	2	41.5	**0.049***

U tabeli 3. prikazane su razlike koji se pojavljuju između dečaka i devojčica u disciplini kate. Značajnije razlike se mogu primetiti u testu duboki čučanj, kao i u testu stabilnosti trupa tokom podizanja iz upora za rukama u korist dečaka.

Tabela 3. Prikaz statistički značajnih razlika između dečaka i devojčica koji se bave disciplinom kate

	Kate devojčice		Kate dečaci			
	Medijana	Interkvartilna razlika	Medijana	Interkvartilna razlika	Mann-Whitney U	p
DČ	2	0	3	0.5	29	**0.005***
PPP	3	1	3	1	70.5	0.946
ISK	3	0	3	0	64	0.449
RAME	3	0	3	0	61	0.348
ZL	3	0	3	1	62	0.485
SKLEK	2	1	3	1	37.5	**0.035***
ST	2	0	2	0	58.5	0.116
Ukupno	17	2	18	2	47	0.15

U tabeli 4. prikazane su razlike između dečaka i devojčica u disciplini borbe. Statistički značajne razlike pronađene su u testovima iskoraka u liniji, testu aktivnog podizanja opružene noge i testu rotatorne stabilnosti trupa u korist devojčica.

Tabela 4. Prikaz statistički značajnih razlika između dečaka i devojčica koji se bave disciplinom borbe

	Borbe devojčice		Borbe dečaci			
	Medijana	Interkvartilna razlika	Medijana	Interkvartilna razlika	Mann-Whitney U	p
DČ	2	1	2	1	113	0.812
PPP	2	0	2	1	90	0.192
ISK	3	0	3	1	84	**0.047***
RAME	3	1	3	0	87	0.106
ZL	3	0	2	1	67	**0.012***
SKLEK	2	2	2	1	104	0.525
ST	2	0	2	0	88	**0.034***
Ukupno	17	2	16	3.75	113.5	0.824

U tabeli 5. Prikazane su razlike između devojčica koje se bave disciplinom kate, odnosno disciplinom borbe. Statistički značajna razlika pronađena je samo u testu prelaska preko prepreke u korist devojčica koje se bave disciplinom kate.

Tabela 5.Prikaz statistički značajnih razlika između devojčica koje se takmiče u disciplini kate i disciplini borbe

	Borbe devojčice		Kate devojčice			
	Medijana	Interkvartilna razlika	Medijana	Interkvartilna razlika	Mann-Whitney U	p
DČ	2	1	2	0	94.5	0.432
PPP	2	0	3	1	54.5	**0.009***
ISK	3	0	3	0	109	0.885
RAME	3	1	3	0	94	0.401
ZL	3	0	3	0	99.5	0.477
SKLEK	2	2	2	1	100.5	0.656
ST	2	0	2	0	104	0.382
Ukupno	17	2	16.5	2	93	0.455

Tabela 6. prikazuje rezultate svih pojedinačnih testova kao i ukupnog rezultata testa ispitanika koji se bave disciplinom borbe u odnosu na to da li su se ranije aktivno takmičili u disciplini kate. Statističke značajne razlike se mogu videti u testu dubokog čučnja i testu prelaska preko prepreke u korist ispitanika koji su se ranije takmičili u discplini kate.

Tabela 6. Prikaz statističkih značajnih razlika između ispitanika koji se bave disciplinom borbe u odnosu na to da li su se ranije takmičili u disciplini kate

	Takmičili se u katama		Nisu se takmičili u katama			
	Medijana	Interkvartilna razlika	Medijana	Interkvartilna razlika	Mann-Whitney U	p
DC	2	1	2	0.5	72	**0.870***
PPP	2	1	2	0	64	**0.029***
ISK	3	0.25	3	0	93.5	0.322
RAME	3	1	3	0.5	107	0.875
ZL	3	1	3	0	88	0.27
SKLEK	2	2	2	2	99.5	0.643
ST	2	0	2	0	91	0.178
Ukupno	17	3.25	16	2	86	0.314

Diskusija

Prosečni rezultati svih ispitanika na testu je iznosio 16.7±2.2. Prema Abrahamu (2015) prosečne vrednosti rezultata dece tog uzrsta iznose 14.6. Sa stanovišta normativnih vrednosti rezultata tog uzrasta, može se primetiti da su rezultati daleko iznad proseka. S obzirom na homogenost grupa u ovom istraživanju, rezultati se mogu apsolutno opravdati. Bolji rezultati ispitanika koji se bave karateom se mogu potkrepiti istraživanjem koje su sproveli Bogusewski i saradnici (2015) u kome se prikazuju bolji rezultati ispitanika koji se bave karateom, u odnosu na one koji se ne bave. Takođe, Mekić (2020) potvrđuje visoke rezultate karatista upoređujući ih sa sportistima iz drugih borilačkih sportiskih grana. Rezultati u ovom istraživanju ukazuju da bavljenje karateom pozitivno utiče na funkcionalnu pokretljivost donjih ekstremiteta. Nešto slabije rezultate u odnosu na rezultate dobijene u ovom istraživanju dobio je Yildiz (2018), pri čemu su

prosečni rezultati iznosili 15,9±2. Slabiji rezutati se mogu objasniti time što su ispitanici bili starijeg uzrasta. U ovom istraživanju upoređivana zavisnost rezultata na FMS testu sa različitim atletskim sposobnostima, pri čemu su pronađene značajne korelacije između visokih rezultata u FMS testu i stabilnosti trupa, kao i visini skoka iz čučnja. Razlika između ispitanika koji se bave disciplinom kate i disciplinom borbe primećena je u svim testovima, ali statistički značajna razlika je viđena jedino u testu prelaska preko prepreke kao i u ukupnim rezultatima. Sličnost ovog rezultata može se uporediti sa rezultatima u istraživanju Mudrića i saradnika (2019) prema kojim dečaci koji se bave disciplinom kate imaju bolje rezultate u testu ravnoteže u odnosu na dečake koji se bave disciplinom borbe. Sa druge strane, dominantna prisutnost tehnike *mae geri* (direktni udarac nogom unapred) u katama, prikazuje sličan motorički obrazac sa ovim testom. Analiza rezultata između ispitanika koji se bave disciplinom borbe koji su se takmičili ranije u katama, i onih koji se nisu ranije takmičili u katama, pokazala je da postoje statistički značajne razlike u testovima dubokog čučnja i prelasku preko prepreke. S obzirom na statistički značajne razlike koje se u ovom istraživanju pojavljuju u ova dva testa u korist dečaka koji se bave disciplinom kate, može se izneti zaključak da kate kao formalni oblik borbi, koji služi kao deo obuke, ima jako veliku ulogu u kreiranju jednog kvalitetnog takmičara u disciplini borbe. Bodden (2015) je takođe u svom radu primetio veliku razliku u funkcionalnosti leve i desne strane tela kada se praktikuju samo specifične vežbe u borilačkim sportovima. Koristeći program korektivnih vežbi zajedno sa uobičajenim treningom, uvideo se napredak u izjednačavanju snage leve i desne strane. S obzirom da su kate apsolutno simetrične u pogledu izvođenja tehnika leve i desne strane kao i kretanja, mogu se ujedno iskoristiti kao alat za održavanje kvalitetne posture i funkcionalnosti jednog takmičara koji se bavi disciplinom borbe.

Zaključak

Osnovni cilj ovog rada je bio da se ispitaju razlike između dečaka i devojčica koji se bave discplinom kate odnosno disciplinom borbe u karateu. Rezultati istraživanja su pokazali da dečaci koji se bave disciplinom kate imaju bolje rezultate u odnosu na dečake koji se bave disciplinom borbe u svim testovima, dok su razlike kod devojčica koje se bave disciplinom kate u odnosu na devojčice koje se bave disciplinom borbe primećene jedino u testu prelaska preko prepreke. S obzirom na različite karakteristike takmičarskih disciplina u karateu (kate i borbe) u pogledu ujednačenosti ispoljavanja snage obe strane tela, dovodi do mišićnog disbalansa još u uzrastu kadeta i juniora, pa kao opasnost koja može uslediti jeste pojava povreda. Primenom ovog testa mogu se uvideti problematičnosti rane specijalizacije koja je sve prisutnija u ovom borilačkom sportu. S tim u vezi, bez obzira na takmičarsku opredeljenost prema jednoj od dve takmičarske discipline (kate i borbe), kate moraju biti obavezni deo trenažnog procesa naročito kod karatista koji se opredeljuju za takmičenje u disciplini borbe. Na osnovu dosadašnjih istraživanja kao i rezultata u ovom istraživanju, neophodno je permanetno usavršavanje i reprogramiranje trenažnih planova kako bi se izbegli neželjeni efekti u celokupnoj obuci.

Literatura

Abraham, A., Sannasi, R., & Nair, R. (2015). Normative values for the functional movement screentm in adolescent school aged children. International journal of sports physical therapy, 10(1), 29.

Bodden, J. G., Needham, R. A., & Chockalingam, N. (2015). The effect of an intervention program on functional movement screen test scores in mixed martial arts athletes. *The Journal of Strength & Conditioning Research*, *29*(1), 219-225.

Boguszewski, D., Jakubowska, K., Adamczyk, J. G., & Białoszewski, D. (2015). The assessment of movement patterns of children practicing karate using the Functional Movement Screen test. *J Combat Sports Martial Arts*, *6*(1), 21-26.

Iide, K., Imamura, H., Yoshimura, Y., Yamashita, A., Miyahara, K., Miyamoto, N., et al. (2008). Physiological responses of simulated karate sparring matches in young men and boys. Journal of Strength and Conditioning Research, 22(3): 839-844.

Imamura, H., Yoshimura, Y., Nishimura, S., Nakazawa, A.T. (2002). Physiological responses during and following karate training in women. Journal of Sports and Medicine Physiological Fitness, 42:431-437.

Jaric, S. (2003). Role of body size in the relation between muscle strength and movement performance. Exercise and Sport Science Reviews, 31(1): 8-12.

Jarić, S., Mirkov, D., Marković, G. (2005). Normalizing psysical performance tests for body. Zbornik radova, Deveti međunarodni naučni skup FIS komunikacije u sportu, fizičkom vaspitanju i rekreaciji, 489-495. Niš, Fakultet sporta i fizičkog vaspitanja.

Koropanovski, N., Berjan, B., Bozic, P., Pazin, N., Sanader, A., Jovanovic, S., Jaric, S. (2011). Anthropometric and Physical Performance Profiles of Elite Karate Kumite and Kata Competitors. Journal of Human Kinetics, 30:107-114.

Mekic, A., Vrevic, E., Malovic, P., Kapo, S., & Kajmovic, H. (2020). Differences in the Quality of Movement Functionality between Judokas, Karatekas, and Non-Athletes. *Journal of Anthropology of Sport and Physical Education*, *4*(4), 21-26.

Mudrić, M., Aleksić, B., Goran, K., Jovanović, S., & Suzović, D. (2019). Morphological characteristics and motor skills of junior age karate athletes different specialization. *Godišnjak Fakulteta sporta i fizičkog vaspitanja*, (24), 40-48.

Nedeljkovic, A., Mirkov, D.M., Bozic, P., Jaric, S. (2009). Tests of muscle power output: the role of body size. International Journal of Sports Medicine, 30(2): 100-6.

Probst, M.M., Fletcher, R., Seeling, D.S. (2007). A comparison of lower-body flexibility, strength, and knee stability between karate athletes and active controls. Journal of Strength and Conditioning Research, 21(2):451-455.

Simonović, Z., Kozomora, G., Mujanović, R., Projović, A. (2010) Razlika u morfološkim karakteristikama između nesportista i karatista. u: Zbornik radova, Deveti međunarodni naučni skup FIS komunikacije u sportu, fizičkom vaspitanju i rekreaciji, Niš: Fakultet sporta i fizičkog vaspitanja, 489-495

Vehrs, P. R., Uvacsek, M., & Johnson, A. W. (2021). Assessment of Dysfunctional Movements and Asymmetries in Children and Adolescents Using the Functional Movement Screen—A Narrative Review. *International Journal of Environmental Research and Public Health*, *18*(23), 12501.

Yildiz, S. (2018). Relationship between Functional Movement Screen and Some Athletic Abilities in Karate Athletes. *Journal of Education and Training Studies*, *6*(8), 66-69.

GAZE FIXATIONS OF U18 BASKETBALL PLAYERS DURING CONTESTED THREE-POINT JUMP SHOTS AFTER PASSES FROM TWO DIFFERENT ANGLES

Matic Sirnik[1], Frane Erčulj[1], Grega Močnik[2], Jernej Rošker[3]
[1] University of Ljubljana ,Faculty of Sport , Ljubljana, Slovenia
[2] University of Maribor, Faculty of Electrical Engineering and Computer Science, Maribor, Slovenia
[3] University of Primorska, Faculty of Health Sciences, Koper, Slovenia

Introduction

Basketball is a polystructural complex sport consisting of technical and tactical elements of offence and defence (Erčulj et al., 2018). One of the most important and at the same time most demanding offensive technical elements is shooting (Covaci et al., 2014). In each game, a single team takes approximately eighty shots, including free throws and jump (game) shots. Unlike free throws, jump shots are taken from different positions on the court and with different techniques. Most often, jump shots are executed with one hand above the head (Erčulj, F., & Zovko, 2020). The success of such a shot during the game is influenced by a number of factors, including: shot time, release angle, height and speed of the shot, stable movement execution, physical characteristics and fatigue of the player, and distance to the basket at the time of the (Okazaki et al., 2015). In addition to these factors, visual attention is an important factor contributing to a better understanding of the successful shooting (Vickers et al., 2019a).

Visual attention, more specifically the fixation of central vision, influences the perception of important information from the environment during the preparation and execution of a movement, in case of basketball, during the preparation and execution of a jump shot (Ripoll et al., 1986; Vickers, 1996b). When such visual attention to a given point persists for at least 100 ms and does not move more than 2° of the visual field, we speak of the Quiet eye (QE) (Vickers, 2007). QE is the final fixation of central vision and has three important functions in the accurate execution of a jump shot (Vickers, 1996a, 1996b):

- it indicates the preparation time for the final movement of the arm and the whole body during the shot (Mann et al., 2011; Vickers, 1996b),
- helps prevent the integration of unwanted movements during the shot (Wilson, 2008), and
- may be related to the processes that reduce or prevent distraction by other, less important auditory and visual information from the environment (Lebeau et al., 2016; Vickers, 2012).

The first research in basketball was conducted in 1986 (Ripoll et al., 1986). 10 years later, in 1996, Joan Vickers began further research on visual attention with the development of eye-tracking devices to monitor central vision during dynamic movement tasks (Vickers, 1996a, 1996b). At the same time, she defined the term "quiet eye". Since then, a rough division of research of visual attention in basketball over the past 26 years has been made; on one side, research on free throws and on the other side, research on jump shots. This division is reasonable due to the temporal and spatial characteristics of the game. Since free throws are consistently taken under constant conditions, without time pressure and without the defender interfering with the shot, research under dynamic game conditions is particularly important. Such dynamic situations are important to

research, since recent trends in the game dictate the use of the three-point shot, which is increasingly common in modern basketball (Erčulj, F., & Zovko, 2020). Therefore, future research should focus mainly on three things: dynamic game shot situations, differences between head and body rotation before the shot and no rotation, and temporal and spatial constraints

Methods

Participants

We used an improbable sample determined by the method of expert selection. 10 elite male basketball players of the final selection for the Slovenian national team in the age categories U18 were tested. Adults and minors participated in the study. Prior to the measurements, the adult participants completed and signed an informed consent form for voluntary participation in the study; for the underage participants, the informed consent form was signed by their parents.

Procedure

Each player participated once in the study and completed two sets of shots. Measurements were performed at the Faculty of Sport, in the same gymnasium and at the same basket for all participants.

Upon arrival at the gym and before the 10-minute warm-up, the height and body weight of the barefoot subjects were measured with a measuring device and a scale. After the initial measurements and a warm-up period, instructions for the test were given. Then we placed an eye tracker on the subjects' heads and instructed them to take 10 test shots to get used to the eye tracker. After 10 test shots, we began the main test (Figure 1), in which each subject performed two sets of three-point shots after receiving the passed ball. In both sets, the player shot from the same position, namely from the longitudinal centre of the court at an angle of 0° to the basket (point guard position). In the first set, the passer stood on the longitudinal midline in relation to the subject and the angle between them was 0°. In the second set, the passer stood on the three-point line at an angle of 70° to the longitudinal centerline of the court. In both sets, the passer was 5 metres away from the shooter, which is approximately the average length of the pass under game conditions (Erčulj et al., 2016; Erčulj et al., 2016). In both sets, the passer executed chest passes with both hands, without the ball bouncing off the floor, directly into the subject's chest. The defender was also present in both sets, attempting to obstruct and block the shooters' shots. The defender started his movement at the moment when the shooter received the ball after the pass. In both sets, the defender started his movement 1.75 metres away from the shooter, in the first set from the side of the subject's non-shooting hand at an angle of 45° to the longitudinal centre of the court and in the second set at an angle of 45° to the passing line. In both sets of a single shooter, the defender was the same person who was as identical as possible to the subject in terms of height and playing position. In addition, the starting positions of the shooter, passer, and defender were marked on the floor with coloured tape. A valid shot for analysis was any shot from the marked spot behind the three-point line that was not blocked or touched by a defender. In addition, only direct hits were valid (hits that bounced off the backboard were not included in the analysis). Before each shot, the subject had to have at least one foot on the marked spot and was allowed to take the approach step with the other leg. In both sets, the subject had to walk from the shooting position to the centre of the court and back to the shooting position after every fifth counted shot to

break the shooting routine. The subject had to hit at least 10 shots and miss at least 10 shots in each set. The required number of hits and misses was not known to the shooters; they were only given an indication of the beginning and end of each set. All shots were performed with a 94fifty smart basketball that recorded the time of a single shot. In this way, the sufficient speed of the shot was verified to be as close as possible to the competitive situation under time pressure.

Placement of players on the court for both sets of shots

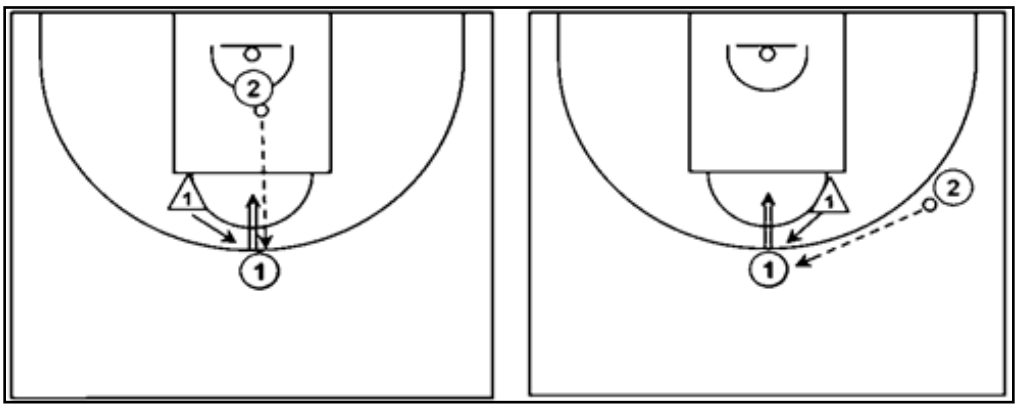


Figure 1. Situation 1 and situation 2; for the first set of three-point shots with passes coming from underneath the basket and for the second set of three-point shots with passes coming from the side. The number 1 in the circle is the shooter, the circled number 2 is the passer, and the number 1 in the triangle is the defender.

Accessories

The characteristics of the QE were studied using objective methods. The subjects' body weight and height were measured using a personal scale and a height measuring device Seca 799 (Seca gmbh & co. KG, Hamburg, Germany). The Tobii Pro Glasses 2 eye tracker (Tobii, Danderyd, Sweden) was used to measure visual attention. We used a 94fifty ball (InfoMotion Sports Technologies Inc., Dublin, Ohio, USA) to measure shot time. In addition, two external Logitech C920 cameras (Logitech, Lausanne, Switzerland) were used to record the measurements and to support data analysis. We recorded the following variables: age, height, weight, duration of QE and onset of QE.

Data analysis

We processed the eye tracker recordings using the Tobii Pro Lab program (Tobii, Danderyd, Sweden). Data analysis was performed using IBM SPSS Statistics 27 (SPSS Inc., Chicago, USA), and Microsoft Excel (version 2016, Microsoft Corporation, Redmond, USA). QE duration, QE onset, and shooting performance were analysed. Differences in QE onset and QE duration between the two passing angles, and hits and misses were analysed using two-way repeated measures ANOVA and post hoc tests. In addition, correlations between observed parameters were analysed. All data were processed with a 95% confidence interval.

Results

Average QE onsets, presented in Figure 2, were calculated as mean values. The average QE onset was longer for successful shots, regardless of the passing angle. When comparing successful shots after the pass from two different angles, the average QE onset was longer when the pass came from under the basket than when the ball was passed from the side along the three-point line.

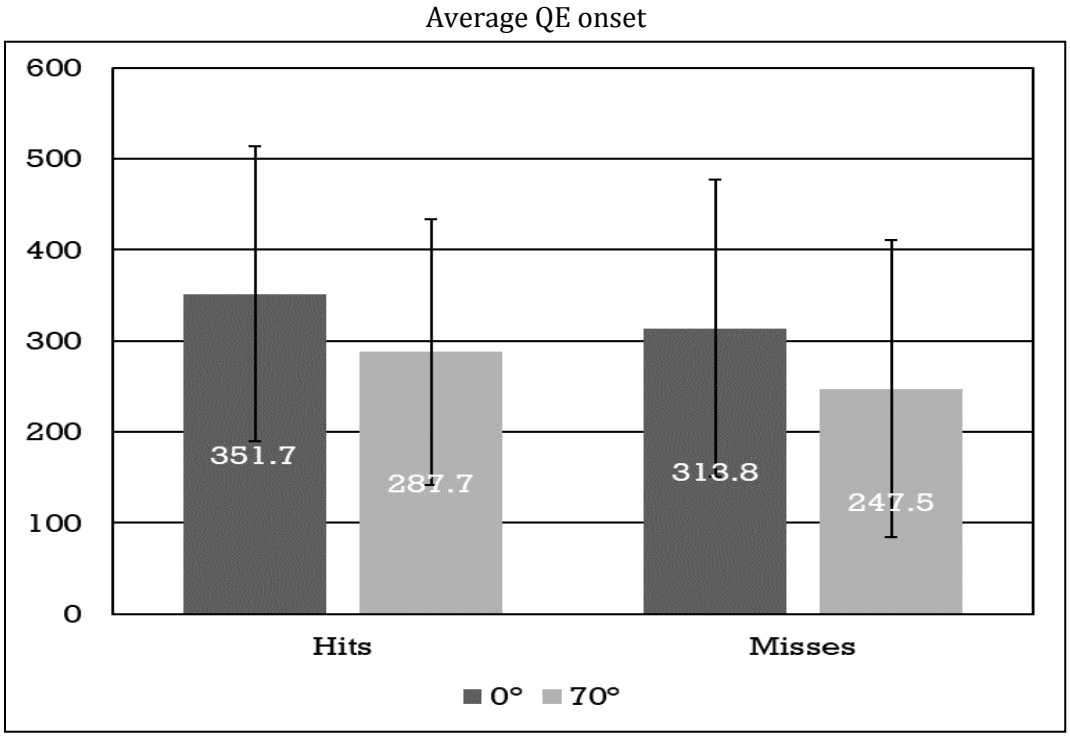


Figure 2. Bar chart of average QE onset, relative to start of elbow extension, during successful and unsuccessful shots at two different passing angles.

The average durations of QE, shown in Figure 3, were calculated as the mean values. The average QE duration was longer for successful shots, regardless of the passing angle. When comparing successful shots after passing from two different angles, the average QE duration was longer when the pass came from under the basket than when the ball was passed from the side. Unlike QE onset, the duration of QE was similar when comparing only successful shots regardless of the passing angle.

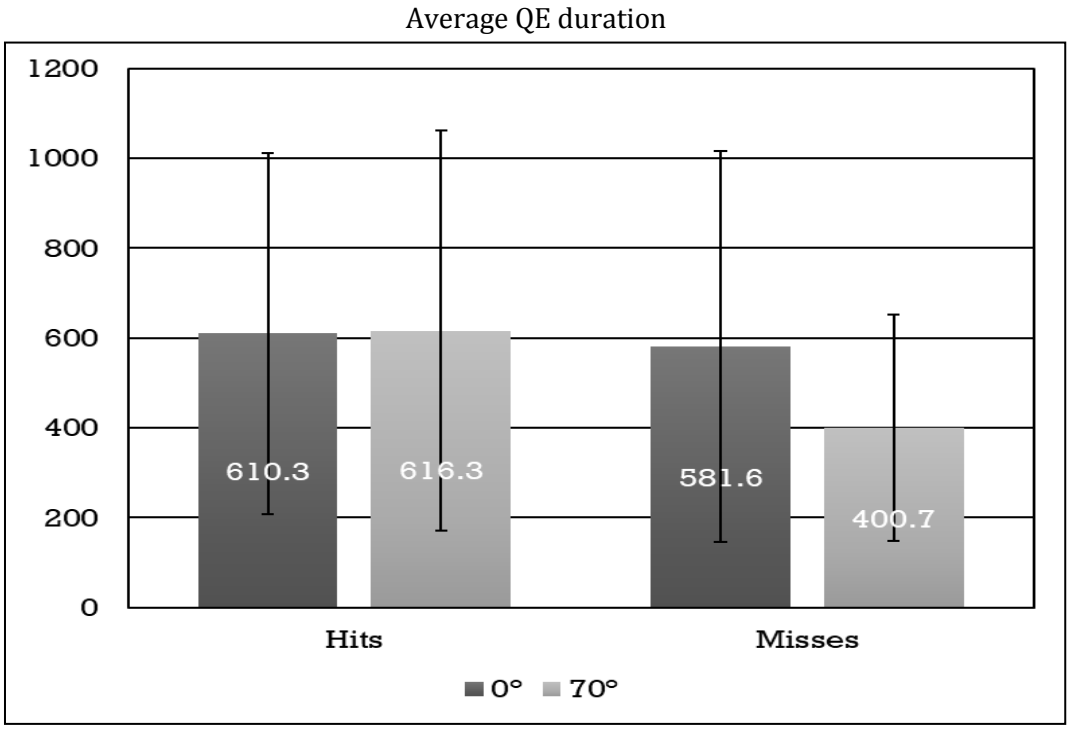


Figure 3. Bar chart of average QE duration during successful and unsuccessful shots at two different passing angles.

Table 1. Effect of passing angle on QE duration and QE onset

	df	F	p	η_p^2
QE duration	9	2.93	.104	.37
QE onset	9	8.21	.010	.31

Notes. df - degrees of freedom; F - test statistics; η_p^2 - partial eta squared.

Table 1 shows the effect of the passing angle on the duration of QE and the onset of QE. A two-way repeated measures ANOVA revealed a nonsignificant effect of passing angle on QE duration (F (1,9) =2.93, p = .104, η_p^2 = .37), but a main effect of passing angle on QE onset (F (1,9) = 8.21, p = .010, η_p^2 = .31) was detected.

Table 2. Post-hoc test analysis for passing angle on QE onset.

	df	t	p	d
Hits	9	2.20	.055	.02
Misses	9	1.90	.091	

Notes. df - degrees of freedom; *t* - test statistics.

The results of the post hoc analysis for the effect of passing angle on the onset of QE are shown in Table 2. No statistically significant effect of passing angle on the onset of QE was found, regardless of the success of the shot. However, the effect of passing angle on QE onset during successful shots was marginally significant (p = .055, d = .02).

Table 3. Correlation between QE duration / QE onset and shooting performance (%).

	r	p
QE duration hits 0°	-.769	.009
QE duration hits 70°	.067	.855
QE duration misses 0°	-.646	.044
QE duration misses 70°	.103	.777
QE onset hits 0°	-.345	.329
QE onset hits 70°	-.382	.276
QE onset misses 0°	-.375	.285
QE onset misses 70°	-.515	.128

Notes. r - Spearman's rho.

Table 3 shows the correlation analysis between the duration of QE and shooting performance for successful and unsuccessful shots, and the correlations between the onset of QE and shooting performance for successful and unsuccessful shots. We found a statistically significant correlation between QE duration and shooting performance after a pass from underneath the basket but not from the side (r = (-.769 - .939), p = (.000 - .044)).

Discussion

For the analysis, we decided to use two variables, that are most often used in research in connection not only to visual attention in basketball but also to performance in sport. These two variables are QE duration and QE onset. In order to recreate game situations as well as possible and not tire the subject more than necessary, we have created two shooting situations. In both situations the defender, which is an important factor affecting QE onset and QE duration (Klostermann et al., 2018; Rojas et al., 2000; Vickers et al., 2019b), was obstructing the shooter and tried to block the shot. The first replication of game situation represents a jump shot after an inside-out play, and the second situation replicates an extra pass along the three-point line.

First, took a look at the average duration of QE and QE onset during three-point jump shots after a pass. We found out, that the QE started earlier on successful shots than on unsuccessful ones. In addition, the QE onset was earlier on successful shots after a pass under the basket than in the situation where the shooter had to turn his head and body before executing the jump shot. Earlier onset of QE was expected, regardless of the discrepancies of previous research (de Oliveira et al., 2008; Oudejans et al., 2005; Vickers et al., 2019b), especially in the situation, where the player has to perform a head and body turn while finding the target, representing a delay for target fixation. Similar results emerged when we analysed the average QE duration. In light of the results of previous research (van Maarseveen et. al., 2018; Vickers et al., 2019b), we also found that successful shots were again characterized by a longer duration of last central vision fixation to the target. An interesting thing emerged regarding QE durations for successful shots; average QE durations were quite similar regardless of the angle of the pass. This finding means that a player has enough time to execute a long enough QE even if he has to turn his head and body prior to the shot.

Further statistical analysis revealed that the passing angle affected the onset of QE but not the QE duration. The results reconfirmed that a player has sufficient time to fix his central vision on

the target regardless of the playing conditions on the court, and in our situation regardless of where the pass comes from. We can speculate that because of a few facts; similar QE duration, the later onset of QE, the need to turn the body and head before the shot when the pass comes from the side, and no statistically significant differences in the duration of QE on hit shots, the duration of the shot itself is probably longer after the pass from the side. Such finding is particularly important for practical work, since a longer shot duration gives the defender a better opportunity to block the shot, and it allows him to get a little farther away from the shooter when he does not have the ball, thus helping his teammates a more. In addition, we tested whether there were differences between successful and unsuccessful shots in terms of passing angle. Although the results are close to statistical significance, we cannot say that the passing angle effecting QE onset differentiates regarding the success of the shot.

Because we recorded subjects' shooting performance (%) during the test, we checked whether there was a correlation between QE duration and shooting performance or QE onset and shooting performance. The only statistically significant results we found were that the duration of QE was correlated to shooting performance in shots after a pass at an angle of 0°. Interestingly, when looking at the correlation during successful shots when the pass comes from underneath the basket, it appears that a shorter QE is associated with higher shooting performance, meaning that subjects shot better when they performed shorter final visual fixations. Such finding is in contradiction with previous research during jump shots after a pass (van Maarseveen et. al., 2018; Vickers et al., 2019a) or even in game situations (Klostermann et al., 2018). Thus, it would be interesting to find out what is the shortest QE duration sufficient for a player to successfully take a shot at the basket. Additionally, according to our analysis, QE onset is not directly correlated to performance, so both types of players can be successful: those who make their visual fixation in the initial phases of the shot and those who do so later.

All in all, caution should be used when applying the results, especially due to small sample size and different QE characteristics that we found when looking at the raw data of the subjects during the shots. There were two subjects whose results particularly influenced our final results and potentially statistical analysis. In this context, we can clearly see what is happening with visual fixation during recording for some subjects, but not for others. The question about such a condition is in whom QE characteristics tell us something in terms of performance and in whom they do not. We can speculate that there is a relationship between QE, the planning and execution of the movement (the shot) and the successful shot, but so far, we cannot make any claims.

We believe that the direction of future research should be mainly in the study of visual attention in replicated game situations, on a bigger sample of the best basketball players of different age categories. In this way, we will obtain more comprehensive information about the importance of QE in basketball shooting performance, along with the directions of how the training of elite basketball players of different ages should be prepared.

Conclusion

Among the many factors influencing shooting performance in basketball is visual attention, more specifically the final central vision fixation, the so-called “quiet eye”. Its characteristics, especially QE onset, can be affected by the angle of the pass; because the head and body must be turned and players must locate the target, delayed QE onset occurs when the pass comes from the

side. Also, a longer QE duration and earlier QE onset does not always lead to a better shooting performance. It is important for successful shooting to have a sufficient time window in which QE can be established, and it appears that there is always sufficient time to do so, regardless of the angle of the pass. In addition, QE needs further investigation to confirm that it may be an absolute measure of performance and to provide guidance for training planning in practise. Future research should therefore focus primarily on investigating how different passing angles and maximal defensive pressure affect QE in top players of different age groups.

References

Covaci, A., Oliver, A.-H., & Multon, F. (2014). Third Person View And Guidance For More Natural Motor Behaviour In Immersive Basketball Playing. In Proceedings of the 20th ACM Symposium on Virtual Reality Software and Technology (Pp. 55-64)., 55–64.

de Oliveira, R. F., Oudejans, R. R. D., & Beek, P. J. (2008). Gaze behavior in basketball shooting: Further evidence for online visual control. Research Quarterly for Exercise and Sport, 79(3), 399–404.

Erčulj, F., & Zovko, V. (2020). Znanost o metu na koš. Fakulteta za šport, Inštitut za šport.

Erčulj, F., Bergant, B., Gašparin, D., & Sila, A. (2018). Košarka v obdobju osnovne šole. Univerza v Ljubljani, Fakulteta za šport.

Erčulj, F., Debeljak, G., & Štrumbelj, E. (2016). Analiza uporabe različnih tipov podaj pri mladih košarkarjih. Revija Šport, 64, 115–119.

Erčulj, F., Mirt, G., & Štrumbelj, E. (2016). Analiza uporabe različnih tipov podaj vrhunskih košarkarskih ekip. Revija Šport, 64, 113–117.

Klostermann, A., Panchuk, D., & Farrow, D. (2018). Perception-action coupling in complex game play: Exploring the quiet eye in contested basketball jump shots. Journal of Sports Sciences, 36(9), 1054–1060.

Lebeau, J.-C., Liu, S., Sáenz-Moncaleano, C., Sanduvete-Chaves, S., Chacón-Moscoso, S., Becker, B. J., & Tenenbaum, G. (2016). Quiet eye and performance in sport: A meta-analysis. Journal of Sport and Exercise Psychology, 38(5), 441–457.

Mann, D. T. Y., Coombes, S. A., Mousseau, M. B., & Janelle, C. M. (2011). Quiet eye and the Bereitschaftspotential: visuomotor mechanisms of expert motor performance. Cognitive Processing, 12(3), 223–234.

Okazaki, V. H. A., Rodacki, A. L. F., & Satern, M. N. (2015). A review on the basketball jump shot. Sports Biomechanics, 14(2), 190–205.

Oudejans, R. R. D., Koedijker, J. M., Bleijendaal, I., & Bakker, F. C. (2005). The education of attention in aiming at a far target: Training visual control in basketball jump shooting. International Journal of Sport and Exercise Psychology, 3(2), 197–221.

Ripoll, H., Bard, C., & Paillard, J. (1986). Stabilization of head and eyes on target as a factor in successful basketball shooting. Human Movement Science, 5(1), 47–58. https://doi.org/10.1016/0167-9457(86)90005-9

Rojas, F. J., Cepero, M., Ona, A., & Gutierrez, M. (2000). Kinematic adjustments in the basketball jump shot against an opponent. Ergonomics, 43(10), 1651–1660.

van Maarseveen, M. J. J., & Oudejans, R. R. D. (2018). Motor and gaze behaviors of youth basketball players taking contested and uncontested jump shots. Frontiers in Psychology, 9(MAY), 1–9.

Vickers, J. N. (1996a). Control of visual attention during the basketball free throw. American Journal of Sports Medicine, 24(SUPPL.), 93–97.

Vickers, J. N. (1996b). Visual control when aiming at a far target. Journal of Experimental Psychology. Human Perception and Performance, 22(2), 342–354.

Vickers, J. N. (2007). Perception, Cognition, and Decision Training: The Quiet Eye in Action. Human Kinetics.

Vickers, J. N. (2012). Neuroscience of the quiet eye in golf putting. International Journal of Golf Science, 1(1), 2–9.

Vickers, J. N., Causer, J., & Vanhooren, D. (2019a). The role of quiet eye timing and location in the basketball three-point shot: A new research paradigm. Frontiers in Psychology, 10(OCT).

Vickers, J. N., Causer, J., & Vanhooren, D. (2019b). The role of quiet eye timing and location in the basketball three-point shot: A new research paradigm. Frontiers in Psychology, 10, 2424.

Wilson, M. (2008). From processing efficiency to attentional control: a mechanistic account of the anxiety–performance relationship. International Review of Sport and Exercise Psychology, 1(2), 184–201.

THE INFLUENCE OF TRAINING PROCESS WITHIN THE VOLLEYBALL CAMP ON TECHNIQUE PERFORMANCE

Teodora Rajevac[1], Nikola Majstorović[1], Catalin Stirbu[2], Goran Nešić[1]
[1] University of Belgrade, Faculty of Sport and Physical Education, Belgrade, Serbia
[2] University of Iași Alexandru Ioan Cuza, Faculty of Physical Education and Sports, Iași, Romania

Introduction

In their program, volleyball camps offer content that contributes to mastering technique, acquiring healthy habits and socialization. The most important things are the high quality trainings, different types of lectures and excursions. Children can see what it's like to be a professional athlete. Some volleyball players are experiencing training twice a day for the first time, since the 2-2-1 training system is most often implemented at the camps. Such a system involves two training sessions a day for two days in a row, while the athletes rest on the third day, and that cycle repeats.

The organizers of the camps can be clubs, where children are trained mainly by coaches already known to them, and as a rule, those who will train them in the upcoming season. Camps can also be organized by a group of individuals, often internationally known volleyball players and coaches. In this case, top volleyball players have a significant role in showing proper volleyball technique. During the presentation of the game elements, it is important that the children's attention and motivation is at a high level. During the training, they will try to perform a given element of the technique as close as possible to the model, in accordance with their capabilities.

The relatively short period of time that covers a volleyball camp can mean a lot to young athletes. They then realize most of the mistakes they make while performing volleyball technique. The role of the coach is to intensively work on correcting errors and to constantly encouraging players to correct a certain movement. Volleyball players understand what they need to do in order to improve further. Shortly, the advice received from the coach can benefit the player not only for period of the camp duration or the upcoming season, but for the entire period of playing this sport. The trainings held at the camp must be age-appropriate in volume, intensity, training methods and exercises. In addition, enough props should be provided for a successful camp, especially if tests are conducted at the camp.

Volleyball technique is complex to learn. There are numerous definitions of volleyball technique in the literature. One of them is: "Volleyball technique is the rational and efficient execution of various locomotions, in order to solve motor tasks in the process of training and matches" (Nešić, 2007). The process of adopting the technique takes years and requires frequent work. The technique of volleyball is characterized by the fact that, unlike the techniques of other sports games, the contact with the ball lasts for a very short time. Playing the ball in this way requires a lot of precision and practice in order to successfully solve the tasks that are put in front of the volleyball players. At volleyball camps main goal is to constantly work on learning and perfecting the correct technique. The topic of the influence of the training process within the volleyball camp is insufficiently researched, especially in domestic literature. Therefore, there is a desire to point out the importance that the camps have for the future development of those who practice this sport.

The opinions of volleyball experts about the influence of the training process within the volleyball camp on the manifestation of technique are different. Coaches often have opposing views when it comes to the importance of volleyball camps. There is not so many data on this topic, and existing facts from the field of science and practice do not give a clear enough answer to this question.

The author Canatach Chris (Canatach, 2015) states that there are three types of camp, the most important for this topic is the all-skills camp. The goal of that camp is to learn all the technical elements that are necessary for playing volleyball. Quality technical presentations by coaches and accurate repetitions by volleyball players are the key to acquiring or improving any skill. In addition to this, there is a team or club camp and a special camp for improving one particular skill.

The subject of the work is the evaluation of technical and tactical elements in volleyball before and after the training process within the volleyball camp. If there is a difference in assessment, it is necessary to state in which elements it was determined and to what extent. The aim of this study is the presentation and analysis of the evaluation of technical and tactical elements in volleyball. Also, the goal is to determine the connection between the training process within the volleyball camp and the possible progress of the volleyball players in performing the technique.

Methods

In this study, there was used a quasi-experimental approach. The applied statistical data processing procedure was done using statistical data processing software. The research was conducted on a sample of 20 female respondents, members of the Volleyball School "Dif". The age of the respondents is 13 ± 1 years. All respondents had been training for three years at the time of testing and all participated in a seven-day camp organized by the aforementioned volleyball school in August 2022. The initial evaluation was carried out three days before the camp, and the final evaluation three days after its finish. The respondents and their parents were informed about the purpose of the research and voluntarily agreed to participate in the research.

The criteria for the selection of respondents were as follows: the age of the respondents in the sample is from 12 to 14 years; that the respondents are active members of the Volleyball School "Dif"; to train volleyball for at least 3 years, 3 to 4 times a week for 60 minutes; to actively participate in the implementation of training; that all subjects are healthy; that they did not have any injury just before or at the time of the research. The sample of variables included five variables of the technical space (overhead pass, "forearm pass", spiking without jump, spike over the net and service). The technical elements were evaluated by an expert evaluation by five evaluators. The evaluators were professors and graduated students of the Faculty of Sports and Physical Education from subject of Volleyball, who were not coaches of the respondents. The range of grades was from 1 to 10. The first three elements were graded in pairs. The spike over the net was performed with the help of another examinee who played the role of setter. The service was performed behind the baseline of the volleyball court.

The experimental treatment lasted 7 days. The program was implemented in the preparatory period within the camp in Kladovo from August 17.08.2022. until 24.08.2022. Each training consisted of a part in which the volleyball players were adequately warmed up and prepared for the exercises that awaited them, after which the exercises were conducted. The morning trainings lasted 60 minutes, and the afternoon trainings lasted 90 minutes, and the test

subjects had trainings two days at a time, then one day one and so on again. The exercises were distributed so that in the first days, less demanding, less stressful exercises were performed, with a smaller number of sets and repetitions, and in later days, more complex exercises were performed with an increased number of repetitions and sets, respecting the principle of easier to harder and familiar towards the unknown. The vast majority of the training was focused on improving the performance of the elements of volleyball technique, but also on the use of those elements in the situation of the volleyball game.

Table 1. Training plan and program of volleyball camp 2022.

	Before noon	Afternoon
Day 1	Arrival	Relaxation, stretching
Day 2	Overhead pass and forearm pass	Freeball, service and reception
Day 3	Blocking technique, footwork, single, double, triple block	Defense (individual, group, team), positioning in court according to opponent's attack
Day 4	Free activities	Block - defense, situation exercises
Day 5	Spiking without jump, defense – individual and group defense	Spike over the net, team defense – positioning
Day 6	Service and reception, attack organisation, attacker protection	Defense – attack transition, counterattack transition
Day 7	3 on 3, tournament	6 on 6, tournament

The chosen methods are in accordance with the set tasks and the subject of the work. The procedures of descriptive statistics (mean value, standard deviation, minimum and maximum value) and comparative statistics (T - test for dependent samples) were used for data processing. The obtained data of the expert assessment were processed by calculating the mean value of the grades of all evaluators. The results were processed using the statistical program Excel (Microsoft Office 2010). The significance of the changes in the value of the variables has been established, so the level of determination for the statistical significance of the differences is $r<0.05$.

Results

The technical level of volleyball elements was determined by an expert assessment. Five evaluators participated in the research. The range of grades was from 1 to 10, so that the research has greater sensitivity. The data in the following table represent the average grades from the initial and final measurements, which were obtained using descriptive statistics procedures.

Table 2. Statistical results using descriptive methods (WJ – without jump, ON –over the net)

Descriptive statistics	OVERHEAD PASS		FOREARM PASS		SPIKE (WJ)		SPIKE (ON)		SERVICE		TOTAL	
	I	F	I	F	I	F	I	F	I	F	I	F
AV	6.75	6.81	6.85	6.82	5.45	5.88	5.05	5.62	5.7	5.67	5.63	6.25
STDEV	0.99	0.84	1.19	1.2	1.47	1.1	1.77	1.53	1.68	1.86	1.46	1.12
MIN	5	5.4	4	3.8	2	3.2	2	2.2	3	2.8	2.2	3.56
MAX	9	8.2	9	8.6	9	7.6	9	8.6	9	9	8.4	8.08

Table 2 shows the descriptive parameters of a sample of 20 volleyball players. The results show that the highest average value of all evaluated elements at the initial measurement was 8.40,

and the lowest was 2.20. At the final measurement, the lowest average grade is 3.56, and the highest is 8.08. The difference between the highest and the lowest average value of the grades on the initial measurement is 6.20, and on the final 4.52 (with the lowest average grade higher by 1.36 than the one on the initial evaluation). This means that the training process within the camp was especially meaningful to the respondents who achieved lower grades on the initial measurement. Over the course of seven days, the group homogenized to a certain extent in the technical aspect of performing volleyball elements.

Table 3. Statistical results using comparative methods

Variable	Differences		T - test	Significance
	AV	STDEV		
OVERHEAD PASS	-0.1	0.455	-0.59	0.562
FOREARM PASS	0.03	0.351	0.382	0.707
SPIKE (WJ)	-0.4	0.816	-2.356	**0.029**
SPIKE (ON)	-0.6	0.941	-2.709	**0.014**
SERVICE	0.03	0.363	0.37	0.716
TOTAL	-0.6	0.664	-4.177	**0.001**

The results in table 3 indicate that statistically significant differences between the initial and final measurements appeared in the technique of spiking without jump and spiking over the net, while there was no change in the other elements. The level of statistical significance for the technique spiking without jump in pair is p=.029, while for the technique of spike over the net it is p=.014. The performance of the mentioned elements has been improved (from 0.43 to 0.57 absolute increase in average values). The overhead pass, the forearm pass and the service technique do not show a statistically significant difference between the measurements, although there was a trend of positive change.

The variability of the results is the highest for spiking without jump (0.816) and spike over the net (0.941), which shows that the element in which the respondents differ the most is spike over the net. This was expected, considering that this element of the technique is the most complex to adopt of all the evaluated ones. The lowest variability of the results was calculated for forearm pass and that value is 0.351. This is justified by the fact that this element takes a long time to learn, as well as overhead pass, but usually the first technique is easier to learn and perform.

Therefore, taking into account the complexity of the mentioned elements and the observed variability among the test subjects, which is a consequence of insufficiently adopted technique, it is expected that there will be a certain significant increase in those elements, compared to the elements that have already been mastered to a large extent and whose variability among respondents is very low.

Discussion

The goal of the research was to determine the adoption level of the volleyball elements technique before and after the training process within the volleyball camp. The obtained results showed that the training process at the volleyball camp can influence certain elements of the technique. There was an improvement in the spiking elements, while the other elements stagnated. Mentioned elements have the most space for improvement, because it takes a lot of time to adopt

them. At this age, progress is relatively fast for the mentioned elements because they have not yet been perfected to the greatest extent possible.

A successful spike over the net requires a high jump and a strong hit on the ball. Spike technique is a combination of explosiveness, agility, coordination and reaction time (Nasuka, 2020). Reaction time is also very important and it can be improved. This was determined by research that showed an improvement in reaction time in team sports with a suitable training program (Badau et al., 2022). Strength is necessary for effective spike, especially: strength of the legs, abdominal muscles, shoulder girdle muscles and arms. Since the research refers to the age of 12 to 14 years, then the sensitive period of strength development takes place (Bijelić, 2005) and this motor ability has to develop yet. Situational conditioning training does not have a significant impact on the precision of performing technical elements in volleyball, but the goal should be to improve motor skills, and among them explosive power, which mostly affects the height of the jump. According to Višnjić and colleagues, strength develops more intensively in the period from 12 to 16 years (Višnjić, 2004).

Explosive power, which is closely related to the vertical jump, is essential for a volleyball player. This is shown by the research conducted by Lidor and Ziv (Lidor, 2010). Players of more successful teams have higher vertical jump values. Accordingly, in a similar study conducted by the same authors, training should be programmed that develops strength and improves fitness while emphasizing the importance of plyometric training that can improve jump height (Ziv, 2010). In women's soccer and volleyball, counter movement jump height results are highly correlated with strength parameters (Krawczyk et al., 2021). Jumps in general, even the jump during the jump, are characterized by the appearance of the spinal stretch reflex (Mrdaković, 2019), the maximum manifestation of which is mainly paid attention to by more experienced athletes.

For other elements, this period of time was not enough to achieve a significant improvement. Overhead pass, the forearm pass and the service are learned first. The respondents had been practicing the above-mentioned elements for years, so the period of intensive training of seven days justifiably did not produce results. In the overhead pass technique contact with the ball is prolonged a little bit more than in other kinds of technique. Playing the ball in this way simulates natural forms of movement, such as catching and throwing. Determining the flight trajectory of the ball, using this type of technique, is complex action, the management of which is in charge of the largest surfaces of brain structures located in the cortex of the cerebrum (Savić, 2017).

The forearm pass is a technique of playing ball with the most proximal part of the body. For this reason, the control of the movement is facilitated and there are fewer errors in execution and to a lesser extent. According the principle of proximodistality, forearm pass has the greatest movement control from the aspect of motor control of all other elements. After playing ball with forearms, the ball moves along an arc path towards the goal and the degree of error that can occur is smaller than with a spike, for example.

The service is the only element that is performed independently in this collective sport. The server is fully responsible for the way it is performed. The ball is held before the performance, so it makes it easier to control. The server has a certain amount of time to prepare for performance, which contributes to better concentration. The conditions in which the serve is served are not as unpredictable as the other elements that depend on the performance of teammates and opposing players. A good ball toss is key to a successful serve. Whatever type of serve it is, except the

underhand serve, in today's volleyball, the aim for the serve is to be an attacking element as much as possible. This request is often made in younger selections as well. The service has a pronounced psychological component, precisely because of its individuality.

Blocking is an indispensable part of volleyball technique and is one of the basic elements of volleyball. However, the block as a technical element was not evaluated in this research, because examined age group has not mastered yet this element in period of intervention. The reason is that more attention is paid to the technique of overhead pass and forearm pass, along with the service technique. The double block technique is just starting to be practiced at the age of 13 to 14 (Nešić, 2021), until then the single block was practiced. The block is a demanding element because it requires proper technique, good timing and coordination with teammates. In addition, blocking aims to stop powerful attacks from opponents who have high spike reach. At this age, such players are exceptions, so there is no very much need to block them.

So, there was a difference in some features, and in some there is no statistically significant difference. The seven-day training process did not give results completely. It is believed that one more week, and a total of 14 days of the training process within the camp, would give even better results. Certainly, it is significant that there has been an improvement in the execution of certain elements of the technique. This speaks in favor of the fact that volleyball camps, in addition to all other advantages, are a good choice for volleyball players for technical training and improvement.

Conclusion

Based on the results, it can be concluded that there are statistically significant differences in the manifestation of two of the five variables examined. During the camp, the execution of the spiking technique was improved. The obtained data show that the training process at the volleyball camp can be extremely important for improving the technique. It is assumed that the fourteen - day training process within the volleyball camp would be even more significant for progress in the technical manifestation of volleyball elements, the adoption of which requires a lot of time and a large number of repetitions. Therefore, future research could investigate the impact of the training process within the two - week camp on the manifestation of technique.

The practical applicability of this study is to look at the volleyball camp even more expediently. Training technology could be modified so that at volleyball camps there are more exercises for learning and perfecting less mastered technical elements, with constant correction of errors in volleyball technique, which are very important to correct on time.

References

American Volleyball Coaches Association, Cecile Reynaud. (2015). The Volleyball Coaching Bible, Volume 2. Human Kinetics.

Bijelić, Simović. (2005). Školski sport Srbije.

Badau D., Badau A., Ene-Voiculescu C., Larion A., Ene-Voiculescu V., Mihaila I., Leonard Fleancuj., Tudor V., Tifrea C, Sebastian Cotovanu A., Abramiuc A. (2022). The Impact of Implementing an Exergame Program on the Level of Reaction Time Optimization in Handball, Volleyball, and Basketball Players. Int J Environ Res Public Health, 19 (9), 5598.

Višnjić, D., Jovanović, A., Miletić, K. (2004). Teorija i metodika fizičkog vaspitanja. Beograd: Univerzitet u Beogradu. Fakultet sporta i fizičkog vaspitanja.

Ziv G., Lidor R. (2010). Vertical jump in female and male volleyball players: a review of observational and experimental studies. Scan J Med Sci Sports, 13 (9), 332-339.
Karalić T. (2015). Odbojka - Tehnički elementi igre, Banja Luka: Fakultet u Banjoj Luci, Fakultet fizičkog vaspitanja i sporta.
Kumar S., Goswami J., Kumar A. (2016). Effect of Training Program on Volleyball Skills of Inter-University level Volleyball Player. International Journal of Movement Education and Sports Sciences, 4 (1), 21-25.
Krawczyk M., Pociecha m., Kozioł P., Stepek A., Gębica G. (2021). Jumping Test for Assessing Peak Power in female Volleyball and football players. Women in Sport and Physical Activity Journal, 29 (2), 87-94.
Lidor R., Ziv G. (2010). Physical and Physiological Attributes of Female Volleyball Players-A Review. Journal of Strength and Conditioning Research 24 (7), 1963-1973.
Mrdaković V., Nikolić D., Bačanac Lj. (2019). Motorno ponašanje: motorna kontrola i motorno učenje,Beograd: Fakultet sporta i fizičkog vaspitanja.
Nešić G., Majstorović N., Vićentijević A., Savić Z., Bratuša Z. (2020). Dugoročni razvoj odbojkaša kroz poredak učenja sistema igre. Fizička kultura 74 (1), 82-92.
Nešić G., Ilić D., Majstorović N., Grbić V., Osmankač N. (2013). Uticaj treninga na opšte i specifične motoričke sposobnosti odbojkašica 13-14 godina. SportLogia, 9 (2), 119-127.
Nešić G. (2021). TiT odbojke. Algoritmi etapnih ciljeva u usvajanju odbojkaške tehnike.
Nešić G. (2022). TiT Odbojke. Oprema za kamp.
Nasuka Nasuka (2020). Conference on Sport Science, Health, and Physical Education. The Antropometric Profile and Motor Skill of Men Elite Volleyball Players. Advances in Health Sciences Research, 21, 34-37.
Trajković N. (2015). Doktorska disertacija. Uticaj situaciono-kondicionog treninga na eksplozivnu snagu i preciznost kod odbojkaša.
Savić V. (2017). Osnove odbojke. Pale: Fakultet fizičkog vaspitanja i sporta.
Haibach, P. S., Reid, G., & Collier, D. H. (2011). Motor learning and development. Human Kinetics.
Wicaksono D., Hidayatullah F., Kristiyanto A., Purnama S. K. (2022). The effect of training based on part and whole combinations on smash techniques improvement in volleyball sports for 11-12 year old athletes. Physical Education Theory and Methodology, 22 (1), 62-69.

UTICAJ TRENAŽNOG PROCESA U OKVIRU ODBOJKAŠKOG KAMPA NA ISPOLJAVANJE TEHNIKE

Teodora Rajevac[1], Nikola Majstorović[1], Catalin Stirbu[2], Goran Nešić[1]
[1] Univerzitet u Beogradu - Fakultet sporta i fizičkog vaspitanja, Beograd, Srbija
[2] Univerzitet u Jašiju Alexandru Ioan Cuza - Faculty of Physical Education and Sports, Jaši, Rumunija

Uvod

U svom programu odbojkaški kampovi nude sadržaje koji doprinose savladavanju tehnike, sticanju zdravih navika i socijalizaciji. Najbitnije je da treninzi budu kvalitetni, ali pored toga organizuju se različite vrste predavanja i izleti. Deca mogu da sagledaju kako je to biti profesionalni sportista. Neki odbojkaši i odbojkašice se po prvi put susreću sa treniranjem dva puta dnevno, budući da se na kampovima najčešće sprovodi sistem treniranja 2-2-1. Takav sistem podrazumeva dva treninga dnevno dva dana zaredom, dok se treći dan sportisti odmaraju, pa se taj ciklus ponavlja.

Organizatori kampova mogu biti klubovi, gde decu treniraju uglavnom njima već poznati treneri i to po pravilu oni koji će ih trenirati predstojeće sezone. Kampove može organizovati i grupa pojedinaca, često međunarodno poznatih odbojkaša i trenera. U ovom slučaju, vrhunski odbojkaši imaju značajnu ulogu u prikazivanju pravilne odbojkaške tehnike. Tokom prikazivanja elemenata igre važno je da pažnja i motivacija dece bude na visokom nivou. Oni će tokom treninga pokušati da izvedu dati element tehnike što približnije modelu, u skladu sa njihovim mogućnostima.

Relativno kratak period koji obuhvata odbojkaški kamp može mnogo da znači za mlade sportiste. Oni tada uviđaju većinu grešaka koje naprave u toku izvođenja odbojkaške tehnike. Uloga trenera je velika i intenzivno se radi na otklanjanju grešaka i stalno se daje podstrek da se određeni pokret ispravi. Odbojkaši i odbojkašice shvataju na čemu treba da rade kako bi se dalje usavršavali. Ukratko, saveti koji se dobijaju od trenera mogu koristiti igraču ne samo za kamp ili predstojeću sezonu, već za čitav period bavljenja ovim sportom. Treninzi koji se održavaju na kampu moraju biti prilagođeni uzrastu obimom, intenzitetom, trenažnim metodama i sredstvima. Pored toga, za uspešan kamp treba obezbediti dovoljno rekvizita, posebno ako se na kampu sprovode testiranja.

Odbojkaška tehnika je kompleksna za usvajanje. U literaturi postoje brojne definicije odbojkaške tehnike. Jedna od njih glasi: „Odbojkaška tehnika je racionalno i efikasno izvođenje različitih lokomocija, radi rešavanja motoričkih zadataka u procesu treninga i utakmice“ (Nešić, 2007). Proces usvajanja tehnike traje godinama i zahteva učestali rad. Tehnika odbojke je karakteristična po tome što, za razliku od tehnika drugih sportskih igara, kontakt sa loptom traje veoma kratko. Odigravajući loptu na taj način, potrebno je mnogo preciznosti i vežbe kako bi se zadaci koji se stavljaju pred odbojkaše uspešno rešili. Imajući ovo u vidu, na odbojkaškim kampovima se neprestano radi na učenju i usavršavanju pravilne tehnike. Tema uticaja trenažnog procesa u okviru odbojkaškog kampa je nedovoljno istražena, posebno u domaćoj literaturi. Zbog toga, postoji želja da se ukaže na značaj koji kampovi imaju za budući razvoj onih koji se bave ovim sportom.

Mišljenja odbojkaških stručnjaka o uticaju trenažnog procesa u okviru odbojkaškog kampa na ispoljavanje tehnike su različita. Treneri često imaju suprotstavljene stavove kada je reč o

značaju odbojkaških kampova. Malo je podataka o ovoj temi, a postojeće činjenice iz oblasti nauke i prakse ne daju dovoljno jasan odgovor na ovo pitanje.

Autor Kanatač Kris (Canatach, 2015) navodi da postoje tri tipa kampa, od kojih je najznačajniji za ovu temu kamp svih veština (eng. all - skills camp). Cilj tog kampa je naučiti sve tehničke elemente koji su neophodni za igranje odbojke. Kvalitetni tehnički prikazi trenera i tačna ponavljanja odbojkaša su ključ za sticanje ili usavršavanje svake veštine. Pored ovog, postoji timski ili klupski kamp i specijalni kamp za usavršavanje jedne veštine.

Predmet rada je evaluacija tehničko - taktičkih elemenata u odbojci pre i nakon trenažnog procesa u okviru odbojkaškog kampa. Ukoliko postoji razlika u oceni, potrebno je navesti u kojim elementima je utvrđena i u kojoj meri. Cilj rada je prikaz i analiza evaluacije tehničko - taktičkih elemenata u odbojci. Takođe cilj je da se utvrdi povezanost između trenažnog procesa u okviru odbojkaškog kampa i eventualnog napretka odbojkašica u izvođenju tehnike.

Metode

U radu je primenjen kvazi - eksperimentalni pristup. Primenjena statistička procedura obrade podataka je urađena pomoću softvera za statističku obradu podataka. Istraživanje je sprovedeno na uzorku od 20 ispitanika ženskog pola, članica Škole odbojke "Dif". Uzrast ispitanika je 13 ± 1 godina. Svi ispitanici su u trenutku testiranja trenirali tri godine i svi su učestvovali na kampu koje je organizovala navedena škola odbojke u avgustu 2022. u trajanju od sedam dana. Inicijalno merenje je sprovedeno tri dana pre kampa, a finalno tri dana po njegovom završetku. Ispitanici i njihovi roditelji su bili upoznati sa ciljem istraživanja i dobrovoljno su pristali da učestvuju u istraživanju.

Kriterijumi za izbor ispitanika su bili sledeći: starost ispitanika u uzorku je od 12 do 14 godina; da su ispitanici aktivni članovi Škole odbojke "Dif"; da treniraju odbojku najmanje 3 godine i to 3 do 4 puta nedeljno u trajanju od 60 minuta; da aktivno učestvuju u realizaciji treninga; da su svi ispitanici zdravi; da nisu imali neposredno pre ili u trenutku istraživanja neku povredu.

Uzorak varijabli obuhvatao je pet varijabli tehničkog prostora (prsti, „čekić", smečiranje u paru/ napucavanje, smeč i servis). Tehnički elementi su evaluirani ekspertskom ocenom od strane pet ocenjivača. Ocenjivači su bili profesori i navršeni studenti Fakulteta sporta i fizičkog vaspitanja sa usmerenja TiT Odbojka, a koji nisu treneri ispitanica. Raspon ocena kretao se od 1 do 10. Prva tri elementa su se ocenjivala u formaciji parova. Smeč preko mreže se izvodio uz pomoć drugog ispitanika koji je imao ulogu dizača. Servis se izvodio iza osnovne linije odbojkaškog terena.

Eksperimentalni tretman trajao je 7 dana. Program je bio realizovan u pripremnom periodu u okviru kampa u Kladovu od 17.08.2022. do 24.08.2022. Svaki trening sastojao se iz dela u kome su odbojkašice bile na adekvatan način zagrejane i pripremljene za vežbe koje su ih očekivale, nakon čega su bile sprovođene vežbe. Prepodnevni treninzi su trajali 60 minuta, a popodnevni 90 minuta i ispitanice su imale treninge dva dana po dva, pa jedan dan jedan i ponovo tako. Vežbe su bile raspoređene tako da se u prvim danima radilo kroz manje zahtevne, manje stresne vežbe, sa manjim brojem serija i ponavljanja, a u kasnijim danima izvodile su se kompleksnije vežbe sa povećanim brojem ponavljanja i serija, poštujući princip od lakšeg ka težem i od poznatog ka nepoznatom. Velika većina treninga bila je usmerena upravo na poboljšanje u izvođenju elemenata odbojkaške tehnike, ali i na upotrebi tih elemenata u situaciji odbojkaške igre.

Tabela 1. Program treninga

	Prepodne	Popodne
1. dan	Dolazak	Rasterećenje od puta
2. dan	Odigravanje prstima i "čekićem", povezivanje	Dodavanje kontre, servis i prijem
3. dan	Tehnika blokiranja, prikaz bloka, kretnja, individualni, dvojni i trojni blok	Odbrana polja, individualno, grupno, ekipno, pozicioniranje u odnosu na protivnički napad
4. dan	Slobodno	Saradnja blok – odbrana, situacione vežbe
5. dan	Smečiranje u paru, odbrana u polju, individualno i grupno	Smečiranje preko mreže, pozicioniranje u odbrani ekipno
6. dan	Servis i prijem, organizacija napada, zaštita napadača	Tranzicija odbrana – napad, organizacija kontranapada
7. dan	Igra 3 na 3, turnir	Igra 6 na 6, turnir

Izabrane metode su u skladu sa postavljenim zadacima i predmetom rada. Za obradu podataka korišćeni su postupci deskriptivne statistike (srednja vrednost, standardna devijacija, minimalna i maksimalna vrednost) i komparativne statistike (T - test za zavisne uzorke). Dobijeni podaci ekspertskog ocenjivanja obrađeni su kroz izračunavanje srednje vrednosti ocena svih ocenjivača. Rezultati su obrađeni korišćenjem statističkog programa Eksel (Majkrosoft Ofis 2010). Značajnost promena u vrednosti varijabli je utvrđena, pa nivo determinacije za statističku značajnost razlika iznosi $p<0.05$.

Rezultati

Tehnički nivo odbojkaških elemenata utvrđen je ekspertskom ocenom. Pet ocenjivača je učestvovalo u istraživanju. Raspon ocena iznosi od 1 do 10, kako bi istraživanje imalo veću osetljivost. Podaci koji se nalaze u narednoj tabeli predstavljaju prosečne ocene sa inicijalnog i finalnog merenja koje su dobijene korišćenjem postupaka deskriptivne statistike.

Tabela 2. Rezultati deskriptivne statističke analize (AV – srednja vrednost, STDEV – standardna devijacija, MIN – minimum, MAX - maksimum)

	PRSTI		ČEKIĆ		NAP.		SMEČ		SERVIS		UKUPNO	
	I	F	I	F	I	F	I	F	I	F	I	F
AV	6.75	6.81	6.85	6.82	5.45	5.88	5.05	5.62	5.7	5.67	5.63	6.25
SD	0.99	0.84	1.19	1.2	1.47	1.1	1.77	1.53	1.68	1.86	1.46	1.12
MIN	5	5.4	4	3.8	2	3.2	2	2.2	3	2.8	2.2	3.56
MAX	9	8.2	9	8.6	9	7.6	9	8.6	9	9	8.4	8.08

U tabeli 2 prikazani su deskriptivni parametri na uzorku od 20 odbojkašica. Rezultati pokazuju da je najveća prosečna vrednost svih ocenjivanih elemenata na inicijalnom merenju bila 8,40, a najmanja 2,20. Na finalnom merenju najmanja prosečna ocena iznosi 3,56, a najveća 8,08. Razlika između najveće i najmanje prosečne vrednosti ocena na inicijalnom merenju iznosi 6,20, a na finalnom 4,52 (sa najmanjom prosečnom ocenom većom za 1,36 od one na inicijalnom merenju). To znači da je trenažni proces u okviru kampa posebno značio ispitanicima koji su ostvarili niže ocene na inicijalnom merenju. Tokom sedam dana, grupa se u tehničkom pogledu izvođenja odbojkaških elemenata homogenizovala u određenoj meri.

Tabela 3. Rezultati komparativne statistike sa statistički značajnim razlikama u trećem i četvrtom redu (AS– aritmetička sredina, SD– standardna devijacija)

Varijabla	Razlike			
	AS	SD	Z	p
PRSTI	-.060	.455	-0.573	.566
ČEKIĆ	.030	.351	-0.608	.543
NAPUCAVANJE	-.430	.816	-2.183	**.029**
SMEČ	-.570	.941	-2.312	**.021**
SERVIS	.030	.363	-0.367	.713
UKUPNO	-.620	.664	-3.269	**.001**

Rezultati u tabeli 3 ukazuju da su se kod tehnike smečiranja u paru (napucavanja) i smeča preko mreže pojavile statistički značajne razlike između inicijalnog i finalnog merenja, dok kod ostalih elemenata nije došlo do promene. Nivo statističke značajnosti za tehniku napucavanja lopte u paru iznosi p=.029, dok za tehniku smeča iznosi p=.014. Izvođenje navedenih elemenata je poboljšano (od 0.43 do 0.57 apsolutni prirast kod prosečnih vrednosti). Tehnika odigravanja lopte prstima, čekićem i tehnika servisa ne pokazuju statistički značajnu razliku između merenja, iako je bio prisutan trend pozitivne promene.

Varijabilnost rezultata je najveća kod napucavanja (0.816) i smeča (0.941), što pokazuje da je element u čijem izvođenju se ispitanici najviše razlikuju upravo smeč. Ovakav podatak je očekivan, sa obzirom da je ovaj element tehnike najkompleksniji za usvajanje od svih ispitivanih. Najmanja varijabilnost rezultata izračunata je kod odigravanja lopte čekićem i iznosi 0.351. To se opravdava činjenicom da se čekić dugo uči, kao i tehnika odigravanja lopte prstima, ali se obično prva tehnika lakše usvaja i izvodi.

Dakle, uzevši u obzir kompleksnost pomenutih elemenata i uočenu varijabilnost kod ispitanica, što je posledica nedovoljno usvojene tehnike, očekivano je da će upravo kod tih elemenata da dođe do određenog značajnijeg prirasta, u odnosu na elemente koji su već u velikoj meri savladani i čija je varijabilnost među ispitanicima vrlo niska.

Diskusija

Cilj istraživačkog rada je bio da se odredi nivo usvojenosti tehnike odbojkaških elemenata pre i nakon trenažnog procesa u okviru odbojkaškog kampa. Dobijeni rezultati su pokazali da trenažni proces na odbojkaškom kampu može da utiče na određene elemente tehnike. U elementima napucavanje i smeč je došlo do poboljšanja, dok su ostali elementi stagnirali. Kod navedenih elemenata je bilo najviše prostora za napredak, jer je dosta vremena potrebno da se usvoje. U ovom uzrastu je relativno brz napredak za navedene elemente jer se oni još uvek nisu usavršavali u najvećoj mogućoj meri.

Za uspešan smeč iz skoka je potreban visok skok i snažan udarac po lopti. Tehnika smeča je spoj eksplozivnosti, agilnosti, koordinacije i vremena reakcije (Nasuka, 2020). Vreme reakcije se može unaprediti. To je utvrđeno istraživanjem koje je odgovarajućim programom treninga pokazalo poboljšanje vremena reakcije u kolektivnim sportovima (Badau et al.,2022). Snaga je neophodna za efikasan smeč i to posebno: snaga nogu, trbušnih mišića, mišića ramenog pojasa i ruku. Budući da se istraživanje odnosi na uzrast od 12 do 14 godina, tada se odvija senzitivni period razvoja snage (Bijelić, 2005) i ova motorička sposobnost treba tek da se razvije. Situaciono -

kondicioni trening nema značajniji uticaj na preciznost izvođenja tehničkih elemenata u odbojci, ali bi za cilj trebalo postaviti poboljšanje motoričkih sposobnosti, a među njima i eksplozivne snage koja u velikoj meri utiče na visinu skoka. Prema Višnjiću i saradnicima snaga se intenzivnije razvija u periodu od 12 do 16 godina (Višnjić, 2004).

Eksplozivna snaga koja je u uskoj povezanosti sa vertikalnim skokom je od suštinske važnosti za odbojkaša. To pokazuje istraživanje koje su sproveli Lidor i Ziv (Lidor, 2010). Igrači uspešnijih timova imaju veće vrednosti vertikalnog skoka. U skladu sa tim, u sličnom istraživanju koje su sproveli isti autori, trebalo bi programirati treninge koji razvijaju snagu i poboljšavaju kondiciju uz isticanje značaja pliometrijskog treninga koji može da poboljša visinu skoka (Ziv, 2010). U ženskom fudbalu i odbojci, rezultati visine sunožnog skoka bez zamaha ruku (eng. counter movement jump) su u visokoj korelaciji sa parametrima snage (Krawczyk et al., 2021). Skokove uopšte, pa i skok prilikom smeća, karakteriše pojava spinalnog refleksa na istezanje (Mrdaković, 2019), na čije maksimalno ispoljavanje pažnju obraćaju uglavnom iskusniji sportisti.

Kod ostalih elemenata ovaj vremenski period nije bio dovoljan za postizanje značajnijeg boljitka. Tehnike odigravanja lopte prstima, čekićem i tehnika servisa se uče prve. Ispitanici su, već godinama uvežbavali navedene elemente, pa period intenzivnog treniranja od sedam dana opravdano nije dao rezultate. U tehnici odigravanja prstima omogućen je produženi kontakt sa loptom. Odigravanjem lopte na ovaj način se simuliraju prirodni oblici kretanja, kao što su hvatanje i bacanje. Određivanje trajektorije leta lopte prstima je složena radnja za čije upravljanje su zadužene najveće površine moždanih struktura koje se nalaze u kori velikog mozga (Savić, 2017).

Tehnika odigravanja lopte „čekićem“ je tehnika odigravanja podlakticama, najproksimalnijim delom tela. Iz tog razloga je upravljanje pokretom olakšano i dolazi do manjeg broja grešaka u izvođenju i u manjoj meri. Što je segment bliži trupu po principu proksimodistalnosti, to je kontrola pokreta veća iz aspekta motorne kontrole. Nakon odigravanja „čekićem“ lopta se kreće lučnom putanjom ka cilju i manji je stepen greške koji može da se javi, nego kod smeća, na primer.

Servis je jedini element koji se izvodi samostalno u ovom kolektivnom sportu. Server je u potpunosti odgovoran za način njegovog izvođenja. Lopta se pre izvođenja drži, pa to olakšava kontrolu. Server ima određeno vreme da se spremi za izvođenje što doprinosi boljoj koncentraciji. Uslovi u kojima se servira nisu u tolikoj meri nepredvidivi kao kod ostalih elemenata koji zavise od odigravanja saigrača i protivničkih igrača. Dobro podbacivanje lopte je ključno za uspešan servis. Koja god vrsta servisa da je u pitanju, osim donjeg servisa, u današnjoj odbojci se teži ka tome da servis bude što je više moguće napadački element. Ovaj zahtev se često postavlja i u mlađim selekcijama. Servis ima izraženu psihološku komponentu, upravo zbog svoje individualnosti.

Blokiranje je neizostavni deo odbojkaške tehnike i čini jedan od osnovnih elemenata odbojke. Međutim, blok kao tehnički element nije ocenjivan u okviru ovog rada, jer se u ispitivanom uzrastu ne radi u velikoj meri na njegovom usavršavanju. Razlog je u tome što se više pažnje obraća na tehniku odigravanja lopte prstima i „čekićem“, uz tehniku servisa. Tehnika dvojnog bloka u uzrastu od 13 do 14 godina tek počinje da se radi (Nešić, 2021), do tada se uvežbavao jedinačni blok. Blok je zahtevan element jer zahteva odgovarajuću tehniku, dobar tajming i usklađenost sa saigračima. Pored toga, blokiranje ima za cilj da zaustavi snažne napade protivnika koji imaju visok dohvat. U ovom uzrastu takvi igrači su izuzeci, pa za njihovim blokiranjem nema prevelike potrebe.

Dakle, došlo je do razlike u nekim osobinama, a kod nekih nema statistički značajne razlike. Sedmodnevni trenažni proces nije dao rezultate u potpunosti. Smatra se da bi još jedna nedelja, a ukupno 14 dana trenažnog procesa u okviru kampa dalo još bolje rezultate. Svakako, značajno je da je došlo do poboljšanja u izvođenu određenih elemenata tehnike. To govori u prilog tome da su odbojkaški kampovi, pored svih ostalih prednosti, dobar izbor odbojkaša za tehničko obučavanje i usavršavanje.

Zaključak

Na osnovu rezultata može se zaključiti da postoje statistički značajne razlike u ispoljavanju dve od pet varijabli koje su ispitivane. Tokom kampa, izvođenje tehnike smečiranja je poboljšano. Dobijeni podaci pokazuju da trenažni proces na odbojkaškom kampu može biti od izuzetnog značaja za poboljšanje tehnike. Pretpostavlja se da bi trenažni proces u okviru odbojkaškog kampa u trajanju od četrnaest dana, bio još značajniji za napredak u tehničkom ispoljavanju odbojkaških elemenata, za čije usvajanje je potrebno dosta vremena i veliki broj ponavljanja. Zbog toga bi istraživanja u budućnosti mogla da istraže uticaj trenažnog procesa u okviru dvonedeljnog kampa na ispoljavanje tehnike.

Praktična primenjivost ove studije je da se odbojkaški kamp posmatra još svrsishodnije. Trenažna tehnologija bi mogla da se modifikuje tako da na odbojkaškim kampovima budu zastupljenije vežbe učenja i usavršavanja manje savladanih tehničkih elemenata, uz stalno ispravljanje grešaka u odbojkaškoj tehnici, koje je važno na vreme ispraviti.

Literatura

American Volleyball Coaches Association, Cecile Reynaud. (2015). The Volleyball Coaching Bible, Volume 2. Human Kinetics.

Bijelić, Simović. (2005). Školski sport Srbije.

Badau D., Badau A., Ene-Voiculescu C., Larion A., Ene-Voiculescu V., Mihaila I., Leonard Fleancuj., Tudor V., Tifrea C, Sebastian Cotovanu A., Abramiuc A. (2022). The Impact of Implementing an Exergame Program on the Level of Reaction Time Optimization in Handball, Volleyball, and Basketball Players. Int J Environ Res Public Health, 19 (9), 5598.

Višnjić, D., Jovanović, A., Miletić, K. (2004). Teorija i metodika fizičkog vaspitanja. Beograd: Univerzitet u Beogradu. Fakultet sporta i fizičkog vaspitanja.

Ziv G., Lidor R. (2010). Vertical jump in female and male volleyball players: a review of observational and experimental studies. Scan J Med Sci Sports, 13 (9), 332-339.

Karalić T. (2015). Odbojka - Tehnički elementi igre, Banja Luka: Fakultet u Banjoj Luci, Fakultet fizičkog vaspitanja i sporta.

Kumar S., Goswami J., Kumar A. (2016). Effect of Training Program on Volleyball Skills of Inter-University level Volleyball Player. International Journal of Movement Education and Sports Sciences, 4 (1), 21-25.

Krawczyk M., Pociecha m., Kozioł P., Stepek A., Gębica G. (2021). Jumping Test for Assessing Peak Power in female Volleyball and football players. Women in Sport and Physical Activity Journal, 29 (2), 87-94.

Lidor R., Ziv G. (2010). Physical and Physiological Attributes of Female Volleyball Players-A Review. Journal of Strength and Conditioning Research 24 (7), 1963-1973.

Mrdaković V., Nikolić D., Bačanac Lj. (2019). Motorno ponašanje: motorna kontrola i motorno učenje,Beograd: Fakultet sporta i fizičkog vaspitanja.

Nešić G., Majstorović N., Vićentijević A., Savić Z., Bratuša Z. (2020). Dugoročni razvoj odbojkaša kroz poredak učenja sistema igre. Fizička kultura 74 (1), 82-92.

Nešić G., Ilić D., Majstorović N., Grbić V., Osmankač N. (2013). Uticaj treninga na opšte i specifične motoričke sposobnosti odbojkašica 13-14 godina. SportLogia, 9 (2), 119-127.

Nešić G. (2021). TiT odbojke. Algoritmi etapnih ciljeva u usvajanju odbojkaške tehnike.

Nešić G. (2022). TiT Odbojke. Oprema za kamp.
Nasuka Nasuka (2020). Conference on Sport Science, Health, and Physical Education. The Antropometric Profile and Motor Skill of Men Elite Volleyball Players. Advances in Health Sciences Research, 21, 34-37.
Trajković N. (2015). Doktorska disertacija. Uticaj situaciono-kondicionog treninga na eksplozivnu snagu i preciznost kod odbojkaša.
Savić V. (2017). Osnove odbojke. Pale: Fakultet fizičkog vaspitanja i sporta.
Haibach, P. S., Reid, G., & Collier, D. H. (2011). Motor learning and development. Human Kinetics.
Wicaksono D., Hidayatullah F., Kristiyanto A., Purnama S. K. (2022). The effect of training based on part and whole combinations on smash techniques improvement in volleyball sports for 11-12 year old athletes. Physical Education Theory and Methodology, 22 (1), 62-69.

CORRELATION BETWEEN SOME MOTOR SKILLS AND KNOWLEDGE OF SKIING

Danijela Kuna[1]
[1] University Josip Juraj Strossmayer of Osijek, Faculty of kinesiology, Osijek, Croatia

Introduction

Alpine skiing is one of the most popular forms of winter sports, which millions of people around the world engage in recreationally. It is a complex sports activity that includes the cardiovascular, neuromuscular, and sensorimotor systems of an individual, static and dynamic muscle work (Müller & Schwameder, 2003; Malliou et al., 2004; Krautgasser et al., 2009; Kröll et al., 2010). Alpine skiing includes different skiing techniques and movement structures in position and movement. An indispensable part of the teaching methodology of alpine skiers consists of snowplowing, parallel, and carving skiing techniques, which encompass numerous specific skiing elements. A prerequisite for the successful acquisition of specific ski skills is the mastery, development, and improvement of basic motor knowledge (Burton & Miller, 1998; Karabournitios et al., 2002; Haibach et al., 2011). Therefore, good skiers have a high level of acquisition of characteristic motor knowledge, which is recognized as the skill of performing characteristic skiing elements. Subsequently, they need a smaller amount of energy compared to skiers with a lower level of skiing knowledge (Franjko, 2012). Along with previous skiing knowledge and experience, the quality of the acquisition and performance of skiing elements is conditioned by precise sensorimotor skills, and specific anthropological characteristics of the individual, namely aerobic-anaerobic capacity, muscle strength, and complex motor abilities of balance, agility, and coordination (Geissler et al., 2012; Gorski et al., 2014; Cigrovski et al., 2016). Nevertheless, the motor ability of balance is probably what distinguishes people who will quickly learn to ski from those who will gain this motor activity more slowly (Kostelić, 2009; Cigrovski et al., 2017). In alpine skiing, both forms of balance, static and dynamic, have special importance. They enable maintenance and establishment of a stable position on skis, return after its disruption, adaptation to different types of ski terrain, and continuous movement on skis (Şimşek et al., 2020., Kuna et al., 2020., Cigrovski et al., 2017., Malliou et al., 2004). The low level of maintenance and establishment of a balanced position on skis increases the risk of falls and injuries for skiers (Hrysomallis 2007), which, due to the specifics of terrain conditions and equipment, can lead to serious consequences. Alpine skiing improves postural stability, regardless of skill level (Wojtyczek et al., 2014., Staniszewski et al., 2016., Cigrovski et al., 2017). Bearing in mind the results of previous research that dealt with the magnitude of the influence of motor abilities such as balance, agility, and coordination on the resulting success of skiing techniques (Franjko 2012., Carlsson et al., 2016., Abrahamson et al., 2019) and the lack of research on the influence magnitude of specific motor abilities on the level of the skiing elements adoption, this research was conducted. In connection with the abovementioned, the main goal of this research is to examine the level of connection between the motor abilities of agility, specific agility, explosiveness, and balance with the level of adoption of ski elements of the snowplow and basic ski turn.

Methods

The research was conducted on a sample of 33 students of the Faculty of Kinesiology, University of Split, of which 15 were female and 18 were male, with an average age of 21.56 years. Before conducting the research, the examinees did not learn or independently try alpine skiing techniques, in other words, they had no previous skiing knowledge.

A sample of variables for motor abilities assessment consisted of the following tests: eight with bending (8 bending) to assess agility. The test was performed in a hall where two racks were placed at a distance of 4 meters between which an elastic band was stretched. The height of the band is adapted to the hip height of each examinee. The examinee's task was to move as fast as possible between the racks in the shape of figure eight from a high start position. Each time the examinee went around the rack, they had to crawl under the elastic band. The test ends when the examinee completes 4 cycles and crosses the start/finish line. The test is repeated 3 times with a minimum 3-minute time break. The examiner measures the time with a stopwatch next to the start/finish line and the result is expressed in seconds. Countermovement Jump (CMJ) – to assess explosive strength. The test was measured using an Optojump optical device that measures ground contact time and flight time during a jump. At the beginning of the test, the examinee stands in an upright position, fully extended with hands on hips. The examinee's task is to jump as high and as fast as possible with the knees slightly bent to a half-squat and hands on the hips. During the jump, the examinee must be fully outstretched, and when landing, damp the jump by leaning on the front part of the foot with the knees extended at the moment of landing. Slalom jumps (SJS S) - test of dynamic balance. The test was measured in the hall where small hurdles were placed in a "zig-zag" pattern so that the examinee starts from the left side by single-leg jumping forward, followed by a single-leg lateral jump to the right, then a single-leg jump forward and a single-leg lateral to the left. It is necessary to jump a total of six hurdles forward, i.e., three hurdles to the right and two hurdles to the left. The height of the hurdles, which are set for jumping forward, is 23 cm, while the side hurdles are slightly lower, i.e., 15 cm. The goal of the test is to cross the hurdles as quickly as possible, without the subject falling over them. The test is repeated 3 times with a minimum time break. The examiner measures the time with a stopwatch, the best result of those 3 attempts is taken and is expressed in seconds. Left leg slalom jumps (SJS L) and right leg slalom jumps (SJS R) - dynamic balance assessment tests whose measurement protocol is the same as for slalom jumps, however, the tests are performed on one leg, either on the left or right leg. Biodex "Balance System" – a test for assessing balance. The examinees performed the test in a closed room without noise with their eyes open on the Biodex platform and without holding the safety handrails with their hands. The comprehensive test for this research was measured by 5 points: total balance index (T), forward balance (F), backward balance (B), right balance (R), and left balance (L). The examinee's task was to move the cursor on the platform screen in the shortest possible time by changing the position of his body's center of gravity from the central point to the next given point and staying at the given place for 0.25 seconds. The goal of the test is to perform a task in the shortest possible time with as little deviation from the ideal direction as possible, and the result is automatically recorded by the computer. The required time for one examinee is between 2 and 5 minutes. To determine the level of acquired skiing knowledge of the respondents, the following tests were selected: snowplow turn (SPT) and basic turn (BT). The snow-plowing turn starts from the straight snowplowing position, middle ski stand, by shifting the body's gravity center to the future lower ski

with simultaneous circular movements of the knees and feet in the direction of the forthcoming turn and by lowering the body's gravity center to a lower ski position. With such an action the skier places the outer ski on the inner curb, and the ski, due to its structural characteristics, makes a turn. By simultaneously reducing the inner ski's pressure, pulling the inner leg, and moving the knee toward the center of the turn, the inner ski in the sliding plow position follows the movement of the outer ski. After passing the fall line, it is necessary to adjust the ski position to the slope of the slope in order not to disturb the balance on the outer ski. When the outer ski passes perpendicular to the fall line, the turn is over, and the skier rises to the middle ski stance and starts a new turn in the same way. The basic turn is a skiing element that makes the transition from snowplowing to parallel skiing technique. It starts from the downhill position obliquely in the middle ski stand, where the skier, while simultaneously spreading the skis' tails and raising them to a higher ski stand, performs a snowplow turn that lasts at the latest until the arrival of the outer ski parallel to the fall line. Consequently, the skier connects the future inner ski to the outer one and from a parallel position in a high ski stance begins the turn towards the hill, which is performed by gradually lowering the gravity center of the skier's body until the skis are at least perpendicular to the fall line.

Divided into groups, according to a precisely determined program of work, the examinees and the associated ski instructor went through the process of teaching the alpine skiing basics for thirty hours over six days. Concerning this research, the criteria for evaluating the performance of the snowplow turn and the basic turn were defined using a Likert scale from 1 to 5, by three judges. The judges independently evaluated the performance of the examinees by reviewing videos of previously recorded performances.

Cronbach's alpha (α) and inter-item correlation (II r) parameters were calculated to test the reliability level and homogeneity level among judges. Basic descriptive statistical parameters were calculated: arithmetic means (M), standard deviations (SD), minimum (Min), maximum results (Max), and values of the Kolmogorov-Smirnov test (D max). In order to examine the level of connection between the selected tests for assessing motor abilities and the level of acquisition of skiing knowledge, the values of the Pearson correlation coefficient (r) and the associated level of statistical significance (p) were calculated. The data were processed with the statistical package Statistica for Windows 13.0.

Results

The prerequisite for further analysis of this paper was the determination of satisfactory reliability and homogeneity levels of the judges in the assessments of ski skills. The value of the inter-item correlation reliability coefficient (IIr) for the snowplow turn was 0.82 and for the basic turn 0.60. The value of the Cronbach alpha (α) coefficient for the snowplow turn was 0.93 and for the basic turn 0.81. Based on the obtained result values of the reliability coefficients, it can be concluded that the judges had uniform criteria when evaluating the snowplow and basic turn. The obtained values of the reliability parameter point to the conclusion that the judges had highly uniform synchronizations and evaluation criteria when evaluating the performance of the examinees' ski skills.

Table 1 shows the basic descriptive parameters of the selected tests for assessing motor abilities and skiing knowledge.

Table 1. Descriptive parameters of the selected tests for assessing motor abilities and skiing knowledge

Variables	M	SD	Min	Max	D-max
CMJ	31,44	21,23	54,53	7,88	0,11
SJS S	4,88	4,05	5,57	0,37	0,07
SJS L	5,35	4,06	7,34	0,75	0,13
SJS D	5,21	4,16	6,86	0,63	0,12
8 bending	12,60	10,91	15,33	0,96	0,10
T	1,06	0,47	4,40	0,71	0,28
F	31,64	6,00	81,00	18,55	0,11
B	35,15	5,00	98,00	25,96	0,24
R	32,79	4,00	72,00	17,84	0,10
L	26,06	3,00	65,00	16,26	0,17
SPT	2,70	0,56	2,00	4,00	0,18
BT	2,60	0,72	2,00	3,89	0,19

The values of the Kolmogorov-Smirnov test for all variables are less than maxD, which means that at the significance level $p<0.05$, the conclusion that all parameters are normally distributed can be accepted. Reviewing the basic descriptive parameters, one can notice the largest range of results in the Biodex tests for dynamic balance assessment, since the software calculates the total score in the dynamic balance assessment considering the time and the body oscillations in the given directions of movement and the position required to establish the balance position. It is apparent that the test examinees adopted the snowplow turn at a higher level compared to the basic turn, which could be assumed due to the difference in the structural performance complexity of the elements.

Table 2 shows the results of the Pearson correlation coefficient (r) between the selected tests for assessing motor abilities and the ski snowplow and basic turn.

Table 2. Ski snowplow and basic turn correlations with motor skills testing

	Snow plow turn		Basic turn	
	r	p	R	p
CMJ	-0,03	0,89	0,05	0,78
SJS S	0,00	1,00	-0,08	0,65
SJS L	0,00	0,99	0,17	0,33
SJS D	0,04	0,84	0,10	0,56
8 bending	-0,01	0,95	0,01	0,95
T	0,40	0,02*	0,11	0,54
F	0,03	0,87	0,38	0,03*
B	0,12	0,51	-0,08	0,67
R	0,28	0,11	0,27	0,12
L	0,32	0,07	0,28	0,11

*Note *p <,05 – level of statistical significance*

The obtained results indicate a statistically significant relationship between some tests for assessing dynamic balance and success in the adoption level of the snowplow and basic turn. In particular, a statistically significant positive correlation was established between the achieved result of the Biodex test for assessing the overall balance index (T) and the success in performing

the snowplow turn (p=0.02), and the balance test to the left (L) (p=0.07) was at the limit of statistically significant correlation. For the basic turn performance, a statistically significant positive correlation was established between the achieved result of the Biodex test for the assessment of forward central balance (F) (p=0.03).

Discussion

According to the obtained results, it can be concluded that within the motor set of variables for the assessment of agility, explosiveness, specific agility, and dynamic balance, the statistically significant correlation, with the adoption level of the ski snowplow and basic turn, lies within the assessment tests of dynamic balance on the Biodex platform. When learning basic skiing techniques, beginners master basic skiing movements that are of key importance in the successful performance of any element of skiing technique. A well-developed proprioceptive system affects the development level of dynamic balance, which is one of the main prerequisites for high-quality skiing movement performance. Timely ski movements coordinated with the necessary load on the skier's body on skis enable the successful maintenance of a balanced position and the performance of the given skiing elements. In his graduation thesis, Kostelić (2005) emphasizes that balance is an ability that determines the differences between those who will master basic skiing techniques faster or slower. When adopting and perfecting the basic skiing elements, in addition to the correct establishment of a balanced position and the load of the skier's body on the skis, circular skiing movements are of principal importance for the success of the performance. Analyzing the movements when maintaining the balance position on the Biodex, a great similarity with the mentioned semicircular movements that are present in the performance of most skiing elements, particularly of the elementary school skiing elements, is noticeable. According to Milanović (2013), balance is the ability to establish and maintain a balanced position, and it is manifested by successfully opposing the forces that disrupt it. It must be emphasized that successfully maintaining a balanced position requires a timely response to changes and anticipation of changes in the postural movement of the body, which results in the activity of the vestibular apparatus and the information synthesis coming from the vision, hearing, and muscle tension receptors (Spörri et al., 2012). Respondents with a better balance position have a greater predisposition to better gain the basic and advanced skiing techniques, which was confirmed by the findings of previous studies (Malliou, et. al., 2002; Palmieri., et. al., 2004; Aerenhouts et al., 2013., Raschner et al., 2017), as well as a dominant predictor value on the result performance in competitive skiing techniques (Mallioua et al.,2004., Noe & Paillard, 2005., Cigrovskog et al., 2009). Well-developed proprioceptive abilities are an important aspect in the prevention and rehabilitation of sports injuries in most sports activities (Schiftan, Ross & Hahne, 2015), including in alpine skiing (Dickson et al., 2020). Proper proprioceptor information from all joint structures ensures the muscle contraction strength, and the proper time sequence of contractions of the agonistic-antagonistic pair of muscles that coordinately participate in the dynamic stabilization of the joint, thus preventing possible injuries (Lephart & Fu, 2000; Vasconcelos & Lima 2020). Improper functioning of proprioceptors can lead to impaired balance, which increases the risk of injury (Hrysomallis 2007). The link between successfully establishing and maintaining a balanced position and preventing injuries among skiers has been proven, which is why the training process of alpine skiers should be systematically adapted to the specifics of gender, age, and developmental stages. Bere et al., (2011) found that loss

of balance (backward and inward direction) was responsible for half of the anterior cruciate ligament injuries that occurred during the Ski World Cup. Similar results were obtained by Ruedl et al., (2014) who found that 87% of skiing injuries are caused by self-inflicted falls. Raschner et al. (2012) found that skiers who have a greater torso strength imbalance (torso flexors and extensors) more often have an anterior cruciate ligament injury, while Steinberg et al. (2016) found that fatigue caused by anaerobic performance leads to a violation of balance and can lead to injury.

Conclusion

The results of this research can conclude that the success of establishing and maintaining a balance position primarily determines the level of basic skiing elements adoption. In addition to balance, timely ski movements coordinated with the necessary load on the skier's body on skis imply well-developed proprioception abilities. Additionally, they present an important factor in the prevention of injuries and the rehabilitation of athletes. Future research would certainly be interesting to examine whether and how the size of the anthropological characteristics' contribution changes during the training process of alpine skiers considering the duration of the training program.

References

Abrahamson, J., Aminoff, A. S., Todd, C., Agnvall, C., Thoreson, O., Jónasson, P. i Baranto, A. (2019). Adolescent elite skiers with and without cam morphology did change their hip joint range of motion with 2 years follow-up. *Knee Surgery, Sports Traumatology, Arthroscopy*, *27*(10), 3149-3157.

Bere, T., Flørenes, T. W., Krosshaug, T., Koga, H., Nordsletten, L., Irving, C., Muller, E., Reid, R. C., Senner, V., & Bahr, R. (2011). Mechanisms of anterior cruciate ligament injury in World Cup alpine skiing: a systematic video analysis of 20 cases. The American journal of sports medicine, 39(7), 1421–1429.

Carlsson, M., Carlsson, T., Wedholm, L., Nilsson, M., Malm, C. i Tonkonogi, M. (2016). Physiological demands of competitive sprint and distance performance in elite female cross-country skiing. *The Journal of Strength and Conditioning Research*, *30*(8), 2138-2144.

Cigrovski, V., Franjko, I., Rupcic, T., Bakovic, M. i Matkovic, A. (2017). Comparison of Standard and Newer Balance Tests in Recreational Alpine Skiers and Ski Novices. *Montenegrin Journal of Sports Science and Medicine, 6*(1), 49-55.

Cigrovski, V., Franjko, I., Rupčić, T., Baković, M. i Matković, B. (2016). Correlation between balance, specific alpine skiing knowledge and situational efficiency in alpine skiing. *Acta Kinesiologica, 10*(1), 66-70.

Franjko, I. (2012). *Analiza ekstrinzičnih povratnih informacija motoričkog učenja u alpskom skijanju (*Doktorska disertacija). Split: Kineziološki fakultet Sveučilišta u Splitu.

Geissler, U., Waibel, K., Maier, W., Scherr en, J. i Wolfarth, B. (2012). Influencing factors on alpine skiing performance. *Science and Skiing, 5,* 173-178.

Gorski, T., Rosser, T., Hoppeler, H. i Vogt, M. (2014). An anthropometric and physical profile of young Swiss alpine skiers between 2004 and 2011. *International Journal of Sports Physiology and Performance, 9*(1), 108-116.

Hrysomallis, C. (2007). Relationship between balance ability, training and sports injury risk. Sports Medicine, 37, 547–556.

Han, J., Anson, J., Waddington, G., Adams, R., & Liu, Y. (2015). The Role of Ankle Proprioception for Balance Control in relation to Sports Performance and Injury. BioMed research international, 2015, 842804. https://doi.org/10.1155/2015/842804

HZUTS. (2008) *Alpsko skijanje.* Zagreb: Znanje.

Kostelić, A. (2005). *Prikaz i analiza kondicijske pripreme Ivice i Janice Kostelić tijekom sportske karijere (razvoj i rezultati)* (Diplomski rad). Zagreb: Kineziološki fakultet Sveučilišta u Zagrebu.

Kuna, D. (2013). Metodički model za poduku osnovnog skijaškog zavoja. *Sport Mont, 37-39*, 636-645.

Lephart, S. M. (2000). Proprioception and neuromuscular control in joint stability. Human kinetics, 405-413.

Malacko, J. i Popović, D. (2001). *Metodologija kineziološko antropoloških istraživanja*. Priština: Fakultet za fizičku kulturu u Prištini.
Milanović, D. (2013). Teorija treninga. Zagreb: Kineziološki fakultet sveučilišta u Zagrebu.
Raschner, C., Platzer, H. P., Patterson, C., Werner, I., Huber, R., & Hildebrandt, C. (2012). The relationship between ACL injuries and physical fitness in young competitive ski racers: A 10-year longitudinal study. British Journal of Sports Medicine, 46, 1065–1071.
Ruedl, G., Philippe, M., Sommersacher, R., Dünnwald, T., Kopp, M., & Burtscher, M. (2014). Aktuelles Unfallgeschehen auf österreichischen Skipisten [Current incidence of accidents on Austrian ski slopes]. Sportverletzung Sportschaden : Organ der Gesellschaft fur Orthopadisch-Traumatologische Sportmedizin, 28(4), 183–187
Schiftan, G. S., Ross, L. A., & Hahne, A. J. (2015). The effectiveness of proprioceptive training in preventing ankle sprains in sporting populations: a systematic review and meta-analysis. *Journal of science and medicine in sport*, *18*(3), 238–244.
Steinberg, N., Nemet, D., Pantanowitz, M., Zeev, A., Hallumi, M., Sindiani, M., ...Eliakim, A. (2016). Longitudinal study evaluating postural balance of young athletes. Perceptual and Motor Skills, 122, 256–279.
Vasconcelos, G. S., Cini, A., & Lima, C. S. (2020). Proprioceptive Training on Dynamic Neuromuscular Control in Fencers: A Clinical Trial. Journal of sport rehabilitation, 30(2), 220–225.

DIFFERENCES IN SITUATIONAL EFFICIENCY PARAMETRES BETWEEN THE COMPETING IN PROFESSIONAL AND AMATEUR FOOTBALL LEAGUE

Hrvoje Ajman[1], Josip Cvenić[1], Luka Batarilo Ćerdić[1]
[1] University Josip Juraj Strossmayer of Osijek, Faculty of Kinesiology, Osijek, Croatia

Introduction

The highest level of football competition in Croatia in season 2018.-2019. is called Croatian telecom first league and consists of 10 clubs. During the season, each club plays 36 matches in the four-round competition system. Nk Osijek is club who is competing very successfully in the first rank of Croatian football and was part in this study sample. The Third Croatian football league is the third level of football competition in Croatia. The league is divided into five separate regions: West, East, North, South and Central. Each of the mentioned leagues has between 12 and 18 clubs. It is played in a two-round system in two parts of the competitive season: summer/autumn and spring. Club from the third class of football competition in Croatia taking a part in this study sample was Nk Čepin.

Vogelbein, Nopp and Hokelmann (2014) analyzed the matches of the German National Football League, i.e. the possession of the ball. Defensive reaction time was observed in order to see the differences between the quality of the team and the final outcome of the matches. The teams are divided into three ranks: high, medium and low ranked teams. High-ranked teams returned the ball to their possession significantly faster than other teams and had a shorter defensive reaction. The results show that regaining possession of the ball significantly affects successful defensive action. If teams have the skill to sustain possession, they have a greater chance of creating a shooting opportunity, but the conversion ratios of shots to goals are lower at longer lengths of possession (Hughes, Franks, 2005). Very few studies compared the situational efficiency of the teams from different levels of competition. The aim of this research is to determine situational efficiency of teams from two different levels of competition in Croatia, and to compare the situational efficiency indicators between teams of a higher and lower level and to determine the differences.

Methods

The study sample was conducted from 12 football matches, six of FC Osijek (1. League) and FC Čepin (3. League). Data analysis was conducted using ONCE software. The variables that will be used and analyzed when comparing two clubs from different levels of the competition are: Number of passes (width and depth), number of passes in the first, second and third part of the football field, number of incorrect passes in the first, second and third part of the football field, dribbling (successful and unsuccessful), a kick on the goal (foot or head) (successful and unsuccessful) and a direct kick (successful and unsuccessful), the total number of passes, dribbling, shooting on goal, and corner kicks. For data analysis, descriptive parameters and the Man-Whitney U test for testing data differences, will be calculated.

Results

The team of NK Čepin achieved five victories and one draw in the six games that were analyzed. In the analyzed matches, they equally tended to play in width as well as in depth. The most passes were played in the second third of the football field, while the least in the last third. The number of incorrect passes is highest in the last third of the pitch. Players do not often dribble into 1-on-1 situations, but with cooperation they make progress towards the opponent's goal. Shots on goal are predominantly kicked from shorter distances, while headers are mostly achieved after corner kicks. Shots towards the goal are mostly accurate and find their way to the goal. There were no direct kicks from the penalty kick, while three unsuccessful attempts were made from direct kicks (Table 1).

Table 1. Summary parameters of situational efficiency by clubs

		FC Čepin	***FC Osijek***
Number of passes	Width	1006	1059
	Depth	1048	1286
	1. Part of field	444	474
Number of passes	2. Part of field	931	1133
	3. Part of field	354	262
Number of incorrect passes	1. Part of field	10	20
	2. Part of field	149	186
	3. Part of field	166	156
Driblling	Successful	34	42
	Unsuccessful	29	46
Shoot on goal	Foot	53	50
	Head	19	19
Shoot on goal	Successful	32	22
	Unsuccessful	40	50
Direct kick	Successful	0	3
	Unsuccessful	3	5

The NK Osijek team achieved three wins and three draws in the six games that were analyzed. In the matches played, they tend to play passes in depth, but they also play in width. The most played passes happened in the second third of the football field, and the least in the last third of the field. Most of the incorrect passes were in the central part of the field, which was contributed by quick counter attack and half-counter attack. The players of NK Osijek focus more on 1-on-1 situations with opposing players and solve them very successfully.

As with NK Čepin, kicks towards the goal are predominantly kicked with the foot, while headers towards the goal are directed after corner kicks or through a cross from a player who previously created an excess of players on one side of the opposing defense. Shots aimed at the goal are mostly imprecise and from long distances, so they do not often hit the goal frame. There were three direct kicks from the penalty kick and all of them were successfully executed, the other five unsuccessful kicks were from direct kicks (Table 1).

Table 2. Differences between NK Čepin and NK Osijek in situational efficiency indicators

	Rank Sum	***Rank Sum 2***	***U***	***Z***	***p-value***
Number of passes width	38.00	40.00	17.00	-0.08	0.94
Number of passes depth	26.00	52.00	5.00	-2.00	0.05
Number of passes 1.part of the field	36.50	41.50	15.50	-0.32	0.75
Number of passes 2.part of the field	29.00	49.00	8.00	-1.52	0.13
Number of passes 3.part of the field	49.00	29.00	8.00	1.52	0.13
Number of incorrect passes 1. part of the field	29.50	48.50	8.50	-1.44	0.15
Number of incorrect passes 2. part of the field	33.00	45.00	12.00	-0.88	0.38
Number of incorrect passes 3. part of the field	44.50	33.50	12.50	0.80	0.42
Dribbling successfully	35.00	43.00	14.00	-0.56	0.58
Dribbling unsuccessfully	29.50	48.50	8.50	-1.44	0.15
Kick on the goal with foot	43.00	35.00	14.00	0.56	0.58
Kick on the goal with head	41.50	36.50	15.50	0.32	0.75
Kick on the goal successfully	50.00	28.00	7.00	1.68	0.09
Kick on the goal unsuccessfully	36.00	42.00	15.00	-0.40	0.69
Direct kick successfully	30.00	48.00	9.00	-1.36	0.17
Direct kick unsuccessfully	34.00	44.00	13.00	-0.72	0.47

Table 2 indicates that there is a statistically significant difference between the two teams in the variable number of passes played in depth (52.00 vs 26.00). The team of NK Osijek more often decides to play vertically towards the opponent's goal. The NK Čepin team also plays more in depth than in width, but not as highlighted as the NK Osijek team.

Discussion

Tables 1 and 2 show that amateur and professional football teams do not differ greatly in terms of the given variables. The results in table 2, the differences between the teams, show that the only statistically significant difference between the teams is in the variable of the number of passes in depth. The team of NK Osijek tends to play in depth a bit more, while they are equal in passing wide. The teams differ in other variables, but not at a statistically significant level.

Broich et al. (2014) found that the variables number of shots on goal, number of passes, number of touches with the ball and quality of the shot are very significant for the final outcome of the match and that they are good indicators of the situational efficiency of a soccer team. The common variables of both studies are the number of shots on goal, the number of passes and the number of shots on goal. A team that has high values in the mentioned variables achieves a positive outcome at the end of the match, which indicates that the mentioned variables are a good indicator of the team's situational efficiency. The mentioned variables were supposed to show differences between two teams of different competition levels, but in this research they did not show differences in situational efficiency between the teams of the 3rd Croatian Football League and the 1st Croatian Football League.

Also, a similar study was conducted by Lago-Penãs et al. (2010) and, based on a sample of 380 matches, they determined that the winning teams dominated the variables: total number of shots, shots on goal, number of assists, total number of corner kicks, possession of the ball and the number of fouls committed and won. The link between these two studies are some of the variables that characterize the winning teams, namely the number of shots, the number of shots on goal and possession of the ball, i.e. the number of accurately played passes. The mentioned variables are

good indicators of situational efficiency, and higher values of results led teams to win matches. The variables indicate differences in the situational efficiency of winning teams and teams that, given the lower level of the mentioned variables, achieve bad results.

Vogelbein, Nopp and Hokelmann (2014) also analyzed teams of different ranks of football competition. The results of this study suggest that higher football ranking of the competition have more passes played and keep the ball longer in their possession and therefore have less defensive action, while the teams of the lower ranking of the competition have shorter possession of the ball and play defensive action a bit longer. Results of this study do not match results of the study Vogelbein, Nopp and Hokelmann (2014), and it could be explained by the fact that the study sample was from the first german league where the competition demands (total running distance, total number of sprints) are higher than in the Croatian league and the differences between the two levels of competition rank are much more expressed. Croatian league players are more oriented on the technical aspect of the game and through that part are trying to make a result, while in the German league, the greater level of conditioning makes the main difference between competition levels.

Conclusion

The results indicate a significant difference in the variable number of passes in depth, while in other variables there are no significant differences. The differences between the teams should be tested in other categories of competitive activity.

References

Broich, H., Mester, J., Seifriz, F. i Yue, Z. (2014). Statistical analysis for the First Bundesliga in the current soccer season. Progress in Applied Mathematics, 7(2), 1-8.

Hughes, M., & Franks, I. (2005). Analysis of passing sequences, shots and goals in soccer. Journal of sports sciences, 23(5), 509-514.

Lago-Peñas, C., Lago-Ballesteros, J., Dellal, A., & Gómez, M. (2010). Game-related statistics that discriminated winning, drawing and losing teams from the Spanish soccer league. Journal of sports science & medicine, 9(2), 288.

Vogelbein, M., Nopp, S. i Hokelman, A., (2014). Defensive transition in soccer – Are prompt possession regains a measure of success? A quantative analysis of German Fussball – Bundesliga 2010/2011. Journal of Sports Sciences, 32(11), 1076-1083.

FUNCITIONAL ABILITES OF KINESIOLOGY STUDENTS IN SPINNING TRAINING

Josip Cvenić[1], Iva Macan[1], Toni Staković[1]
[1] Faculty of kinesiology Osijek, Osijek, Croatia

Introduction

Spinning, is a type of indoor fitness activity performed on stationary bikes by participants who pedal together to the rhythm of music and the motivating words of an instructor (Caria et al., 2007). Spinning can be classified as group endurance training with music in which the coach rides a stationary bike in front of his trainees and leads the training and motivates the trainees. The choreography of the music plays an important role in spinning because it may modify the participant's motivation and the intensity of the exercise (Elliot et al., 2004). In the fitness world, new trends appear from time to time, and one of these trends is spinning. Spinning, also known as indoor cycling, is a very popular form of exercise, especially among women, but its impact on the effect has not been examined to date (Szabo, 2015).

Functional abilities indicate the efficiency of energy processes in the organism and refer to the efficiency of aerobic and anaerobic functional mechanisms, that is, basic energy processes (Jukić, 2003). In cyclic sports activities of the endurance type, the leading role is played by aerobic energy capacity, i.e. maximum oxygen intake, as a measure of the aerobic abilities of the subjects. Spinning has the advantage of having a lower impact on the joints compared with running and aerobics (Jones et al. 1994). Spinning is a type of indoor cycling programme originally designed to help train professional cyclists and is specifically aimed at improving cardiovascular fitness, muscle tone, and exercise endurance (Johnny, 1996). The Spinning program is derived from real road cycling and combines four basic hand positions and five core movements that are simple and easy to learn. A spinning class is usually very demanding and challenging for participants.

The main aim of this study was to determine the differences in cardiovascular functions during a standard 50-min spinning class between the male and female kinesiology student groups.

Methods

The research was conducted on 11 males (age 21 +/- 2.7 years, height 183.3+/- 7.6 cm, weight 83.1+/-14.2 kg) and 9 females (age 21 +/- 1.8 years, height 168.1+/- 4.7 cm, weight 60.9+/- 8.4 kg) 3rd year students of Faculty of kinesiology in Osijek. The study was approved by the University's ethics committee.

This training was realized on Impulse stationary bikes. The training took place in the spinning hall of the Sokol Center Osijek under the guidance of a student who leads spinning training. Both groups performed training in the morning of the same day. The participants' body cardiovascular fitness was monitored by H9 Polar system.

The sample of variables will consist of 10 variables: POSUM (%) – average heart rate in percentages; POSUM (BPM) – average heart rate, MOSUM (%) – maximum heart rate in percentages; MOSUM (bpm) – maximum heart rate; KCAL - calories burned; VUPZ (sec) – time

spent in the first zone; VUDZ (sec) – time spent in the second zone; VUTZ (sec) – time spent in the third zone; VUCZ (sec) – time spent in the fourth zone; VUPEZ (sec) – time spent in the fifth zone.

The Statistica software package, TIBCO Software Inc, version 13.5.0.17, was used for statistical data analysis. The acquired data were imported into a Microsoft Excel spreadsheet and analysed by sex. Standard descriptive statistics were used to generate mean values and standard deviations. Shapiro Wilk test was used for normality of distribution. The t-test was used to verify the significance of differences relative to the parametric data, and non-parametric Mann-Whitney U rank-sum test was used to verify the significance of differences relative to the non-parametric variables. Statistical significance was set at $p<0.05$.

Results and discussion

Table 1. Descriptive statistics, Shapiro Wilk test, Mann Whitney Test, T-test for independent samples

Variables	All Mean +- STD (Min-Max)	W	Male Mean+- STD (Min-Max)	W	Female Mean+- STD (Min-Max)	W	p
POSUM (%)	78.40+-5.75 (67-87)	0.27	76,18+-5,51 (67-82)	0.08	81.11+-5.06 (73-87)	0.36	0.05#
POSUM (BPM)	154.15+-12.51 (129-173)	0.46	148.18+-11.14 (129-163)	0.54	161.44+-10.38 (145-173)	0.21	0.01#
MOSUM (%)	90.75+-4.77 (80-96)	0.05	89.82+-5.21 (80-96)	0.34	91.89+-4.17 (85-96)	0.11	0.35#
MOSUM (BPM)	178.40+-9.49 (160-191)	0.33	174.82+-9.13 (160-190)	0.73	182.78+-8.41 (168-191)	0.13	0.06#
KCAL	624.10+-109.50 (457-835)	0.43	662.09+-117.25 (468-835)	0.77	577.67+-82.95 (457-704)	0.66	0.09#

Legend: POSUM (%) – average heart rate in percentages; POSUM (BPM) – average heart rate, MOSUM (%) – maximum heart rate in percentages; MOSUM (bpm) – maximum heart rate; KCAL - calories burned. *- Mann-Whitney U test result; # - t-test result for independent variables. Mean-average of a data; Std- Standard deviation; W- Shapiro Wilk Test for normality of distribution

Variable average heart rate in percentages, although it is not statistically significant, it indicates a difference between respondents, where female students have a higher heart rate percentage ($p=0.05$). The statistical calculation revealed that the variable average heartbeats per minute (bpm) ($p=0.01$) is statistically significantly different, more specifically, male students have a significantly lower average heart rate per minute compared to female students, which is expressed in the percentage and number of beats. Regarding the variable of maximum heart beats per minute expressed as a percentage and number of beats, the maximum heart beats per minute expressed as a percentage are not significantly different between male and female students ($p=0.35$). Male students statistically have fewer maximum heart beats per minute expressed in the number of beats. Although there is no statistically significant difference, male students consumed statistically significantly more calories than female students (662.09+-117.25). If we compare this data with other group fitness classes we can conclude that spinning class burned more calories compared to aerobics – 424 kcal, circuit training – 463, pilates – 238, step aerobic – 424 (Ainsworth et al., 2015). This data is expected, given that they have a larger body mass. We can conclude that although there are no big statistical differences, certain differences, although smaller, exist in all variables. We can

attribute the non-existence of differences to the fact that these students are regularly physically active.

Table 2. Descriptive statistics, Shapiro Wilk test, Mann Whitney Test, T-test for independent samples

Variables	All Mean +- STD (Min-Max)	W	Male Mean+- STD (Min-Max)	W	Female Mean+- STD (Min-Max)	W	p
VUPZ (sec)	148.00+-115.97 (1-466)	0	182.36+-135.62 (48-466)	0.01	106+-73.09 (1-206)	0.48	0.32*
VUDZ (sec)	343.45+-421.17 (19-1452)	0	474.36+-523.02 (19-1452)	0.01	183.44+-164.26 (29-505)	0	0.36*
VUTZ (sec)	983.85+-555.59 (29-2069)	0.42	1119.45+-388.19 (42-2300)	0.12	818.11+-698.97 (29-1937)	0.19	0.23#
VUČZ (sec)	1314.10+-720.71 (42-2300)	0.05	1162.55+-787.10 (42-2300)	0.38	1499.33+-623.73 (438-2173)	0.06	0.31#
VUPEZ (sec)	239.15+-335.79 (0-1096)	0	90.09+-108.08 (0-329)	0.02	421.33+-430.48 (0-1096)	0.07	0.25*

Legend: VUPZ (sec) – time spent in the first zone; VUDZ (sec) – time spent in the second zone; VUTZ (sec) – time spent in the third zone; VUCZ (sec) – time spent in the fourth zone; VUPEZ (sec) – time spent in the fifth zone; *- Mann-Whitney U test result; # - t-test result for independent variables. Mean-average of a data; Std-Standard deviation; W-Shapiro Wilk Test for normality of distribution

The research measured the time of students spent in a certain zone. The zones were divided into five different ones. Of which the 1st zone is 50-60% of the intensity, the 2nd zone is 60-70% of the intensity, the 3rd zone is 70-80% of the intensity, the 4th zone is 80-90% of the intensity, and the 5th zone is 90-100 % intensity. Although not statistically significant, there are differences between males and females in averages results in all zones. The male students spent more time in lower zones (1st-3rd). These values correspond to cardiac outputs that confirm the involvement of cardiovascular function during a spinning class. Female students spent more time in higher zones (4th-5th) which means that in this spinning training females performed with higher intensity or it can be concluded as better physical condition of male students. In the present study male students spent around 9% more time in second zone, and 10% more time in third zone compared to females, while female students spent around 11% more in the fourth zone and fifth zone, or 22 % more in submaximal and maximal intensity zone 80-100%. In female group some individuals during the class reached the higher values in fifth zone (Š.A. - 36%, I.E.-28%, S.M.-24%). In male group excellent results reached two individuals with 48% and 44% spent in second zone. In summary, our results suggest that spinning is not for everyone. The intensity of exercise reached during the class, notwithstanding heart rate monitoring is far beyond what most novices or part-time exercisers can achieve and maintain. In statistical calculations for the variables related to the time spent in the zones, we concluded that there is no statistically significant difference between male and female students for any of the five zones. Based on these statistical calculations, we can conclude that male and female students did the same training because the time in the zones does not statistically differ between them. Male students have better functional abilities than female students when we compared the variables of average heartbeats per minute (% and bpm) and the maximum number of beats (bpm), and they spent a higher energy expenditure during spinning training.

The main finding of the latest published systematic review was that spinning training may be effective for enhancing VO2 max, HDL, and lean body mass levels, and also for reducing body fat mass, SBP, DBP, LDL, and triglycerides. However, the studies included in the current manuscript often report within-group differences and no between-group differences (Chavarrias et al.,2019). In this research, we can interpret these results as positive, considering that these are young students, who are very physically active during the week, and have good fitness preparation.

Conclusion

During one hour of spinning training lasting 50 minutes, we can conclude that there are no statistically significant differences in functional abilities between male and female students. In the maximum heart rate per minute (bpm) variable, we can see that male students have a statistically significantly lower value than female subjects, which proves that male students have better-developed functional abilities and that they more easily coped with a load of spinning training. We see equality in training performance between both sexes in that the time spent in the zones during training does not differ statistically significantly. Likewise, male students consumed statistically significantly more calories than female students.

The results show that this type of fitness activity has a high impact on cardiovascular function and suggest that it is suitable for sport students and especially the population who are willing to begin a recreational physical activity programme.

Spinning training is good training according to previous research for the development of aerobic capacities. The combination of indoor cycling and diet is recommended to improve the lipid profile, lose weight, and reduce blood pressure (Chavarrias et al, 2019). The aim of this research was to monitor cardio parameters and intensity during one spinning training comparing male and female kinesiology students. Testing should be repeated on a larger sample and last longer to obtain better data and include more parameters.

References

Ainsworth, B.E., Haskell, W.L., Herrmann, S.D., Meckes, N., Bassett Jr, D.R., Tudor-Locke, C., Greer, J.L., Vezina, J., Whitt-Glover, M.C., Leon, A.S. (2015). The Compendium of Physical Activities Tracking Guide. Healthy Lifestyles Research Center, College of Nursing & Health Innovation, Arizona State University. Retrieved May 11, 2015, from the World Wide Web.

Caria, M. A., Tangianu, F., Concu, A., Crisafulli, A., & Mameli, O. (2007). Quantification of Spinning bike performance during a standard 50-minute class. *Journal of sports sciences*, *25*(4), 421–429.

Chavarrias, M., Carlos-Vivas, J., Collado-Mateo, D., & Pérez-Gómez, J. (2019). Health Benefits of Indoor Cycling: A Systematic Review. Medicina, 55(8), 452.

Elliott, D.; Carr, S.; Savage, D. (2004). Effects of motivational music on work output and affective. Journal of Sport Behaviour, 27, 134–147

Johnny, G. (1996). Spinning1 Instructor Manual. Phase 1:The Spinning1 Journey 1.01. Givisiez, Switzerland: Schwinn Fitness International.

Jones, B. H., Cowan, D. N., & Knapik, J. J. (1994). Exercise, training and injuries. Sports Medicine, 18, 202 – 214.

Jukić, I. (2003). Osnove kondicijskog treninga. Kondicijski trening, 1(1), 4-9

Szabo, A., Gáspár, Z., Kiss, N., & Radványi, A. (2015). Effect of spinning workouts on affect. Journal of mental health (Abingdon, England), 24(3), 145–149.

DIFFERENCES IN THE AGILITY TESTS VALUES PERFORMED ON DIFFERENT TYPES OF SPORTS SURFACES

Zoran Špoljarić[1], Hrvoje Ajman[1], Tomislav Rukavina[1]
[1] University Josip Juraj Strossmayer of Osijek, Faculty of Kinesiology Osijek, Osijek, Croatia

Introduction

Agility is one of the motor skills that play an important role in success in a large number of sports. It is defined as a complex set of independent skills that come together to enable an athlete to respond to an external stimulus by rapidly decelerating, changing direction, and accelerating again (Sheppard and Young, 2006; Young, James, & Montgomery, 2002). The authors suggest that agility is influenced by the athlete's perceptive and decision-making ability, as well as the ability to quickly change the direction of movement. Ivković (2007) states that in basketball, the characteristics that are the basis for the performance of almost all movement structures are agility, speed and explosive power. Likewise, the most successful basketball players are characterized by agility and endurance, speed and explosiveness, precision, frequency of movement and balance (Matković, Matković and Knjaz, 2005). Sports surfaces play an important role for participants in sports, whether they are recreational or professional players. In the world of sports, there are different sports surfaces that are used in different sports, but in this paper, the emphasis will be on the two types of surfaces artificial grass and parquet.

Previous research on this topic, is very rare. Oliveira L. et al. (2019) conducted a study with eight futsal goalkeepers, who play on the parquet, and eight soccer goalkeepers, who play on natural grass, between the ages of 14 and 18. Two tests were performed, a square test and T-test. The research results indicate that the type of surface had a slight effect on the agility results. In the T-test, futsal goalkeepers were 8.7% faster than football goalkeepers on the parquet (d = -0.654) and 4.5% on the natural grass (d = -0.390). Similarly, futsal goalkeepers were only 0.2% faster in agility tests than soccer goalkeepers on the parquet (d = -0.039) and 1% less on the natural grass (d = 0.035) in the square test.

Choi, Sum and Leung (2015) compared the difference between natural grass and artificial grass in agility tests. The sample of respondents consisted of 12 players from a rugby team. They conducted three tests and one of them tested the speed of the changing direction. Although the test performance time on artificial grass was faster, there was no statistically significant difference in results ($P > 0.05$) comparing artificial and natural grass.

The aim of this study was to determine differences in the values of the agility tests carried out on artificial grass and parquet.

Methods

The research was conducted on 23 students of the Faculty of kinesiology Osijek (19 males and 4 females), all participants were healthy and highly motivated. Agility testing was performed on artificial grass and a parquet. Tests in the study were: 4x5m, 93639 and T-test. All subjects performed a warm-up that lasted 20 minutes and consisted of 5 minutes of continuous low-intensity running, 10 minutes of dynamic stretching and 5 minutes for preparation and additional warm-up. The tests were performed in the following order: the 4x5 meter test, the 93639 test (with

a twist) and finally the T-test. First day of testing was conducted on the artificial grass and the next day, testing was conducted in the sports hall, on the parquet floor. Before the actual implementation of the tests, the subjects performed the same warm-up as the day before on the artificial grass. The results of the study are analyzed with the program Statistica 10.0 for Windows. Basic descriptive parameters were calculated for all variables that were measured in this research (arithmetic mean, standard deviation, maximum value, minimum value). To determine the differences between the tests performed on parquet and artificial grass, a t-test for dependent samples was used.

Results

The results of this study have determined statistically significant differences in the results of all three agility tests depending on the sports surface.

Table 1. Results of agility tests performed on the parquete

	Valid N	Mean	Minimum	Maximum	Std. Dev.
T-TEST	23	9,22	8,06	10,38	0,67
4x5	23	5,052	4,36	5,91	0,39
93639	23	8,32	7,02	9,77	0,75

Table 2. Results of agility tests performed on the artificial grass

Variable	Valid N	Mean	Minimum	Maximum	Std. Dev.
T-TEST	23	9,85	9,07	11,01	0,50
4x5	23	5,83	5,17	6,77	0,46
93639	23	9,22	8,19	10,10	0,55

The tested subjects achieved significantly better results (4x5m 5,05 vs 5,83s; 93639 8,32 vs 9,22s; T-test 9,22 vs 9,85s) when they were tested on a wooden floor compared to artificial grass.

Table 3. Differences in agility on the study agility tests

	Mean	Std.Dv.	N	Diff.	Std.Dv.	T	df	p
Parquet 4x5m	5,0522	0,3958						
AG 4x5m	5,8326	0,4637	23	- 0,7804	0,3629	-10,313	22	0,0000
Parquet 93639	8,3217	0,7519						
AG 93639	9,2222	0,5534	23	-0,9004	0,7778	-5,552	22	0,0000
Parquet T-test	9,2204	0,6754						
AG T-test	9,8526	0,5088	23	-0,6322	0,5209	-5,821	22	0,0000

Discussion

Agility was tested on grass and parquet, and the test results of participants were faster when they perform on the parquet. The results of the study by Oliveira L. et al. (2019) are similar to the results of this study, they also determined faster results of participants performing agility tests on the parquet compared to artificial grass (d= -0.632).

In comparison with the results of the study by Choi, Sum and Leung (2015), it can be concluded that the subjects are the fastest in agility tests on parquet, then on artificial grass, and

are the slowest on natural grass which has been partly confirmed in this study. Participants in this study achieved significantly better results when they were tested on a parquet floor compared to artificial grass.

Conclusion

The obtained results confirmed the research hypotheses. Agility results are better in all tests (4x5 meters, 93639 and T-test) performed on the parquet floor versus artificial grass. The obtained research results were significantly influenced by the properties of the sport surface.

References

Banovac, J. (2021). Trening agilnosti u nogometu. Završni rad. Kineziološki fakultet. Sveučilište u Splitu.

Dos Santos Oliveira, L., Elis Cabral Pontes, N., Garcia de Souza, G., Luiz de Brito-Gomes, J., Ramalho Aniceto, R., Perez-Gomez, J. i Serrano Braz de Holanda, V. (2019). Are there any differences in the agility preformance tests among goalkeepers depending on the type of surface? A crossover study. Human movement, 20(4), 56-67.

Grozdanić, M. (2018). Diferencijacije u testovima agilnosti košarkašica i košarkaša juniorskog uzrasta. DIplomski rad. Kineziološki fakultet. Sveučilište u Zagrebu.

Horička, P., Šimonek, J. (2020). Agility in sport. Cambridge Scolars.

Koštro, D. (2017). Razlike u funkcionalno - motoričkim kapacitetima nogometaša U-10 različitog natjecateljskog statusa i igračke pozicije. Diplomski rad. Kineziološki fakultet. Sveučilište u Zagrebu.

Los Arcos, A., Mendiguchia, J. i Yanci, J. (2017.) Specifity of jumping, aceleration and quick change-of-direction motor abilities in soccer players. Kinesiology, 49(1), 22-29.

Lin Elan Leung, F., Ming Choi S., Way Raymond Sum, K. (2015). Comparison between Natural Turf and Artifical Turf on Agility Preformance of Rugby Union Players. Advances in Physical Education, 5, 273-281.

Milanović, D. (2005). Teorija treninga priručnik za praćenje nastave i pripremanje ispita.

Milša, T. (2021). Horizontalni skokovi kao prediktor uspješnosti startnog ubrzanja na 5 i 10 metara, te sprinta na 30 metara kod nogometnih juniora. Diplomski rad. Kineziološki fakultet, SVeučilište u Splitu.

Pehar, M. (2016). Sport specifični testovi agilnosti i eksplozivne snage u košarci. Disertacija. Kineziološki fakultet. Sveučilište u Splitu.

Pljalović, D. (2020). Drveni sportski podovi. Završni rad. Šumarski fakultet. Sveučilište u Zagrebu.

Zeljko, I. (2020). Reaktivna i nereaktivna agilnost u futsalu; razvoj i validacija specifičnih procedura, analiza faktora utjecaja. Disertacija. Kineziološki fakultet. Sveučilište u Splitu.

EFFECTS OF TRAINING AND AGE RELATED DIFFERENCES IN BASIC AND SPECIFIC MOTOR ABILITIES IN BASKETBALL STUDENTS AT THE SPORTS ACADEMY -SKOPJE

Borche Daskalovski, Aleksandar Aceski, Zikica Tasevski, & Luka Popovski
[1] Cyril and Methodius University in Skopje, Faculty of Physical Education,Sport and Health, Skopje, Republic of North Macedonia

Introduction

Before the start of each academic year, expert teams formed by the sports federations and the Sports Academy, perform the selection of young talented athletes for each sport respectively. The final list is verified by the relevant sports federation, the Sports Academy and the Agency for Youth and Sports. During the course of academic year, student-athletes are obliged to regularly follow the theoretical part of the curriculum and actively participate in every training session. Student-athletes have two training sessions every day of the week, and during the break between training sessions, they attend theoretical classes. On Saturdays or Sundays, they have matches with the teams they are drafted for. During their schooling, they actively participate in all sports activities organized by the Sports Academy. Every student basketball player is tested for motor and specific motor abilities at the beginning and at the end of the school year. The selected students are educated and trained according to curriculums and training sessions prepared in advance and carried out by professional staff for each sport respectively. All this necessitates the need to monitor the development of young athletes in each sport. The training system and methods should be defined, planned, programmed and implemented in an appropriate way, so that their effect can be aimed at adequately transforming the abilities that are important for the aforementioned sports.

The differences in the motor skills among basketball players from different age groups are already documented in the literature (Gonzalo-Skok et al. 2017; Karalejic & Jakovljevic 2009; Macha-Triguero et al. 2021). However, due to the scarcity of research studies of this kind in our country the purpose of the research is aimed at determining the effects of the programmed training process in the studied sample of respondents, as well as the intergroup differences in motor and specific motor abilities among first, second and third year basketball students from the Sports Academy in Skopje.

Methods

The research was conducted at the Faculty of Physical Education, Sports and Health, at the University "St. Cyril and Methodius" from Skopje, Republic of North Macedonia. Motor and specific motor skills tests were carried out in the halls and sport fields where the athletes perform the training sessions.

Sample of subjects

The research was carried out on a sample of 79 respondents and it was divided into three subsamples (basketball players) at the Sports Academy in Skopje. The first subsample consists of

29 first-year basketball players aged 14 years, the second subsample consists of 27 second-year basketball players aged 15 years, and the third subsample consists of 23 third-year basketball players aged 16 years. Each subgroup performed the same tests, which assessed their motor and specific motor abilities. Measurements in all three age groups were carried out by trained professionals (professors of physical education, sports and health). Due to the age of the respondents, parental consent was required prior to enrolment in the research study.

Sample of variables

A total of 16 variables have been used in the research, 7 for assessment of the basic motor skills and 9 for assessment of the specific motor abilities. The tests used to evaluate the specific motor skills of basketball students are as follows: 1. Two-handed passing speed /sec/ (THPS) - 4 passes against the wall at 2.5m distance; 2**.** Passing speed with one and the other hand alternately /sec/(PSOHA) - 4 alternating cycles of driving the ball with the left and right hand, followed by shooting against the wall at 2.5m distance; 3.Running between racks /sec/(RBR) - 5 racks in a straight line, the first rack was placed 1m from the starting line, while the distance between the remaining racks was 1.5m; 4. Driving the ball between the posts /sec/ (DBBP) - 5 posts in a straight line, the first post was placed 1 m from the starting line, while the distance between the remaining posts was 1.5m; 5. Fast lead to the middle of the field and back with the weaker hand /sec/(FLMFBWNH), 6. Fast lead to the middle of the court and back with the stronger (dominant) hand /sec/(FLMFBWDH), 7. Dribbling from the side and through the legs with the right and left hand within 30sec/n/(DSTLRLH),8. 10 (ten) consecutive shots at the basket from the free throw line /n/(10FT), 9. Shot from 4 meters then from 6 meters and again the same, starting from the right corner and moving clockwise direction with a displacement of 45° (0°, 45° ,90°, 135°, 180°) and then in the opposite direction until the end of the time of 1 min /n/(4MS6MS1M), Shot from 4 meters then from 6 meters and again the same, starting from the right corner and moving clockwise direction with a displacement of 45° (0°, 45°, 90°, 135°, 180°) and then in the opposite direction until the end of the time of 2 min**.** /n/(4MS6MS2M), Shot from 4 meters then from 6 meters and again the same, starting from the right corner and moving clockwise direction with a displacement of 45° (0°, 45°, 90°, 135°, 180°) and then in the opposite direction until the end of the time of 3 min**.** /n/(4MS6MS) To assess the basic motor abilities of all students the following tests were conducted: 1. Beep test (Leger's test) /levels/ (BEEP), 2. Illinois agility test /sec/ (IA), 3. Push-ups /n/(PU), 4. Sit and reach /cm/(SR), 5. Long jump from standing /cm/(LGS), 6. 20 meters running /sec/(20MR), 7. Trunk lift in 30 seconds /n/(TL30S). (Metikosh, D.,et al. 1982; Karalejic, M & Jakovljevic, S. 1998).

Data collection

The testing was conducted within two days. On the first day, the basic motor skills were assessed in the following order: (SR), (LGS), (20MR), (IA), (PU), (TL30S), (BEEP). On the second day, specific motor ability tests were carried out in the following order: (10FT), (THPS), (PSOHA), (RBR), (DBBP), (FLMFBWNH), (FLMFBWDH), (DSTLRLH), (4MS6MS1M), (4MS6MS2M), (4MS6MS3M). Each test was repeated twice apart from the last three specific motor ability tests, which were performed only once and the best result was considered in the further analysis. Leger's test was also conducted only once. Time interval measurement was carried out using UnoLux

photocell system, which was placed at hip level. During the assessment the respondents were constantly motivated to give their best performance.

Data processing methods

In accordance with the research objectives, the obtained data were processed with the appropriate statistical methods. The following basic descriptive data were calculated for all applied variables: arithmetic mean (X), the standard deviation (SD**)** and Kolmogorov-Smirnov test (KS). Preliminary analysis confirmed normal distribution of the results. The significance of the differences between the arithmetic means of the initial and final measurements was determined by applying the Student's t-test for small dependent samples. An analysis of variance was used to determine intergroup differences between the initial and final measurements.

Results

Table 1. Presents the results of the t-test for first-year basketball students. It can be noted that out of 15 studied variables, only 8 had statistically significant differences between the average values of the initial and final measurements. Statistically significant differences were identified in the following motor variables: Illinois test with a percentage improvement of 6.5%, long jump with a percentage increase of 6.3% and Running for 20 metres with a percentage increase of 11%. Although no statistically significant difference was determined between the arithmetic means of the initial and final measurements, the percentage increase was noticeable in the motor variables Sit and reach with 19.1% and Push-ups with 13.5%. The remaining motor variables showed insignificant improvements. This indicates that the curriculum had not achieved the intended results among the first year basketball students. However, such results should be taken with reservations as the students are going through puberty, which due to the disproportions between the development of the muscles and growth of the bones, often reduces their motor skills. Among the specific motor variables, statistically significant differences between the arithmetic means from the initial and final measurement were identified for the following variables: Two-handed passing speed, with an improvement in the result by 22.1%, Passing speed with one and the other hand alternately, with an improvement in the result by 12.3%, Running between racks, with a deterioration of the result by 25%, Driving the ball between the posts, with a deterioration by 26.3% and Dribbling from the side and through the legs with the right and left hand (spider drill), with deterioration by 11.5%. Also worth noting is the extremely poor result of the final measurement in the variables related to agility and ball manipulation. The students were expected to achieve better results after a six -month training process.

Table 2. shows the results of the t-test for second-year basketball students. As shown, out of a total of 15 studied variables, 6 of them have statistically significant differences between the average values from the initial and final measurements. Statistically significant differences were found in the following motor variables: running for 20 meters, with a percentage increase of 19.7% and trunk lift for 30 seconds, with a percentage increase of 12%.

Table 1. T-tests for the studied variables in first-year basketball students

Variables	Initial		Final		r	T-test	%	sig
	Mean	SD	Mean	SD				
BEEP	8,90	1,03	9,29	1,56	0,59	-1,13	4,4	,277
IA	17,49	0,84	16,36	0,81	0,51	4,59	-6,5	**,001**
PU	20,18	9,87	22,91	8,03	0,85	-1,75	13,5	,110
SR	6,18	4,14	7,36	5,55	0,75	-1,06	19,1	,312
LJS	222,27	20,64	236,36	21,57	0,88	-4,53	6,3	**,001**
20MR	3,27	0,26	3,63	0,24	0,81	-7,68	11,0	**,000**
TL30S	25,91	2,98	26,18	3,66	0,67	-0,33	1,0	,750
THPS	3,21	0,27	2,50	0,26	0,77	15,75	-22,1	**,000**
PSOHA	5,05	0,65	4,43	0,71	0,52	3,68	-12,3	**,002**
RBR	6,12	0,41	7,65	0,52	0,75	-17,73	25,0	**,000**
DBBP	6,54	0,42	8,26	0,48	0,76	-21,53	26,3	**,000**
FLMFBWNH	6,35	0,30	6,25	0,34	0,70	1,56	-1,6	,140
FLMFBWDH	6,39	0,30	6,25	0,34	0,60	1,91	-2,2	,075
DSTLRLH	16,81	1,87	18,75	1,81	0,79	-6,56	11,5	**,000**
10FT	7,06	1,44	7,81	1,11	-0,16	-1,54	10,6	,145
4MS6MS1M	3,56	2,06	3,63	1,54	0,24	-0,11	2,0	,914
4MS6MS2M	3,31	1,82	3,94	1,73	0,01	-1,00	19,0	,333
4MS6MS3M	3,13	1,67	2,69	1,62	-0,30	0,66	-14,1	,520

Although no statistically significant difference was determined between the arithmetic means of the initial and final measurements, the percentage increase is most noticeable in the motor variable Push-ups, with a percentage increase of 100%. Among the specific motor variables, statistically significant differences between the arithmetic means from the initial and final measurements were determined for the following variables: Two-handed passing speed Two-handed passing speed, with an improvement in the result by 22.2%, Running between racks, with a deterioration of the result by 24.5%, Driving the ball between the posts, with a deterioration of the result by 24% and Shot at the basket from the free throw line, with the deterioration of the result by 20.9%. Although the results of the t-test are not statistically significant, an adverse trend in the results is also observed for the A test to measure specific basketball endurance and accuracy variable, where a decrease in accuracy is observed in the first minute by 15.8% and in the third minute by 14.3%. The extremely poor results of the final measurement in the variables related to agility, ball manipulation and precision when performing shots from different positions are also worth noting. The expectation was that after a six-month training process, the student basketball players would achieve better results. The explanation for the poor performance could potentially be found in the impaired coordination, which is a result of the acceleration that occurs in this developmental period, or the insufficient engagement of the respondents during the performance of the test. Ball handling techniques demand special attention in the ongoing training process, as large proportion of basketball students showed unsatisfactory level of performance. Considering that these students were selected as the most talented individuals in our country, the obtained results don't seem to confirm their quality. Therefore, the professional teams carrying out the selection process are advised to sharpen the selection criteria for the future student basketball candidates at the Sports Academy.

Table 2. T-tests for the studied variables in second-year basketball students

Variables	Initial		Final		r	T-test	%	sig
	Mean	SD	Mean	SD				
BEEP	8,97	0,93	9,97	2,80	-0,93	-0,88	11,1	,470
IA	17,89	0,86	17,50	0,71	1,00	3,55	-2,2	,175
PU	10,00	7,07	20,00	14,14	1,00	-2,00	100,0	,295
SR	6,50	2,12	7,00	1,41	1,00	-1,00	7,7	,500
LJS	224,50	45,96	245,0	35,36	1,00	-2,73	9,1	,223
20MR	3,20	0,28	3,83	0,24	1,00	-21,00	19,7	**,030**
TL30S	25,00	5,66	28,00	5,66	0,36	6,16	12,0	**,004**
THPS	3,11	0,11	2,45	0,26	0,36	6,16	-21,2	**,004**
PSOHA	5,27	1,06	5,10	1,09	0,78	0,54	-3,2	,616
RBR	6,41	0,62	7,98	0,54	0,85	-10,60	24,5	**,000**
DBBP	6,74	0,59	8,36	0,40	0,75	-9,38	24,0	**,001**
FLMFBWNH	6,11	0,24	6,30	0,27	0,37	-1,46	3,1	,218
FLMFBWDH	6,12	0,50	6,30	0,27	0,94	-1,58	2,9	,189
DSTLRLH	17,00	4,12	18,00	3,81	0,94	-1,58	5,9	,189
10FT	8,60	0,55	6,80	0,45	0,61	9,00	-20,9	**,001**
4MS6MS1M	3,80	0,84	3,20	2,17	0,30	0,65	-15,8	,553
4MS6MS2M	3,60	1,82	3,80	1,48	0,80	-0,41	5,6	,704
4MS6MS3M	4,20	2,17	3,60	1,67	0,23	0,56	-14,3	,607

Table 3. presents the results of the t-test for third-year basketball students. The results show that out of a total of 15 studied variables, statistically significant differences between the average values from the initial and final measurements were identified in 9 of them. The following motor variables showed statistically significant differences: Illinois test, where the performance time was improved by 6.3%; 20-meter Running, where the time improved by 9.8% and Trunk lift for 30 seconds, with a percentage increase in the average value of 7.8%. Although no statistically significant difference has been found between the arithmetic means of the initial and final measurements, there is a noticeable deterioration in the results for the Sit and reach variable, which is 49.9%. Among the specific motor variables, statistically significant differences between the arithmetic means of the initial and final measurement were determined for the following variables: Two-handed passing speed, with an improvement of the result by 6.8% and Passing speed with one and the other hand alternately, with an improvement of the result by 5.1%; The remaining variables showed negative trends: Running between racks and Driving the ball between the posts, with declining results by 26.6% and 26.9% respectively. The same applies to the Fast lead to the middle of the court and back with the stronger hand and Dribbling from the side and through the legs with the right and left hand9 (spider drill)variables, showing declining results by 4.3% and 10.7%, respectively. Although the results of the t-test are not statistically significant, there is a noticeable improvement in the results for the A test to measure specific basketball endurance and accuracy variable, showing an increase in accuracy in the first minute by 27.6%, improvement of the results in the second minute by 9.8%, but deterioration of the results by 3.5% in the third minute.

Table 4. presents the results of the analysis of variance, showing which of the applied tests found statistically significant differences among the student basketball players from all three years.

Table 3. T-tests for the studied variables among third-year basketball students.

Variables	Initial		Final		r	T-test	%	sig
	Mean	SD	Mean	SD				
BEEP	9,72	0,79	9,66	1,29	0,40	0,15	-0,6	,885
IA	16,98	0,51	15,91	0,83	0,59	5,31	-6,3	**,000**
PU	29,18	7,69	32,64	4,08	-0,63	-1,07	11,9	,311
SR	7,27	6,33	3,64	11,94	0,18	0,97	-49,9	,355
LJS	230,91	16,40	224,77	75,28	0,03	0,27	-2,7	,796
20MR	3,17	0,10	3,48	0,19	-0,06	-4,64	9,8	,001
TL30S	27,91	4,06	30,09	3,59	0,80	-2,91	7,8	**,015**
THPS	2,93	0,22	2,73	0,19	0,20	2,67	-6,8	**,022**
PSOHA	4,71	0,55	4,47	0,44	0,58	1,78	-5,1	,103
RBR	6,10	0,45	7,72	0,39	0,04	-9,59	26,6	**,000**
DBBP	6,47	0,74	8,21	0,38	0,01	-7,24	26,9	**,000**
FLMFBWNH	6,02	0,42	6,03	0,17	0,35	-0,09	0,2	,931
FLMFBWDH	5,78	0,24	6,03	0,17	0,69	-4,78	4,3	**,001**
DSTLRLH	18,67	2,19	20,67	2,19	0,73	-4,34	10,7	**,001**
10FT	8,08	1,24	8,00	1,65	0,27	0,16	-1,0	,874
4MS6MS1M	3,92	2,02	5,00	2,70	0,58	-1,68	27,6	,121
4MS6MS2M	4,17	1,64	4,58	1,08	-0,16	-0,68	9,8	,508
4MS6MS3M	4,92	1,56	4,75	1,66	0,34	0,31	-3,5	,761

The results show that statistically significant differences between the arithmetic means in the initial measurement were found for the following variables: Leger's test - the best results are achieved by first-year basketball students; Push-ups – the best results are achieved by third-year basketball students; Among the specific motor variables of the initial measurement, statistically significant differences were determined in the variables: Two-handed passing speed – the best results were achieved by third-year basketball players; Fast lead to the middle of the field and back with the weaker hand and Fast lead to the middle of the court and back with the stronger hand – the best results were achieved by the third-year basketball players. The final measurement showed statistically significant differences between student basketball players from different years in the following variables: Leger's test - the best results were achieved by first-year basketball players; Push-ups – the best results were achieved by third-year basketball players; Running 20 meters - the best results were achieved by third-year basketball players; Trunk lift in 30 seconds - the best results were achieved by third-year basketball players. The final measurement of the specific motor variables showed statistically significant differences in the variables: Two-handed passing speed – the best results were achieved by second-year basketball players; Dribbling from the side and through the legs with the right and left hand (spider drill) - the best results were achieved by second-year basketball players and A test to measure specific basketball endurance and accuracy - in the third minute, the best results were achieved by third-year basketball players.

Table 4. Analysis of variance for the studied variables among student basketball players from all three years

Variables	Year I		Year II		Year III		F	Sig.
	Mean	SD	Mean	SD	Mean	SD		
INITIAL MEASUREMENT								
BEEP	8,95	1,02	9,82	1,43	9,84	0,94	3,20	**0,05**
IT	17,52	0,81	17,59	0,81	16,95	0,50	2,50	**0,10**
PU	20,50	9,47	8,00	6,08	28,00	8,40	6,81	**0,01**
SR	5,75	4,22	6,00	4,69	8,17	6,78	0,62	0,55
LJS	223,58	20,2	232,25	32,4	230,83	15,6	0,49	0,62
20MR	3,26	0,25	3,25	0,19	3,18	0,10	0,50	0,61
TL30S	25,83	2,86	26,50	3,79	27,58	4,03	0,74	0,49
THPS	3,21	0,27	3,10	0,19	2,93	0,21	5,39	**0,01**
PSOHA	5,12	0,73	4,66	1,66	4,67	0,55	1,09	0,35
RBR	6,20	0,51	6,34	0,50	6,09	0,44	0,76	0,47
DBBP	6,64	0,60	6,71	0,51	6,44	0,72	0,64	0,53
FLMFBWNH	6,45	0,49	6,07	0,25	6,01	0,40	5,26	**0,01**
FLMFBWDH	6,40	0,49	6,05	0,40	5,77	0,24	9,37	**0,00**
DSTLRLH	16,68	2,67	15,50	5,89	18,62	2,10	2,30	0,11
10FT	7,11	1,37	8,10	0,88	8,15	1,21	3,66	**0,04**
4MS6MS1M	3,47	1,98	4,20	1,03	4,31	2,39	0,85	0,43
4MS6MS2M	3,32	1,83	3,30	1,83	4,15	1,57	1,04	0,36
4MS6MS3M	3,11	1,94	3,50	2,01	4,92	1,50	3,92	**0,03**
FINAL MEASUREMENT								
BEEP	9,49	1,57	24,72	29,3	9,66	1,29	4,03	**0,03**
IT	16,75	1,00	15,83	1,47	15,42	1,88	3,06	0,06
PU	22,44	7,76	24,33	10,5	31,75	4,96	5,52	**0,01**
SR	7,25	5,54	10,33	5,39	4,83	12,1	0,87	0,43
LJS	231,25	22,77	242,50	18,10	227,70	72,50	0,21	0,82
20MR	3,68	0,23	3,70	0,16	3,48	0,18	4,00	**0,03**
TL30M	26,38	3,14	27,83	3,43	29,83	3,54	3,69	**0,04**
THPS	2,50	0,26	2,43	0,23	2,73	0,19	4,52	**0,02**
PSOHA	4,43	0,71	5,17	0,99	4,47	0,44	2,75	0,08
RBR	7,65	0,52	7,93	0,49	7,72	0,39	0,80	0,46
DBBP	8,26	0,48	8,38	0,36	8,21	0,38	0,32	0,73
FLMFBWNH	6,36	0,31	6,23	0,23	6,13	0,21	2,43	0,11
FLMFBWDH	6,25	0,34	6,28	0,25	6,03	0,17	2,81	0,08
DSTLRLH	18,75	1,81	18,00	3,41	20,67	2,19	3,63	**0,04**
10FT	7,81	1,11	7,17	0,98	8,00	1,65	0,83	0,45
4MS6MS1M	3,63	1,54	3,00	2,00	5,00	2,70	2,31	0,12
4MS6MS2M	3,94	1,73	3,67	1,37	4,58	1,08	1,00	0,38
4MS6MS3M	2,69	1,62	3,33	1,63	4,75	1,66	5,50	**0,01**

Discussion

Among year I basketball students, the one-year training process had a positive effect on the following motor abilities: agility, explosive power of the lower limbs and starting speed, however no significant improvements were observed in the repetitive strength of the upper limbs, flexibility of the trunk and repetitive strength of the abdominal muscles. Although not statistically significant, the sit and reach motor variable showed the greatest percentage improvement by 19.1%. The training process had a positive effect on the students' ability to successfully perform the majority of

the technical elements with or without ball, however, when it came to performing the more complex motor structures with or without ball, particularly when performing jump shots- the results were significantly worse. The fact that the shooting accuracy from the free throw line has not improved is surprising. What is also surprising is that the respondents achieved better results in the initial measurement of the tests: running between racks and walking between racks. This can be explained by the acceleration that is present at this stage of development and the impairment of students' motor skills. After one year of training sessions, no significant improvement was observed in the fast ball passing with left and right hand. Additionally, the results of these two tests showed no differences, which means that the respondents drive the ball similarly with both hands. Among the year II basketball students, the one-year training process caused positive changes in the following motor abilities: running for 20 meters and trunk lift in 30 seconds, but it showed no sufficient improvement in endurance, agility, repetitive strength of the upper limbs, flexibility of the trunk and the explosive strength of the lower limbs. Although not statistically significant, the greatest percentage improvement was achieved in the motor variable: push-ups, with 100%. At the initial measurement, the average value for this variable was 10 push-ups, and at the final measurement it was 20 push-ups. The training process caused positive changes in students' abilities to successfully perform the majority of technical elements with and without ball, but they achieved significantly weaker results when performing more complex motor structures with and without ball, especially while performing jump shots where specific basketball endurance is required . As was the case with the year I students, the year II students achieved better results in the initial measurement, when performing the following tests: running between the racks and driving between racks. This can be explained by the acceleration characteristic for this period of development and the impairment of students' motor skills. No significant improvement was determined after one year of training process in fast ball passing with left and right hand, but also no difference was observed between the results of these two tests, which means that the respondents drive similarly with both hands. It was expected that after a two-year training process, students would achieve better results in all tests. As for the year III basketball students, the one-year training process caused positive changes in flexibility and repetitive strength of the abdominal muscles. The largest negative percentage reduction was observed in the motor variable - sit and reach, with -49.9%. The training process caused positive changes in the students' ability to successfully perform the majority of technical elements with and without ball, but they achieved significantly weaker results when jump shot. The fact that shooting accuracy from the free throw line has not improved is surprising. It is also surprising that the respondents achieved better results during the initial measurement of the performance of the tests: running between racks and walking between racks. This can be explained by the acceleration present at this stage of development and the impairment of students' motor skills. The one-year training process showed no significant improvement in fast ball passing with right hand only. Based on the overall analysis of the obtained results for the basketball students from all three years, the following conclusions were drawn: Leger test - the best results were achieved by basketball students from year I, as for the Push-ups variable - the best results were achieved by the basketball students from year III. Regarding the specific motor variables, the initial measurement showed that: Two-handed passing speed – the best results were achieved by basketball players from year III; Fast lead to the middle of the court and back with the stronger hand and Fast lead to the middle of the court and back with the stronger

hand – the best results were achieved by basketball students from year III. It could be stated that, based on the initial measurement, the best results were achieved by students in year III. The final measurement showed statistically significant differences among students from different years in the following variables: Leger test - the best results were achieved by basketball players from year I; Push-ups - best results were achieved by year III students; Running for 20 metres - best results achieved by year III students; Trunk lift in 30 seconds - best results achieved by year III students. The final measurement of the specific motor variables revealed statistically significant differences in the following variables: Two-handed passing speed - best results were achieved by year II players; Dribbling from the side and through the legs with the right and left hand (spider drill) - best results achieved by year II students; A test to measure specific basketball endurance and accuracy - in the third minute, the best results were achieved by year III students. It was surprising that for the Leger test, the best results in both the initial and final measurements were achieved by year I students. Greater motivation of this group seems to be only explanation for this result.

Conclusion

The results and conclusions obtained in this project will primarily help the athletes - students in the sports academy. The main beneficiaries will be the experts from the Sports Academy, who actively participate in the educational and training process. Among other things, these findings could enable a more efficient programming and implementation of their teaching and sports activities. The results obtained from this research could also be used for assessment, monitoring, control and comparison of the condition and further development of the motor and specific motor area . The obtained results will help in creating norms and criteria that will improve the quality of the selection process.

References

Blaskovic M., E. Hofman.(1983): The relationship between basic motor skills and success in basketball. Kinesiology, no. 2, Zagreb.

Badrić M. And Petračiħ T. (2007): Differences in anthropometric characteristics and motor abilities of students from urban and rural environments. Proceedings of the interdisciplinary scientific conference of international students - Anthropological status and physical activity of children and youth, 265-271.

Bala, G. (1981): Structure and development of morphological and motor dimensions of children SAP Vojvodina. OUR Institute of Physical Culture, Novi Sad.

Vukojevic, M. (1978): Relationship between anthropometric dimensions and some situational basketball tests. Zagreb.

Daskalovski, B., Naumovski, M., Misovski, A., & Aceski, A. (2017). TENDENCIES OF MOTOR SKILLS DEVELOPMENT IN STUDENTS-BASKETBALL PLAYERS FROM THE SPORTS ACADEMY IN SKOPJE. Research in Physical Education, Sport & Health, 6(1).

Dukovski, S., M. Naumovski, I R. Hristovski. (1994): The influence of general motor skills on some situational-motor variables that define the attack in basketball. FIS communication 94, Series Fizicka kultura, Nis.

Dukovski, S., M. Naumovski, R. Hristovski. (1995): Basketball. Union of School Sports of Macedonia, Skopje.

Gonzalo-Skok, O., Serna, J., Rhea, M. R., & Marín, P. J. (2017). Age differences in measures of functional movement and performance in highly youth basketball players. *International journal of sports physical therapy*, *12*(5), 812–821.

Jovanovic I. (1994): Relation tests for the precision of additions and substitutions in canonical space. FIS Communication 94, Physical Culture Series, Niš.

Karalejić, M., Jakovljević, S. (1998). Testiranje i merenje u košarci. Beograd: KSS. [Testing and measuring in basketball. Belgrade: KSS] In Serbian.

Karalejic. M., Jakovljevic S. (2009). *Dijagnostika u kosarci*. 3D+ Novi Sad.

Kurelic N, Momirovic K, Stojanovic M. et al. (1975) Structure and development of the morphological and motor dimensions of youth. Belgrade: Institute for Scientific Research FFV in Belgrade.
Matkovic B. (1986): Uticaj morfoloskih characteristics na successnost u kosarci. Kinesiology, no. 2, Zagreb.
Mancha-Triguero, D., García-Rubio, J., Gamonales, J.M., Ibáñez, S.J. (2021). Strength and Speed Profiles Based on Age and Sex Differences in Young Basketball Players. *Int. J. Environ. Res. Public Health,* 18, 643. https://doi.org/10.3390/ijerph18020643
Metikoš, D., Prot, F., Horvat, V., Kuleš, B., & Hofman, E. (1982). Bazične motoričke sposobnosti ispitanika natprosječnog motoričkog statusa. *Kineziologija, Zagreb*, *14*, 21-62.
Naumovski M. (1994): Influence of some specific motor skills on the accuracy of throwing the ball into the basket from different distances. International scientific conference "Optimization of the pedagogical process in basketball, volleyball, handball". Sofia, 1994.
Naumovski M. (2002): Relationships between quantitative and qualitative variables in basketball players from European national teams. Science in the function of sport. Skopje.
Pavlovic, M. (1983): Testing and baskets, FFK VTS, Sarajevo.

MODELING OF THE RELATIONSHIP BETWEEN ANTHROPOMETRY AND NUTRITION KNOWLEDGE OF PROFESSIONAL VOLLEYBALL ATHLETES

Marta Tomljanović[1,2], Tea Bešlija[1] Mario Tomljanović[1]
[1] University of Split, Faculty of Kinesiology, Split, Croatia
[2] University of Zagreb, Faculty of Food Technology and Biotechnology, Zagreb, Croatia

Introduction

Volleyball is a high-intensity sport with special nutritional needs and requirements. Large muscle groups are used and speed is required for actions such as jumping, spiking and blocking. Actions take place in 30-second intervals, over a period of 30 to 180 minutes (Valliant et al., 2012). Proper nutrition is critical for successful sports results (Papadopoulou et al., 2002), but also proper recovery and health of female athletes (Danh et al., 2021). In addition to the need to take into account the available energy, it is extremely important to pay attention to the intake of macronutrients, as well as hydration before, during and after the activity (de Almeida and Soares, 2003). The most common problems faced by this population are insufficient energy intake and carbohydrate intake, excessive fat intake and increasingly frequent dietary disorders (Danh et al., 2021). Current findings indicate lack of knowledge about the nutrition of the athletes themselves, but also of their coaches, who are often their primary source of information (Torres-McGhee et al., 2012). There is insufficient research that assesses the knowledge of the nutrition of volleyball players, and those that have been conducted show that volleyball players overestimate protein intake and underestimate carbohydrate intake (Daniel et al., 2016; Anderson et al., 2010; Heaney et al., 2008), but they also indicate positive changes after the education (Valliant et al., 2012). There is no gold standard for measuring nutrition knowledge using questionnaires, and inadequate knowledge can be a combination of many factors (insufficient time, poor source of information, etc.). Sufficient knowledge about nutrition can be crucial in improving eating habits and choosing the right fuel for the body in volleyball (Danh et al., 2021). Based on previous research, the knowledge of volleyball players about nutrition was found to be inadequate (Faccin et al., 2017), and based on this, the goals of the research were set: to examine and evaluate the knowledge of proper nutrition and sports nutrition of professional volleyball players and to put the obtained results into relation with anthropometric parameters.

Methods

In this research participated seventeen respondents, ages 15 to 29, all volleyball players from ŽOK Ribola Kaštela. All respondents play in the 1st Croatian League. Before the start of the survey, the respondents signed the Statement of Consent to participate in the research. Respondents who were minors collected the signature of their parents or guardians.

Body mass (kg), percentage of adipose tissue %), fat mass (kg), muscle mass (kg) and body mass index (kg/m2) were calculated on a Taniti Pro BC-418 scale, where the subjects were without shoes and with minimal clothing. Body height was measured on a stadiometer, in an upright position, without shoes and with the heels together. Validated questionnaires by Parmenter and

Wardle (1999) and Blennerhassett et al. (2018) were used to assess knowledge about nutrition. The first part of the questionnaire refers to socio-demographic characteristics and general questions related to their volleyball career, the second part to their eating habits, and the third part to knowledge about proper nutrition and sports nutrition. Data was presented as relative percentage frequencies and partial least squares regression (PLS) was used to assess the quantitative relationship between anthropometric parameters and food patterns.

Results

Table 1. Basic diet habits

Number of meals/day		Eating place		Diets in last year		Consumation of diet food	
<3	11,8 %	Home	94,1%	Reduction diet	11,8 %	Daily	11,8 %
3-5	70,6 %	Out	5,9 %	Diet because of medical condition	5,9 %	Sometimes	58,8 %
>5	17,6 %			No	82,4 %	Never	29,4 %

Almost all respondents (94.1%) dine at home, so we assume that it is a cooked meal, with only one respondent that dines outside of the home. The vast majority consume three to five meals a day, which agrees with the recommendations, but there are respondents who consume less than three meals (11.8%) and more than five meals (17.6%). In the last year, three respondents followed a diet; two on a reduction diet, and one on a diet due to a medical condition.

Table 2. Results of the questionnaire for assessing knowledge about nutrition in general and sports nutrition in percentage values

Question		**1.**	**2.**	**3.**	**4.**	**5.**	**6.**	**7.**	**8.**	**9.**	**10.**	**11.**	SUM
Mean percentage		%	%	%	%	%	%	%	%	%	%	%	%
All respondents		45	47	60	51	51	32	65	47	54	12	35	45
Age	12-15 (n=2)	42	50	71	64	67	50	0	50	50	0	33	43
	16-18 (n=9)	35	33	54	44	37	22	89	33	56	11	33	41
	19-24 (n=4)	54	25	61	54	58	38	50	50	50	25	33	45
	>24 (n=2)	75	100	71	64	83	50	50	100	63	0	50	64
% adipose tissue	14,4-19,6 %	39	33	48	48	28	33	67	33	50	0	39	38
	19,6-24,8 %	44	50	62	46	58	31	63	50	56	12	29	46
	24,8-30 %	44	33	62	71	78	33	67	67	58	33	44	54
Number of meals/day	<3	42	50	43	64	83	25	100	100	50	0	67	57
	3-5	44	50	62	44	47	29	58	50	56	0	31	43
	>5	44	0	62	71	44	50	67	0	50	67	33	44
Following a diet	Yes	50	67	57	62	89	25	100	100	58	0	56	60
	No	44	36	60	49	43	34	57	36	54	14	31	42

Questions in the questionairre were following: „Are the foods listed bellow rich or low in proteins: turkey, banana, cheese, butter, peanuts, potatos?“, „Which fats are recommended to take in smalles possible quantities?“, „Are the foods listed bellow rich or low in fats: pasta, honey, nuts, eggs, butter, white bread?“, „Are the foods listed bellow rich or low in carbohydrates: sardines, popcorn, chicken, oats, butter, spaghetti, Cedevita?“, „Do you agree with following senteces: "Whole

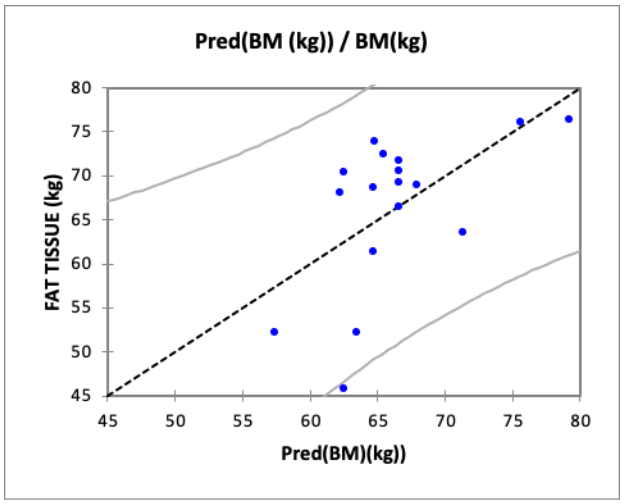
milk contains more protein than skim milk", "Whole milk contains more calcium than skim milk" and "Flax seeds, chia seeds and walnuts are a good source of omega 3 fatty acids"“, „Do you agree with following senteces: "A high-carbohydrate diet helps reduce muscle breakdown in the body," "Spinach is a good source of iron that is easily absorbed by the body," "Green leafy vegetables contain calcium that is easily absorbed by the body," and "Vitamin C increases the absorption of iron in the body."“, „What is the optimal quantity of water for athlete?“, „What is the most important macronutrient for replenishing glycogen storages?“, „Do you agree with following sentences: "Caffeine can improve endurance by reducing the perception of exertion", "Energy drinks like 'Red Bull' are good drinks to consume 30 minutes before training", "The body uses vitamins and minerals better from food in which they are naturally found than from food enriched with them", "Vitamin supplementation is recommended for all physically active people"“, „In what timeframe should athlete consume meals after the workout?“ and „Do you agree with following sentences: "B vitamins should be taken in case of lack of energy", "Fruit juice is a good type of liquid to take during training" and "Sports bars may be contaminated with substances banned by the doping agency"“.

The values shown in the table are in percentage values. Marked red are the percentages of correct answers that are extremely unsatisfactory, i.e. below 30% of correct answers from a certain population, and marked green are the percentages above 80%, which indicate a high percentage of correct answers in certain categories.

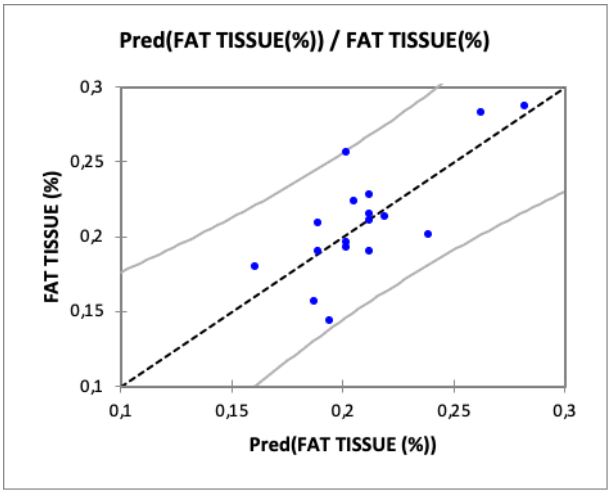
There are certain questions that have a very large number of percentages marked in red and orange (questions 1, 6, 10 and 11). Conversely, there are very few questions marked in green (questions 5, 7 and 8). The total accuracy of answers to all questions on the survey is 45%, which is quite low and can be characterized as "no knowledge" of our respondents about proper nutrition and sports nutrition (Andrews et al., 2016).

In PLS modeling, the characteristic that was observed as an indicator of the relationship between the observed parameters was the coefficient of determination, R^2, and the dependent variable in the linear model was: (i) body mass, (ii) percentage of adipose tissue and (iii) the fat mass of the test subjects.

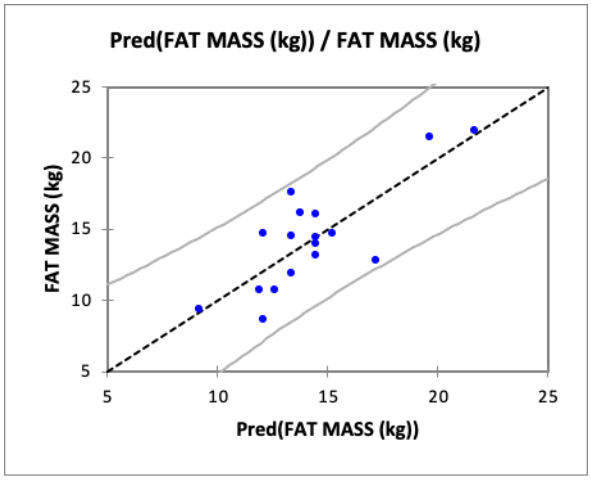
The coefficient of determination (R^2) in the range from 0.33 to 0.67 indicates a moderate prediction accuracy (moderate association of variables), and for an R^2 value below 0.19 it is considered that PLS cannot predict a variable, i.e. that the connection between variables is weak . On graphs 1-3 we see the predictions of the variables based on the PLS model.



Graph 1. Prediction of body mass based on answers to questions about eating habits (R^2=0,34)



Graph 2. Prediction of the percentage of fat tissue based on answers to questions about eating habits (R^2=0,56)



Graph 3. Prediction of fat mass based on answers to questions about eating habits (R^2=0,64)

Discussion

According to the questionnaire, many respondents (45%) recognized turkey as a food rich in protein, even 100% of them in the categories ">24 years old", "24.8-30.0% fat tissue", "<3 meals" and "on diet". Surprising results were obtained for banana, where the respondents failed to recognize that it's a food that is low in proteins, and in many subgroups the percentage of accuracy is equal to 0. Only 41.2% of the respondents recognized "saturated fat" as a fat that would be should be taken in smaller quantities. Percentage of 100% accuracy was obtained by respondents older than 24 years, while respondents who consume more than 5 meals a day gave 0 correct answers to this question. Foods rich in fat was recognized by the respondents in the percentages above 60%. Pasta and honey are the foods that gave them problems and they failed to recognize them as low in fat and rich in carbohydrates. Mostly younger respondents (16-18 years old) and those who consume less than 3 meals a day had fewer correct answers to this question. As for carbohydrates, as expected, the highest percentage of correct answers (76%) was for spaghetti, which is rich in carbohydrates, although younger respondents and those with a lower percentage of fat tissue failed to recognize it. Butter caused the most incorrect answers, where a certain number of respondents classified it in the category of foods rich in carbohydrates and not fats, even though it was offered as such in the last question where the accuracy of the answers was extremely high. We can evaluate the answers to questions related to macronutrients with a total accuracy of 53%, which can be characterized as inadequate knowledge, which coincides with previous studies where athletes do not know enough about macronutrients in food (Vasquez-Espino et al., 2022; Danh et al., 2021) and only 30% of them recognize food components (Feng and Yuan, 2022). The percentage of correct answers above 75% is generally accepted as adequate (Andrews et al., 2016),

When agreeing with the statements, the respondents could choose whether they agreed, disagreed or did not know the answer. The following statements were offered: "Whole milk contains more protein than skim milk", "Whole milk contains more calcium than skim milk", "Flax seeds, chia seeds and walnuts are a good source of omega 3 fatty acids", "A high-carbohydrate diet helps reduce muscle degradation in the body", "Spinach is a good source of iron that is easily absorbed by the body", "Green leafy vegetables contain calcium that is easily absorbed by the body" and "Vitamin C increases the absorption of iron in the body.". The first statement is incorrect and 59% of respondents agreed with it (100% of respondents over 24 years old, with a higher % of fat tissue and those on a diet). The second statement divided the respondents, and although it is incorrect, a large percentage of them believe it is correct (30%) or do not know the answer to the question (35%). The third statement, like the first, has 10 out of 17 correct answers (59%). The fourth statement has a total of 0 correct answers in all categories, which is surprising considering that all respondents are professional volleyball players. The fifth and seventh statements were recognized by the majority of respondents as correct. One-hundred percent accuracy was achieved by respondents older than 24 years and those who consume more than 5 meals a day. The respondents on a diet, the respondents who consume less than 3 meals a day and the young volleyball players had lower rate of correct answers. Knowledge about macronutrients, as well as about micronutrients, is extremely inadequate, as confirmed by research (Vasquez-Espino et al., 2022).

When it comes to hydration, 65% of respondents recognized that the needs are determined individually for each athlete. Respondents under the age of 16 had 0% correct answers, which we can attribute to their age. All respondents who consume less than 3 meals a day answered this question correctly. Questions related to hydration have had a high percentage of correct answers in previous research aswell (Vasquez-Espino et al., 2022; Heikkila et al., 2017)

Volleyball as a sport, during training and matches, consumes glycogen from the body, which needs to be replenished later. To restore glycogen storage athletes need to consume cabohydrates after trainig. 47% of respondents answered the question correctly, respondents older than 24 years and those who consume less than 3 meals a day had 100% correct answers, while respondents who consume more than 5 meals a day had 0 correct answers. After carbohydrates, 29% of them estimated that we replenish glycogen stores by consuming protein.

Also related to sports nutrition, agreement with the following statements was examined: "Caffeine can improve endurance by reducing the perception of effort", "Energy drinks like 'Red Bull' are good drinks to consume 30 minutes before training", "The body makes better use of vitamins and minerals from food in which they are found naturally rather than from food enriched with them", "Vitamin supplementation is recommended for all physically active people". The majority of respondents correctly answered that caffeine reduces the perception of effort (53%), that energy drinks such as "Red Bull" are not good for consumption before training (82%), and that the body uses vitamins and minerals better from food in which they are naturally found than from food enriched with them" (76%). A very small percentage (6%) answered correctly to the last statement "Vitamin supplementation is recommended for all physically active people", where the correct answer would be that such supplementation is not recommended if the diet is balanced. The highest percentage of correct answers was given by respondents older than 24 years (63%) and respondents on a diet (58%). Questions related to supplementation have the lowest percentage of correct answers and proved to be the most complex for athletes in previous research aswell (Heikkila et al., 2017).

The majority of respondents (82%) answered that the meal should be consumed within an hour of training. Although the answer is not incorrect, it would be more accurate within 30 minutes, which was recognized by only 12% of respondents (respondents who consume more than 5 meals a day, respondents with increased fat mass and respondents aged 19 to 24). Athletes recognize the periodization of food intake as important in previous research same as Croatian volleyball players (Vasquez-Espino et al., 2022).

The last question related to agreement with the following statements: "B vitamins should be taken in case of lack of energy", "Fruit juice is a good type of liquid to take during training" and "Sports bars can be contaminated with substances banned by the doping agency". The total number of correct answers is once again extremely low (35%). Few female respondents know that B vitamins are not taken in case of lack of energy (24%), of which young female respondents aged 12 to 15 years were the only with more than 50% of correct answers. The majority of respondents recognized that fruit juice is not a good liquid for consumption during training, namely respondents older than 24 years and respondents who consume less than 3 meals a day. A small number of respondents (35%) know what is in sports chocolate bars and that they may contain substances prohibited by the doping agency.

The prediction of body mass (graph 1), percentage of fat tissue (graph 2) and fat mass (graph 3) for all test subjects are within the confidence interval, except for one subject and body mass, and the strongest connection is between fat mass (in kg) and the dietary habits of the test subjects. The other anthropometric parameters are linked medium strong with eating habits. The three observed variables belong to the R^2 group ranging from 0.33 to 0.67, i.e. they have moderate prediction accuracy based on answers to questions about eating habits (Chin, 1998). The following variables were observed in order to assess how much their eating habits and knowledge about nutrition affect their body mass, percentage of fat tissue and fat mass, because there is often a need to lose weight or increase muscle tissue. In order to correctly assess which habits to cultivate and which to discard, we performed PLS regression and defined predictions based on the coefficient of determination.

Conclusion

The subjects' knowledge of proper nutrition and sports nutrition was assessed using a validated questionnaire in 11 questions: The highest percentage of correct answers were given by subjects older than 24 years, subjects who had a higher percentage of fat tissue (24.8-30%) and subjects who consumed less than three meals a day and followed a diet. Knowledge about nutrition in general and sports nutrition is inadequate: 53% of total correct answers on the content of macronutrients in the foods they use daily; 32% of total correct answers to micronutrients in the foods they use daily; 47% of respondents recognize the need for carbohydrates after volleyball training, which depletes carbohydrate reserves; 12% of the test subjects eat food within 30 minutes after training for optimal muscle hypertrophy and replenishment of glycogen stores; 35% of respondents know the benefits and dangers of the supplements they often consume. The low percentage of accuracy is consistent with research and knowledge questionnaires conducted so far on professional athletes (Mitchell et al., 2022; Dahn et al., 2021; Klein et al., 2021; Turner et al., 2021; Heaney et al. , 2011). Quantitative model (PLS regression) shows that the success of predicting body mass, percentage of fat tissue and fat mass based on their basic eating habits is moderate (R^2 is in the range from 0.33 to 0.67). By using the PLS model it can be concluded that respondents who have more knowledge about nutrition and follow positive eating habits (more meals a day, monitoring diet) have a more favorable body mass, percentage of fat tissue and fat mass. One subject is not within the confidence interval for the body mass predicted by the model, i.e. she does not follow the prediction model (the anthropometry is not in accordance with her eating habits). This research has its own limitations, considering the number of respondents is too low (n=17), and the ages vary from adolescents to working adults. Furthermore, the PLS modeling used to predict certain anthropometric parameters is linear whereas maybe a non-linear model would give more information considering how many variables there are.

References

Anderson ED (2010) The impact of Feedback on Dietary Intake and Body Composition of Collage Women Volleyball Players over a Competitive Season. J Strenght Cond Res, 24, 2220-2226.

Andrews A, Wojcik JR, Boyd JM, Bowers CJ (2016) Sports Nutrition Knowledge among Mid-Major Division 1 University Student-Athletes. *Journal of Nutrition and Metabolism*

Chin WW (1998) The partial least squares approach to structural quation modeling. U: Marcoulides GA (ured.) Modern Methods for Business Research, Lawrence Erlbaum Associates, Mahwah, NJ, 295-358

Danh PJ, Nucci A, Doyle A, Feresin GR (2021) Assessment of sports nutrition knowledge, dietary intake, and nutrition information source in female collegiate athletes: A descriptive feasibility study. J Am Coll Health, 1-4.

Daniel SVN, Jurgensen PL, Padovani R, Juzwiak RC (2016) Impact of an Interdiciplinary Food, Nutrition and Health Education Program for adolescent Brazilian volleyball players. Rev Nutr, 29, 567-577.

De Almeida AT, Soares AE (2003) Nutritional and anthropometric profile of adolescent volleyball athletes. Rev Bras Med Esporte, 9, 198-203.

Faccin AP, Alves MK, Macedo RCO (2017) Anthropometric profile, food and nutrition knowledge of volleyball athletes. Rev Bras Nutricao Esportiva, 11, 259-264.

Feng B, Yuan Y (2022) Investigation and Strategy Research on Dietary Nutrition Knowledge, Attitude adn Behaviour of Athletes. *Journal of Food Quality*

Heaney S, O'Connor H, Micheal S, Gifford J, Naughton G (2011) Nutrition Knowledge in Athletes: A Systematic Review. *International Journal of Sport Nutrition and Exercise Metabolism,* 21, 248-261.

Heaney S, O'Connor H, Naughton G, Gifford J (2008) Towards an Understanding of the Barriers to Good Nutrition for Elite Athletes, Int J Sports Sci Coa, 3, 391-401.

Heikkila M, Valve R, Lehtovirta M, Fogelholm M (2017) Nutrition Knowledge Among Young Finnish Endurance Athletes and their Coaches. *International Journal of Sport Nutrition and Exercise*

Klein,D.J.;Eck,K.M.; Walker, A.J.; Pellegrino, J.K.; Freidenreich, D.J. (2021) Assessment of Sport Nutrition Knowledge, Dietary Practices, and Sources of Nutrition Information in NCAA Division III Collegiate Athletes. *Nutrients* , 13,2962.

Mitchell L, Lehane P, McCarthy M, O'Shea K, Tracey M, Whyte T, Neville R (2022) Nutrition knowledge of elite and non-elite Gaelic footballers, *Science and Medicine in Football*, 6, 159-163

Papadopoulou KS, Papadopoulou DS, Gallos KG (2002) Macro- and Micro-Nutrient Intake of Adolescent Greek Female Volleyball Players. Int J Sport Nutr Exe, 12, 71-78

Torres-McGhee TM, Pritchett KL, Zippel D, Minton DM, Cellamare A, Sibilia M (2012) Sports Nutrition Knowledge Among Collegiate Athletes, Coaches, Athletic Trainers and Strenght and Conditioning Specialists. J Athl Training, 47, 205-211.

Turner O, Mitchell N, Ruddock A, Purvis A, Ranchordas M (2021) Elite squash players nutrition knowledge and influencing factors. *Journal of the International Society of Sports Nutrition,* 18.

Valliant WM, Emplaincourt PH, Wenzel KR, Garner HB (2012) Nutrition Education by a Registered Dietitian Improves Dietary Intake and Nutrition Knowledge of a NCAA Female Volleyball Team. Nutrients, 4, 506-516.

Vázquez-Espino, K.; Rodas-Font, G.; Farran-Codina, A. Sport Nutrition Knowledge, Attitudes, Sources of Information, and Dietary Habits of Sport-Team Athletes. *Nutrients* 2022, *14*, 1345.

ANALYSIS OF THE START REACTION TIME IN THE 60 M RACES AT THE WORLD INDOOR CHAMPIONSHIP IN ATHLETICS – BELGRADE 2022

Milan Matić[1], Irina Juhas[1], Nenad Janković[1], Marko Ristov[2]
[1] University of Belgrade, Faculty of Sport and Physical Education, Belgrade, Serbia
[2] Serbian Athletics Federation, Belgrade, Serbia

Introduction

Start reaction time (SRT) is one of the factors that affects the result in sprint running (Mero & Komi, 1990; Bruggemann & Glad, 1990; Babić, 2008). The SRT is measured through force sensors located in the starting blocks and as data are included in official statistics. When it comes to crouch start, the reaction is simple (one stimulus and one motor response), but in many sports and sports games, complex reaction times play an important role. A large number of authors have so far investigated the SRT at major international competitions, outdoor and indoor World Championships, as well as at the Olympic Games (Moravec et al., 1988; Collet, 1999; Babic & Delalija, 2009; Pilianidis, Kasabalis, Mantzouranis, Mavvidis, 2012; Pilianidis, Mantzouranis, Kasabalis, 2012; Paradisis, 2013; Tonnessen, Haugen, Shalfawi, 2013; Pavlovic, Bonacin, Bonacin, 2014; Juhas, Matić, Janković, 2016). Analyzing this factor is particularly important since it is known that hundredths, and in some situations even thousandths of a second are important for winning or setting a record. At the 2022 World Indoor Athletics Championships held in Belgrade, in the final race, Marcel Jacobs beat the second-placed Christian Coleman by 0.003.

The shorter the discipline (60m and 100m), the more important the start reaction time is (Collet, 1999). Tonnessen, Haugen & Shalfawi (2013) analyzed the SRT at the World Championships in the period from 2003 to 2009 and obtained a statistically significant correlation between the SRT and the achieved results in the races. Similar conclusions were reached by Paradisis (2013) analyzing the SRT in the 100 m races at the World Indoor and Outdoor Championships, and at the Olympic Games in the period from 1996 to 2012.

Pavlović, Raković, Idrizović and Mihajlović (2013) analyzed the start reaction times of the finalists of the 2013 World Athletics Championships in the sprint disciplines and found no statistically significant gender-related differences. When analyzing the values of SRT finalists in the disciplines 100 m, 200 m and 400 m at the World Athletics Championships in 2013 and 2015, Juhas, Matić, Janković (2016) also found no statistically significant gender-related differences.

However, more studies have analyzed the results of outdoor competitions than indoor ones, which is understandable from given that indoor championships are more recent events The aim of this research was to analyze the results and SRT achieved by males and females in the 60 m races at the 2022 World Indoor Championship in Athletics, held in Belgrade.

Methods

The research includes the results of the SRT in men's and women's events achieved in the qualifying, semi-final and final races of the 60 m discipline at the 2022 World Championships (WC) in athletics, held in Belgrade. The achieved race results and SRT were obtained from the official WC reports.

The results were processed using standard descriptive and comparative statistical procedures. The linear Pearson correlation coefficient (r) was used to examine the relationship between the achieved results and the time of the start reactions. Values of r in the range of 0.10 to 0.29 were considered low, from 0.30 to 0.49 moderate, and above 0.50 high (Cohen, 1988). The distribution of data was done using the Kolmogorov-Smirnov test, and the homogeneity of variances using the Levene's test with the criterion that sig.>0.05. The t test for independent samples was used for comparison. Differences in start reaction times between men and women were investigated: all participants at 60 m, in qualifications, semi-finals, and final races. Statistical data processing was performed in the program (SPSS 21.0; Chicago, IL).

Results

Table 1 shows the arithmetic means (M) and standard deviations (SD) of all participants in the qualifying, semi-final and final races at 60 m at the 2022 World Championships in Athletics.

Table 1. Descriptive statistics of the analyzed results (presented in seconds) in men and women.

	Men		**Women**	
60 m	**M**	**SD**	**M**	**SD**
All competitors	6.65	0.13	7.24	0.17
Qualifications	6.69	0.14	7.31	0.18
Semi-final	6.59	0.09	7.16	0.08
The final	6.55	0.11	7.05	0.08

Table 2 shows arithmetic means (M) and standard deviations (SD) of reaction times in men and women.

Table 2. Descriptive statistics of analyzed reaction times (presented in seconds) in men and women.

	Men		**Women**	
60 m	**M**	**SD**	**M**	**SD**
All competitors	0.137	0.01	0.143	0.02
Qualifications	0.136	0.01	0.144	0.02
Semi-final	0.141	0.02	0.143	0.02
The final	0.134	0.01	0.14	0.01

Table 3 shows the correlations (r) between the results and the reaction time of all competitors in the category of men or women, competitors in the qualifying, semi-final and final races.

It can be seen from Table 3 that there is a statistically significant correlation between the results and the SRT in women when observing the entire sample of participants and when observing participants in qualifications. In the semi-final and final group of women and in all groups of men, there is no significant correlation between the results and SRT, but there is a positive trend.

Table 3. Correlation (r) between the results and reaction time in men and women.

	Reaction time							
Results	M all	M qual.	M semifin.	M fin.	W all	W qual.	W semifin.	W fin.
M all	0.1							
M qual.		0.1						
M semifin.			0.35					
M fin.				0.43				
W all					0.27*			
W qual.						0.29*		
W semifin.							0.23	
W fin.								0.57

Legend: M – men; W – women; all - all competitors who participated in the men's or women's competition in the 60 m discipline; qual. - competitors who participated in qualifying races; semifin. - competitors who participated in the semi-final races; fin. - competitors who participated in the final races; r – linear Pearson correlation coefficient; * – level of statistical significance $p<0.05$.

To determine the statistical difference between SRT: all male and female competitors, male and female competitors in the qualifications, male and female competitors in the semi-finals, male and female competitors in the final, a t-test for independent samples was used (Table 4).

Table 4. Independent samples t test results for men and women.

Group	Gender	t	p	η
All competitors	Women Men	2.48	0.01	0.04
Qualifications	Women Men	2.47	0.02	0.07
Semi-final	Women Men	0.37	0.71	/
The final	Women Men	1.2	0.25	/

Legend: p - if the value of $p<0.05$ there is a statistically significant difference between men and women in the VSR; η – 0.01 small impact; 0.06 medium impact; 0.14 large impact.

The results presented in Table 4 show that there is a statistically significant difference between SRT when comparing all male and female competitors, and when comparing male and female competitors in qualifying races. In the semi-final and final groups, no significant difference between men and women was obtained.

Discussion

Average SRT values were obtained for men in the range of 134 to 141 ms, and for women from 140 to 144 ms. In the study of Paradisis (2013), it can be seen that VSR in the 60 m race is not consistent (it increases, which negatively affects the result), and it is on average from 150 to 240 ms in male finalists, and from 154 to 214 ms in female finalists. The reason of VSR increase in the final

races at 60 m in the research that analyzed the times of starting reactions at the indoor World Championships in the period from 2003 to 2012 should be determined. Is the reason for the extension of SRT from 150 ms (average start reaction time in Budapest in 2004) to 240 ms (average start reaction time in Istanbul in 2012) the caution of athletes in order to reduce the risk of transgression and disqualification, or is it the different way of measuring SRT at that competition?

This research showed that there is a positive trend between the SRT and results. A review of the available literature did not find many studies examining the link between SRT and 60 m sprint performance. In the study by Paradisis (2013), the correlation coefficient between VSR and the results in the analyzed indoor WCs from 2003 to 2012 in races over 60 meters for men is $r = 0.550$, $p < 0.05$, and for women $r = 0.601$, $p < 0,05$. In our research, a higher correlation between SRT and results was obtained in women than in men (see Table 3), which corresponds to the results obtained by Paradisis (2013).

In several studies, it was found that men have shorter SRT than women (Babić and Delalija 2009). In a study by Der and Deary (2006) which examined the differences between men and women in SRT on a sample of several thousands of respondents, it was determined that men have shorter SRT than women. Winter and Brookes (1991) found that women have a longer electromechanical delay after the stimulus when compared to men. A review of the available literature did not find a biological reason for the slower reaction time in women compared to men, but it is assumed that certain neurological and mechanical factors are responsible for the slower reaction time in women (Der & Deary, 2006). In this paper, when comparing the entire sample of both male and female competitors from the qualifications, statistically significantly less SRT was obtained in men compared to women, which is in agreement with the results of Babić and Delalija (2009). However, these results are in contrast to the results of the study (Martin & Buoncristiani, 1995) which showed that in the world's best athletes, no significant differences in SRT were observed between men and women in sprinting disciplines. In the research of Shahahani et al. (2018) by analyzing the SRT in men and women at the Olympic Games (OI) from 2004 to 2016 in the 100 m discipline, it was determined that the SRT in women has shortened almost linearly at each subsequent OI, while in men it was observed shortening of SRT on OI from 2012 to 2016. As one of the explanations for the shortening of the SRT between 2012 and 2016 is the reduction of the force threshold in the starting blocks used in electronic timing as the moment when the competitor's movement begins (Shahshahani et al., 2018). It is necessary to examine the legitimacy of different start information systems used in competitions to identify false starts (Milloz et al., 2021). It is interesting that in the study by Paradisis (2013) there is a significant difference in SRT between men and women at 60 meters only in two World Championships out of a total of six analyzed (at the 2010 Championship in Doha, men had shorter VSR, while in Istanbul in 2012 women had shorter SRT). This approximate parity in SRT between men and women at four SPs out of a total of the six analyzed can be considered unexpected.

Conclusion

Descriptive statistics of the obtained results show that there is a "time space" within the SRT, the reduction of which can improve the result, and therefore in future research it is important to examine possibilities to optimize SRT. Is optimization possible by applying certain training methods or using certain neurophysiological methods such as transcranial magnetic stimulation

(TMS)? If SRT optimization is possible in both ways, then it should be determined whether the functional and structural connection of brain structures, i.e. influence on brain plasticity (with the help of plastic changes in the brain, people develop, learn and master new skills) is achieved more effectively by applying certain training methods or by means of modern neurophysiological methods that increase the excitability of the motor cortex.

Analyzing SRT in sprint disciplines will certainly be the subject of further research. There is an ongoing discussion in the IAAF about whether the achieved reaction time value of less than 0.100 ms at the start is the value for the disqualification of the competitor.

In future research, the relationship between SRT and results at 60 m and differences in the SRT between men and women should be examined on a larger sample of respondents (at several recent World Indoor Championships). We suggest that regression analysis be applied in subsequent research in order to examine the percentage impact of SRT on the achieved result.

References

Babić, V. (2008). Reaction time and sprint results in athletics. In M. Čoh (Ed.), Biomechanical diagnostic methods in athletic training (183-193). University of Ljubljana

Babic, V., & Delalija, A. (2009). Reaction time trends in the sprint and hurdle events at the 2004 Olympic Games: Differences between male and female athletes. New Studies in Athletics, 24 (1), 59-68.

Bruggemann, G.P., & Glad, W. (1990). Biomechanical analyses of the jumping events; time analysis of the sprint and hurdle events: IAAF Scientific Research Project at the Games of XXXIVth Olympiad-Seoul 1988: Final Report. Monaco: IAAF.

Collet, C. (1999). Strategic Aspects of Reaction Time in World-Class Sprinters. *Perceptual and Motor Skills*, *88*(1), 65–75

Der, G. & Deary, I. J. (2006). Age and Sex Differences in Reaction Time in Adulthood: Results From the United Kingdom Health and Lifestyle Survey. Psychology and Aging, 21 (1), 62–73.

Juhas, I., Matić, M., Janković, N. (2016). Uporedna analiza vremena startne reakcije elitnih sprintera/ki na svetskim prvenstvima 2013. i 2015. godine. *Godišnjak,* 21, 43-45.

Martin, D. & Buoncristiani, J. (1995). Influence of reaction time on athletic performance. New Studies in Athletics, 10(1), 67-79.

Mero, A, & Komi, P. (1990). Reaction time and electromyographic activity during a sprint start. European Journal Applied Physiology, 61:73-80

Moravec, P., Ruzicka, J., Susanka, P., Dostal, E., Kodejs, M., & Nozek, M. (1988). The 1987 International Athletic Foundation/IAAF Scientif ic Project Report: Time analysis of the 100 metres events at the II World Championships in Athletics. New Studies in Athletics, 3, 61-96

Milloz, M., Hayes, K., Harrison, A.J. (2021). Sprint Start Regulation in Athletics: A Critical Review. *Sports Med. 51*, 21–31.

Paradisis, G. P. (2013). Reaction Time and Performance in the Short Sprints. *New Studies in Athletic*, 28(1/2), 95-103.

Pavlović, R., Bonacin, D., Bonacin, D. (2014). Differences in time of start reaction in the sprint disciplines in the finals of the Olympic Games (Athens 2004 - London 2012). *Acta Kinesiologica*, 8(1), 53-61

Pilianidis, Th., Kasabalis, A., Mantzouranis, N., Mavvidis, A. (2012). Start Reaction Time and Performance at the Sprint Events in the Olympic Games. Kinesiology 44(1), 67-72

Pilianidis, Th., Mantzouranis, N., Kasabalis, A. (2012). Start reaction time and performance at the sprint events in World Athletic Championships. International Journal of Performance Analysis in Sport 12, 112-118

Shahshahani P.M., Lipps D.B., Galecki A.T., Ashton-Miller J.A. (2018). On the apparent decrease in Olympic sprinter reaction times. PLoS One. 13(6) 1-7.

Tonnessen, E., Haugen, T., Shalfawi, S.A. (2013). Reaction time aspects of elite sprinters in athletic world championships. *The Journal of Strenght and Conditioning Research*, 27(4), 885-892.

Winter, E. M. & Brookes, F. B. C. (1991). Electromechanical response times and muscle elasticity in men and women. European Journal of Applied Physiology and Occupational Physiology, 63 (2) 124-128.

ANALIZA VREMENA STARTNE REAKCIJE U DISCIPLINI TRČANJA NA 60 M NA SVETSKOM DVORANSKOM PRVENSTVU – BEOGRAD 2022

Milan Matić[1], Irina Juhas[1], Nenad Janković[1], Marko Ristov[2]
[1] Univerzitet u Beogradu, Fakultet sporta i fizičkog vaspitanja, Beograd, Srbija
[2] Srpski atletski savez, Beograd, Srbija

Uvod

Vreme startne reakcije (VSR) je jedan od faktora koji utiče na rezultat u sprinterskom trčanju (Mero & Komi, 1990; Bruggemann & Glad, 1990; Babić, 2008).VSR se meri preko senzora sile koji se nalaze u startnim blokovima i kao podatak se ubacuju u zvanične statistike. Kada je u pitanju niski start reakcija je prosta (jedna draž i jedan motorni odgovor), u mnogobrojnim sportovima i sportskim igrama bitnu ulogu imaju složena vremena reakcija. Veći broj autora je do sada istraživao VSR na velikim međunarodnim takmičenjima, svetskim prvenstvima na otvorenom i u dvorani, kao i na olimpijskim igrama (Moravec et al., 1988; Collet, 1999; Babic & Delalija, 2009; Pilianidis, Kasabalis, Mantzouranis, Mavvidis, 2012; Pilianidis, Mantzouranis, Kasabalis, 2012; Paradisis, 2013; Tonnessen, Haugen, Shalfawi, 2013; Pavlovic, Bonacin, Bonacin, 2014; Juhas, Matić, Janković, 2016). Analiziranje ovog faktora je posebno značajno kada se zna da su za pobedu ili postavljanje rekorda bitni stoti, a u nekim situacijama i hiljaditi delovi sekunde. Na svetskom dvoranskom prvenstvu u atletici održanom u Beogradu 2022. godine u finalnoj trci Marsel Džejkobs (Marcell Jacobs) je pobedio drugoplasiranog Kristijana Kolemana (Christian Coleman) za samo 3 ms.

Što je disciplina kraća (60m i 100m) značaj vremena startne reakcije se povećava (Collet, 1999). Tonesen, Haugen i Šalfavi (Tonnessen, Haugen & Shalfawi, 2013) su analizirajući VSR na svetskim prvenstvima u periodu od 2003. do 2009. dobili statistički značajnu korelaciju između VSR i ostvarenih rezultata u trkama. Do sličnih zaključaka je došao Paradisis (2013) analizirajući VSR na svetskim prvenstvima u dvorani, na otvorenom i olimpijskim igrama u disciplini 100 m u periodu 1996 – 2012.

Pavlović, Raković, Idrizović i Mihajlović (2013) analizirajući vremena startne reakcije finalista svetskog prvenstva u atletici 2013. u sprinterskim disciplinama nisu našli statistički značajne razlike u odnosu na pol. Prilikom analiziranja vrednosti VSR finalista u disciplinama 100 m, 200 m i 400 m na svetskim prvenstvima u atletici 2013. i 2015. godine Juhas, Matić, Janković (2016) takođe nisu našli statistički značajne razlike u odnosu na pol.

Mnogo je više istraživanja u kojima su analizirani rezultati na takmičenjima na otvorenom, nego u dvorani, što je razumljivo iz aspekta kraće istorije održavanja dvoranskih prvenstava. Cilj ovog istraživanja je bio da se analiziraju rezultati i VSR u muškoj i ženskoj konkurenciji ostvareni u disciplini trčanja na 60 m na svetskom dvoranskom prvenstvu u atletici, održanom u Beogradu 2022. godine.

Metod

Istraživanjem su obuhvaćeni rezultati i VSR u muškoj i ženskoj konkurenciji ostvareni u kvalifikacionim, polufinalnim i finalnim trkama discipline 60 m na Svetskom prvenstvu (SP) u atletici, održanom u Beogradu 2022 godine. Rezultati i VSR su dobijeni iz zvaničnih službenih izveštaja sa SP.

Rezultati su obrađeni standardnim deskriptivnim i komparativnim statističkim procedurama. Za ispitivanje povezanosti postignutih rezultata i vremena startnih reakcija korišćen je koeficijent linearne Pirsonove korelacije (*r*). Vrednosti *r* u opsezima od 0.10 do 0.29 su smatrane niskim, od 0.30 do 0.49 umerenim, a preko 0.50 visokim (Cohen, 1988). Raspodela podataka je urađena pomoću Kolmogorov-Smirnovog testa, a homogenost varijansi pomoću Leveneovog testa sa kriterijumom da je *sig.*>0,05. Za komparaciju je korišćen *t test* za nezavisne uzorke. Istraživane su razlike u vremenima startnih reakcija između muškaraca i žena: svih učesnika/ca na 60 m, u kvalifikacijama, polufinalnim, finalnim trkama. Statistička obrada podataka je izvršena u programu (SPSS 21.0; Chicago, IL).

Rezultati

U Tabeli 1 prikazane su aritmetičke sredine (M) i standardne devijacije (SD) svih učesnika/ca, u kvalifikacionim, polufinalnim i finalnim trkama na 60 m na SP u atletici 2022. godine.

Tabela 1. Deskriptivna statistika analiziranih rezultata (predstavljenih u sekundama) kod muškaraca i žena.

	Muškarci		**Žene**	
60 m	**M**	**SD**	**M**	**SD**
Svi takmičari	6.65	0.13	7.24	0.17
Kvalifikacije	6.69	0.14	7.31	0.18
Polufinale	6.59	0.09	7.16	0.08
Finale	6.55	0.11	7.05	0.08

U Tabeli 2 prikazane su aritmetičke sredine (M) i standardne devijacije (SD) vremena reakcija kod muškaraca i žena.

Tabela 2. Deskriptivna statistika analiziranih vremena reakcija (predstavljenih u sekundama) kod muškaraca i žena.

	Muškarci		**Žene**	
60 m	**M**	**SD**	**M**	**SD**
Svi takmičari	0.137	0.01	0.143	0.02
Kvalifikacije	0.136	0.01	0.144	0.02
Polufinale	0.141	0.02	0.143	0.02
Finale	0.134	0.01	0.14	0.01

U Tabeli 3 su prikazane povezanosti (*r*) između rezultata i vremena reakcija svih takmičara u kategoriji muškaraca ili žena, takmičara/ki na kvalifikacionim, polufinalnim i finalnim trkama.

Tabela 3. Povezanost (r) rezultata i vremena reakcije kod muškaraca i žena.

	Vreme reakcije							
Rezultat	M svi	M kvalif.	M polufin.	M finale	Ž svi	Ž kvalif.	Ž polufin.	Ž finale
M svi	0.1							
M kvalif.		0.1						
M polufin.			0.35					
M finale				0.43				
Ž svi					0.27*			
Ž kvalif.						0.29*		
Ž polufin.							0.23	
Ž finale								0.57

Legenda: M – muškarci; Ž – žene; svi – svi takmičari koji su učestvovali u muškoj ili ženskoj konkurenciji u disciplini 60 m; kvalif. – takmičari koji su učestvovali u kvalifikacionim trkama; polufin. – takmičari koji su učestvovali u polufinalnim trkama; *r* – koeficijent linearne Pirsonove korelacije; * – nivo statističke značajnosti $p<0.05$.

Iz Tabele 3 se vidi da postoji statistička značajna povezanost između rezultata i VSR kod žena kada se posmatra ceo uzorak učesnica i kada se posmatraju učesnice u kvalifikacijama. U polufinalnoj i finalnoj grupi žena i kod svih grupa muškaraca ne postoji značajna povezanost između rezultata i VSR, ali postoji pozitivan trend.

Za utvrđivanje statističke razlike između VSR: svih takmičara i takmičarki, takmičara i takmičarki u kvalifikacijama, takmičara i takmičarki u polufinalu, takmičara i takmičarki u finalu korišćen je *t test* za nezavisne uzorke (Tabela 4).

Tabela 4. Rezultati t testa za nezavisne uzorke kod muškaraca i žena.

Grupa	Pol	t	p	η
Svi učesnici	Žene Muškarci	2.48	0.01	0.04
Kvalifikacije	Žene Muškarci	2.47	0.02	0.07
Polufinale	Žene Muškarci	0.37	0.71	/
Finale	Žene Muškarci	1.20	0.25	/

Legenda: p – ako je vrednost p<0,05 postoji statistička značajna razlika između muškaraca i žena u VSR; η – 0,01 mali uticaj; 0,06 srednji uticaj; 0,14 veliki uticaj.

Rezultati prikazani u Tabeli 4 pokazuju da postoji statistička značajna razlika između VSR kada se uporede svi takmičari i takmičarke, i kada se uporede takmičari u kvalifikacionim trkama sa takmičarkama iz kvalifikacionih trka. Kod polufinalne i finalne grupe značajna razlika između muškaraca i žena nije dobijena.

Diskusija

Dobijene su prosečne vrednosti VSR kod muškaraca u opsegu od 134 do 141 ms, a kod žena od 140 do 144 ms. U studiji Paradisisa (2013) se vidi da VSR u trci na 60 m nije konzistentno (povećava se što negativno utiče na rezultat), i u proseku je kod finalista od 150 do 240 ms, a kod finalistkinja od 154 do 214 ms. Treba utvrditi šta je razlog povećanja VSR u finalnim trkama na 60 m u istraživanju koje je analiziralo vremena startnih reakcija na dvoranskim svetskim prvenstvima u vremenskom periodu od 2003. do 2012. godine. Da li je razlog produžavanja VSR od 150 ms (prosečno vreme startne reakcije u Budimpešti 2004. godine) do 240 ms (prosečno vreme startne reakcije u Istanbulu 2012. godine) opreznost atletičara kako bi smanjili rizik od prestupa i diskvalifikacije, ili je način merenja VSR na tom takmičenju bio drugačiji?

Ovo istraživanje je pokazalo da postoji pozitivan trend između VSR i rezultata. Pregledom dostupne literature nije pronađeno puno istraživanja koja ispituju povezanost između VSR i rezultata u sprintu na 60 m. U studiji Paradisis (2013) koeficijent korelacije između VSR i rezultata u analiziranim dvoranskim SP od 2003 do 2012. godine u trkama na 60 metara za muškarce je $r = 0,550$, $p < 0,05$, a za žene $r = 0,601$, $p < 0,05$. U našem istraživanju je dobijena veća povezanost VSR i rezultata kod žena nego kod muškaraca (pogledati Tabelu 3), što je u saglasnosti sa dobijenim rezultatima kod Paradisis (2013).

U više proučavanja je utvrđeno da muškarci imaju kraća VSR od žena (Babić i Delalija 2009). U studiji Dera i Deari (Der & Deary, 2006) koja je ispitivala razlike kod muškaraca i žena u VSR na uzorku od nekoliko hiljada ispitanika utvrđeno je da muškarci imaju kraća VSR od žena. Vinter i Bruks (Winter & Brookes, 1991) su utvrdili da je kod žena veće elektromehaničko kašnjenje nakon stimulusa u odnosu na muškarce. Pregledom dostupne literature nije pronađeno koji je biološki razlog sporijeg vremena reakcije kod žena u odnosu na muškarce, ali se pretpostavlja da su određeni neurološki i mehnički faktori odgovorni zbog sporijeg vremena reakcija kod žena (Der & Deary, 2006). U ovom radu su na celokupnom uzorku i kada se uporede takmičari i takmičarke iz kvalifikacija dobijena statistički značajno manje VSR kod muškaraca u odnosu na žene što je u saglasnosti sa rezultatima Babić i Delalija (2009). Međutim, ovi rezultati su u suprotnosti sa rezultatima studije (Martin & Buoncristiani, 1995) koja je pokazala da kod najboljih svetskih sportista nisu primećene značajne razlike u VSR između muškaraca i žena u sprinterskim disciplinama. U istraživanju Šahahani i sar. (Shahshahani et al., 2018) je analiziranjem VSR kod muškaraca i žena na Olimpijskim igrama (OI) od 2004. do 2016. u disciplini 100 m utvrđeno da se VSR kod žena skoro linearno skraćuje na svakim narednim OI, a kod muškaraca je uočeno skraćenje VSR na OI od 2012. do 2016. godine. Kao jedno od objašnjenja zbog čega je prisutno skraćenje VSR između 2012. i 2016. godine je smanjenje praga sila u startnim blokovima koje se koriste u elektronskom merenju vremena kao trenutak započinjanja kretanja takmičara (Shahshahani et al., 2018). Neophodno je ispitati legitimnost različitih startnih informacionih sistema koji se koriste na takmičenjima za identifikaciju pogrešnog starta (Milloz et al., 2021). Interesantno je da u studiji Paradisisa (2013) postoji značajna razlika u VSR između muškaraca i žena na 60 metara samo na dva svetska prvenstva od ukupno šest analiziranih (na prvenstvu u Dohi 2010. godine muškarci su imali kraće VSR, a u Istanbulu 2012. godine su žene imale kraće VSR). Ovaj približni paritet u VSR između muškaraca i žena na četiri SP od ukupno šest analiziranih se može smatrati neočekivanim.

Zaključak

Deskriptivna statistika dobijenih rezultata pokazuje da postoji „vremenski prostor" unutar VSR, čijim smanjenjem se može poboljšati rezultat, i zato je značajno u narednim istraživanjima ispitati na koji način je moguće optimizovati VSR. Da li je optimizacija moguća primenom određenih trenažnih metoda ili korišćenjem određenih neurofizioloških metoda kao što je transkranijalna magnetna stimulacija (TMS)? Ako je optimizacija VSR moguća na oba načina, onda treba utvrditi da li se funkcionalno i strukturalno povezivanje moždanih struktura, tj. uticaj na plasticitet mozga (pomoću plastičnih promena mozga ljudi razvijaju, uče i ovladavaju novim veštinama) postiže efikasnije primenom određenih trenažnih metoda ili pomoću savremenih neurofizioloških metoda kojima se povećava ekscitabilnost motornog korteksa.

Analiziranje VSR u sprinterskim disciplinama biće sigurno predmet daljih istraživanja. U okviru IAAF je aktuelna diskusija o tome da li je ostvarena vrednost vremena reakcije manja od 0,100 ms na startu odgovarajuća vrednost za diskvalifikaciju takmičara.

U budućim istraživanjima treba ispitati na većem uzorku ispitanika (sa nekoliko poslednjih Svetskih prvenstava u dvorani) povezanost VSR i rezultata na 60 m i razlike u VSR između muškaraca i žena. Predlažemo da se u narednim istraživanjima primeni i regresiona analiza kako bi se ispitao procentualni uticaj VSR na postignuti rezultat.

Literatura

Babić, V. (2008). Reaction time and sprint results in athletics. In M. Čoh (Ed.), Biomechanical diagnostic methods in athletic training (183-193). University of Ljubljana

Babic, V., & Delalija, A. (2009). Reaction time trends in the sprint and hurdle events at the 2004 Olympic Games: Differences between male and female athletes. New Studies in Athletics, 24 (1), 59-68.

Bruggemann, G.P., & Glad, W. (1990). Biomechanical analyses of the jumping events; time analysis of the sprint and hurdle events: IAAF Scientific Research Project at the Games of XXXIVth Olympiad-Seoul 1988: Final Report. Monaco: IAAF.

Collet, C. (1999). Strategic Aspects of Reaction Time in World-Class Sprinters. *Perceptual and Motor Skills*, *88*(1), 65–75

Der, G. & Deary, I. J. (2006). Age and Sex Differences in Reaction Time in Adulthood: Results From the United Kingdom Health and Lifestyle Survey. Psychology and Aging, 21 (1), 62–73.

Juhas, I., Matić, M., Janković, N. (2016). Uporedna analiza vremena startne reakcije elitnih sprintera/ki na svetskim prvenstvima 2013. i 2015. godine. *Godišnjak,* 21, 43-45.

Martin, D. & Buoncristiani, J. (1995). Influence of reaction time on athletic performance. New Studies in Athletics, 10(1), 67-79.

Mero, A, & Komi, P. (1990). Reaction time and electromyographic activity during a sprint start. European Journal Applied Physiology, 61:73-80

Moravec, P., Ruzicka, J., Susanka, P., Dostal, E., Kodejs, M., & Nozek, M. (1988). The 1987 International Athletic Foundation/IAAF Scientif ic Project Report: Time analysis of the 100 metres events at the II World Championships in Athletics. New Studies in Athletics, 3, 61-96

Milloz, M., Hayes, K., Harrison, A.J. (2021). Sprint Start Regulation in Athletics: A Critical Review. *Sports Med. 51*, 21–31.

Paradisis, G. P. (2013). Reaction Time and Performance in the Short Sprints. *New Studies in Athletic*, 28(1/2), 95-103.

Pavlović, R., Bonacin, D., Bonacin, D. (2014). Differences in time of start reaction in the sprint disciplines in the finals of the Olympic Games (Athens 2004 - London 2012). *Acta Kinesiologica*, 8(1), 53-61

Pilianidis, Th., Kasabalis, A., Mantzouranis, N., Mavvidis, A. (2012). Start Reaction Time and Performance at the Sprint Events in the Olympic Games. Kinesiology 44(1), 67-72

Pilianidis, Th., Mantzouranis, N., Kasabalis, A. (2012). Start reaction time and performance at the sprint events in World Athletic Championships. International Journal of Performance Analysis in Sport 12, 112-118

Shahshahani P.M., Lipps D.B., Galecki A.T., Ashton-Miller J.A. (2018). On the apparent decrease in Olympic sprinter reaction times. PLoS One. 13(6) 1-7.

Tonnessen, E., Haugen, T., Shalfawi, S.A. (2013). Reaction time aspects of elite sprinters in athletic world championships. *The Journal of Strenght and Conditioning Research*, 27(4), 885-892.
Winter, E. M. & Brookes, F. B. C. (1991). Electromechanical response times and muscle elasticity in men and women. European Journal of Applied Physiology and Occupational Physiology, 63 (2) 124-128.

HEART FREQUENCY DURING TRAINING AND COMPETITION IN KICK BOXING AND SAVATE BOXING

Dejan Gavrilović[1], Nikola Vukašinović[1], Miloš Mudrić[1], Feđa Piščevic[2]
[1] University of Belgrade, Faculty of Sport and Physical Education, Belgrade, Serbia
[2] Ministry of Defence, Serbian Armed Forces, Guard, Belgrade, Serbia

Introduction

Kick boxing originated in Japan in the 1950s. The first kick boxing match was held between Joe Lewis and Greg Baines in America, at the beginning of the 1970s. It is considered to be a mixture of a few different striking sports. Hand techniques are adopted from boxing, whereas foot techniques are close to karate, Thai boxing and savate boxing. First competitors who competed at the kick boxing competitions were the masters of the mentioned sports. Thanks to the simple rules, fast and strong strokes, diverse techniques and attractive fights, this sport became tremendously popular and therefore spread from America around the whole world. Today's disciplines of kick boxing are defined on the basis of the intensity of the stroke, as well as the techniques which are allowed in the fights. The underlined disciplines are semi-contact disciplines, in which strokes are performed with limited intensity (strokes which can lead to the knockout are prohibited), and full-contact disciplines, in which the intensity of strokes is not limited. Semi-contact disciplines are performed on a tatami mat (a pad similar to that from karate arena) and these are: light contact, point fight, and light kick, whereas the full-contact disciplines are held in the classic boxing ring and these are: full-contact, low-kick and K1. (Cirkovic, Jovanovic, Kasum, 2010) Today, World Association of Kickboxing Organizations (WAKO) brings together 118 countries from five continents and approximately three million practitioners. (Jotic, 2019)

Savate boxing or French boxing is a combat sport which appeared in France as early as XVI century, but it is considered that the first instructor was Michael Piso who was the instructor of fencing from the beginning of the XIX century. (Nikolajevic, 1914) Piso's student, Charles Lecour, travelled to England in 1830 in order to test his savate technique in the match against the representative of the English boxing Owen Swift. After the defeat in the match, Lecour understood the significance of the English boxing whereby he spent two years in England, in the course of which he mastered his boxing techniques. Lecour returned to Paris in 1832 and, in the same year, commenced with the systematization of savate boxing. He united the English and French boxing, i.e. he adopted the hand techniques from the English boxing, and kept French kicks, defined techniques and first rules of savate boxing which have not been significantly changed to these days. In 1924, savate boxing appeared in the Olympic Games in Paris as the demonstration sport. (Brković, 2007,). In the course of the World War II, savate boxing, as well as the significant number of sports was not played, while it flourished again in the 1970s. In the same period, it became the national sport of France. The merit for the appearance and development of savate boxing in our region belongs to the officers of the Kingdom of Serbia who were sent to the military education in France. The first instructor of savate boxing in Serbia is considered to be the Captain Dragomir Nikolajevic who initiated the classes of French (savate) and English boxing in 1904, and in 1914, he wrote the book "French and English Boxing" which is, certainly, one of the first books on combat sports in our

region. (Gavrilović, 2019) Today, International Savate Federation has 66 member countries from different parts of the world.

Physiological answer of the organism is a frequently researched problem in combat sports. Thanks to the specificity of the competition activity, in kick boxing and savate boxing, the heart frequency is an acceptable and available evidence of the load to which a competitor is exposed. Heart frequency in the course of physical activity is proportionally increasing with regard to the increase of the practice intensity. (Ilic, 2006) The simplest measurement of the heart frequency is performed on the spoke artery, by counting the beats of the pulse as the consequence of heart muscle activity, when stretching and shrinkage of artery wall segments occur. Heart frequency measurement can also be done on the neck, on the carotid artery, on the temporal artery, as well as on the left side of the chest. (Janssen, 2001) The aim of this paper is to establish the values of the heart frequency before training, as well as in two situations before the competition activity commencement.

Methods

Total number of 28 respondents participated in the research and those were the competitors in savate boxing and kick boxing, junior and senior, of male and female sex, and of approximately 20.2±2.2 years of age. Competition experience, observed through the number of fights in which the competitors participated in the previous period, amounted to 30.42±26.2 fights. Design of the research included three quantitative measurements. The device used for the heart frequency measurement in the course of research is the pulse oximeter (Prizma).

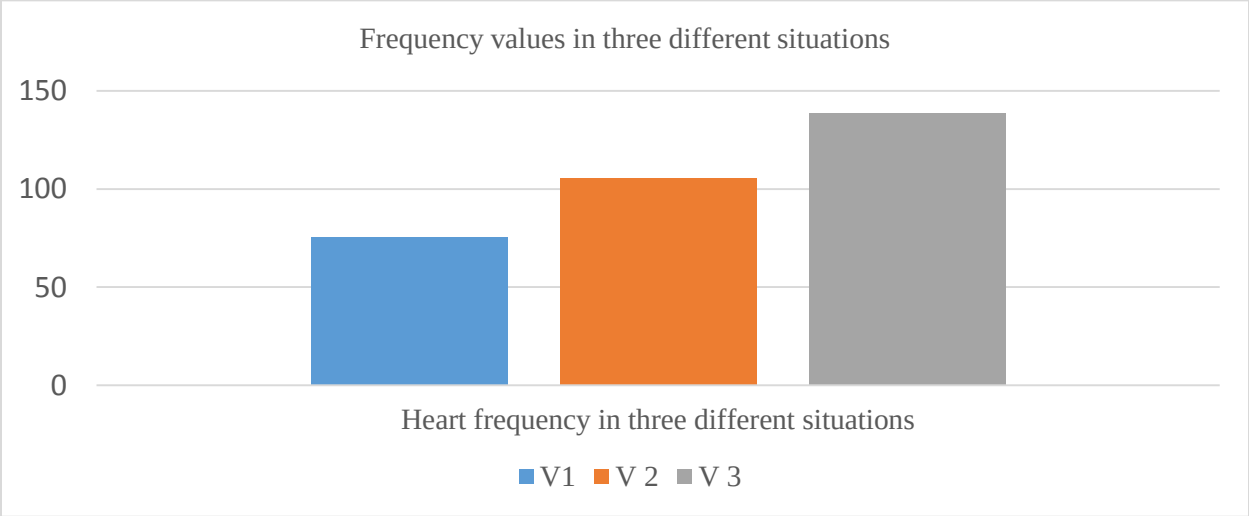
The values of the heart frequency have been monitored in three situations as follows:

1. Before warm-up in training (V1)
2. Before warm-up in the competition (V2) and
3. Before the fight commencement (before putting on gloves and just prior to stepping on the tatami mat or entering the ring) (V3)

Heart frequency measured before the warm-up in training represents the first variable (V1). Heart frequency measured before the warm-up in a competition represents another variable (V2). As regards the variables V1 and V2, there was no physical activity before the measurement. Third variable represents the values of the heart frequency which are measured before the fight commencement (before putting on gloves and just prior to stepping on the tatami mat or entering the ring, V3). The respondents as regards the variable (V3) were subordinated to 15-minute load which included the exercises intended for increase of pliability, as well as the work on the focusers. The aim of the 15-minute load was the necessary preparation for the fight. The actual sequence of load was implemented through the programme of exercises for pliability development lasting for 3 minutes and 2 minutes of work on focusers (repeated 3 times without pause). The work on the focusers contained 6 attacks in the course of one minute, which were made of two punches and one kick in a combination. All techniques in the course of one minute were evenly present within six units, each lasting for ten seconds. Before measuring the third variable, the respondents were inactive for 5 min (last five minutes before the fight commencement) and after that, i.e. third variable was measured just prior to entering the ring (V3, heart frequency before putting on gloves and stepping on the tatami mat or entering the ring).

Results and discussion

Average heart frequency of the respondents before warm-up in training was (V1) M= 75.6 ud/min, whereas the achieved maximum value was MAX=101 ud/min, and minimum value MIN=60 ud/min. Standard deviation was SD= 9.5. Average heart frequency before warm-up in the competition (V2) was 105.6 ud/min, whereas the maximum value reached 126 ud/min, and minimum value 78 ud/min. Standard deviation was 12.78. As the competition activity was approaching, to be specific, at the moment just prior to putting on gloves and before entering the ring or stepping on the tatami mat, i.e. into the fight (V3), the average values of the heart frequency were 138.6 ud/min. Maximum value amounted to 162 ud/min, and minimum value was 102 ud/min. Standard deviation was 16.7.



Legend: The average values of all three variables are shown in the chart No.1.
Heart frequency before warm-up in training (V1)
Heart frequency before warm-up in the competition (V2) and
Heart frequency before the fight commencement (before putting on gloves and just prior to stepping on the tatami mat or entering the ring) (V3)

Table 1. *Mean, maximum and minimum values, as well as the standard deviation for all three variables*

Heart frequency (ud/min)	Before warm-up in training V1	Before warm-up in the competition V2	Before the fight V3 (before putting on gloves and before stepping on the tatami mat or entering the ring)
Mean value (M)	75.6	105.6	138.6
Maximum (MAX)	101	126	162
Minimum (MIN)	60	78	102
Standard deviation (SD)	9.5	12.8.	16.7

On the basis of the analysis of the results obtained, it has been defined that the values of the heart frequency are increasing starting from the situation before warm-up in training (V1), to warm-up in the competition (V2), to the situation before putting on gloves just prior to entering the

fight in the competition (V3). Although the respondents were relatively inactive (5-minute rest without physical activity) before the fight commencement, heart frequency values continued to increase (V3), i.e. they reached greater values with regard to the previous variables (V1 and V2). As the competition, as well as the competition circumstances, were approaching, the values of heart frequency were greater.

The obtained results confirm the trend of the previous research of the savate and kick boxing fighters in which the heart frequency values were monitored. In the paper from 2010 (Gavrilovic, Mudric, Cirkovic, 2010), a similar tendency was noticed on the sample of savate boxing fighters exclusively. In the mentioned research, the values of heart frequency determined were those at the occasion of one-minute standardized recovery between the rounds in three different situations, i.e. in punching the boxing bag, in sparring and in competition. As the competition and competition circumstances were approaching, the heart frequency values were higher, i.e. the recovery between the rounds was less efficient. In the paper in which the values of heart frequency were monitored, on the sample of the kick boxers exclusively (Gavrilovic, Petrovic, Dopsaj, Kasum, Pajic, Koprivica, 2016), the recovery in the course of one-minute rest between the rounds, monitored through heart frequency, was also established. The obtained results are close to the results of the research from 2010, which was carried out on the sample of the savate boxers. The results of this research have also confirmed that the recovery is less efficient under the circumstances closer to those in the competition.

Conclusion

On the basis of the monitored three situations mentioned above, it has been determined that the values of the heart frequency are lower before warm-up in training with regard to the situation before warm-up in the competition, whereas the greatest values are achieved before the competition activity itself. The competition practice (competition) represents the most important type of the preparation for a sportsman (Koprivica, 2001), but it implies the greater load with regard to the condition in which the competitor is at the occasion of his/her training in the club environment. In order that a competitor is adapted to the specific competition conditions, observed through monitoring of heart frequency, it is necessary to bring the physiological condition of the competitor in training circumstances closer to his/her expected physiological condition in the competition. The recommended activities which may have a positive impact on the mentioned adaptation are as follows: change of the sparring partner, change of the place of training, shortening of the pause between the rounds, use of the competition equipment and similar. It is recommendable to have trainings, at most, two times a week with shorter pause between the rounds (with regard to the standardized pause), the aim of which should be to imitate the competition load. It is, also, necessary that the mentioned loads are accompanied by the lower intensity trainings. (Janssen, 2001)

References

Brkovic, S. (2007). Fundamentals of Savate Tactics. Belgrade: SIA.

Cirkovic, Z., Jovanovic, S., Kasum, G. (2010) Borenja, Belgrade: University of Belgrade, Faculty of Sport and Physical Education

Gavrilovic, D., Mudrić, M., Cirkovic, M. (2010). Measurement of heart response after training and competition load in savate boxing fighters, *Collection of works, International scientific conference-Physical activity for everyone,* 354-357.
Gavrilovic, D., Petrovic, A., Dopsaj, M., Kasum, G., Pajic, Z., Koprivica, V. (2016): Work and rest peak heart rate variability response during the different technical and tactical situations of elite kick boxers, *International Journal of Performance Analysis in Sport*, 16, 96-110.
Gavrilovic, D. (2019) Serbian Sportsmen in Great War, Belgrade: SIA.
Janssen, P. (2001). Lactate threshold training, Windsor: Human Kinetics.
Jotic, M (2019). Kick Boxing, Elementary Training Handbook, Novi Sad: SIA.
Ilic, N. (2006) Physiology of Sport, Belgrade: SIA.
Koprivica, V. (2001). Fundamentals of Sports Training, Belgrade: SIA.
Nikolajevic, D. (1914). French and English Boxing, Belgrade: Library of Physical Education

FREKVENCIJA SRCA TOKOM TRENINGA I TAKMIČENjA U KIK BOKSU I SAVATEU

Dejan Gavrilović[1], Nikola Vukašinović[1], Miloš Mudrić[1], Feđa Piščević[2]
[1] Univerzitet u Beogradu, Fakultet sporta i fizičkog vaspitanja, Beograd, Srbija
[2] Ministarstvo odbrane, Vojska Srbije, Garda, Beograd, Srbija

Uvod

Kik boks je nastao u Japanu 50-tih godina XX veka. Početkom 1970-tih u Americi je održan prvi kik boks meč, između Džo Levis-a i Greg Bejnes-a. Smatra se mešavinom više različitih udaračkih sportova. Ručne tehnike su preuzete iz boksa, dok su nožne tehnike bliske karateu, tajlandskom boksu i savateu. Prvi takmičari koji su se nadmetali na kik boks takmičenjima bili su majstori navedenih sportova. Zbog jednostavnih pravila, brzih i snažnih udaraca, raznovrsnih tehnika i atraktivnih borbi ovaj sport je postao jako popularan, pa se iz Amerike proširio na čitav svet. Današnje discipline kik boksa određene su na osnovu inteziteta udarca kao i tehnika koje su dozvoljene u borbama. Izdvajaju polukontaktne discipline, gde se udarci izvode sa ograničenim intezitetom (udarci koji mogu dovesti do nokauta su zabranjeni) i punkontaktne discipline u kojima intezitet udaraca nije ograničen. Discipline polukontakta se izvode na tatamiju (podloga slična karate borilištu) i to su: lajt kontakt, point fajt, kik lajt, dok se discipline punog kontakta održavaju u klasičnom bokserskom ringu i to su: ful kontakt, lou kik i K1. (Ćirković, Jovanović, Kasum, 2010) Danas, Svetska kik boks organizacija (WAKO) okuplja 118 zemalja sa pet kontinenata i sa približno tri miliona vežbača.(Jotić, 2019)

Savate ili Francuski boks je borilački sport koji se pojavljuje u Francuskoj još u XVI veku, ali se za prvog učitelja uzima Mišel Piso, nastavnik mačevanja sa početka 19 veka. (Nikolajević, 1914) Učenik Pisoa, Čarls Lekur, otputovao je u Englesku 1830. godine kako bi isprobao svoju savate tehniku u meču protiv predstavnika engleskog boksa Ovena Svifta. Nakon poraza u meču, Lekur je uvideo značaj engleskog boksa, te je u Engleskoj proveo dve godine, tokom kojih je usavršavao svoje bokserske tehnike. Lekur se u Pariz vratio 1832. godine i iste godine počinje sa sistematizacijom savatea. On je spojio engleski boks sa francuskim, tj. od Engleza preuzeo ručne tehnike a zadržao francuske udarce nogama, utvrdio tehnike i odredio prva pravila savatea koja se nisu značajno promenila do danas. Godine 1924, savate se pojavio na Olimpijskim igrama u Parizu kao demonstracioni sport. (Brković, 2007). U periodu Drugog svetskog rata savate kao i značajan broj sportova prestaje sa radom, a ponovni procvat dostiže 70-tih godina XX veka. U istom periodu postaje i nacionalni sport Francuske. Za pojavu i razvoj savatea na našim prostorima zaslužni su oficiri Kraljevine Srbije koji su upućivani na vojno usavršavanje u Francusku. Za prvog učitelj savatea smatra se kapetan Dragomir Nikolajević koji je 1904. godine pokrenuo časove francuskog (savatea) i engleskog boksa, a 1914. godine napisao knjigu „Boks francuski i engleski“ koja je zasigurno jedna od prvih knjiga o borenju na našim prostorima. (Gavrilović, 2019) Danas Internacionalna savate federacija okuplja 66 zemalja iz različitih delova sveta.

Fiziološki odgovor organizma je često istraživan problem u borilačkim sportovima. Zbog specifičnosti takičarske aktivnosti, u kik boksu i savateu, frekvencija srca je prihvatljiv i dostupan pokazatelj opterećenja u kojoj se nalazi takmičar. Frekvencija srca u toku fizičke aktivnosti se

proporcionalno povećava u odnosu na povećanje inteziteta rada. (Ilić, 2006) Najjednostavnije merenje frekvencije srca je na žbičnoj arteriji, brojanjem udara pulsa kao posledica aktivnosti srčanog mišića, pri čemu se događa rastezanje i skupljanje segmenata arterijskog zida. Takođe, merenje frekvencije srca možemo izvršiti na vratu, na karotidnoj arteriji, zatim na temporalnoj arteriji kao i na levoj strani grudi. (Janssen, 2001) Cilj ovog rada je da utvrdi vrednosti frekvencije srca pre treninga, kao i u dve situacije pre početka takmičarske aktivnosti.

Metod

U istraživanju je ukupno učestvovalo 28 ispitanika, takmičara u sportovima savate boks i kik boks, juniorskog i seniorskog, muškog i ženskog pola, prosečne starosti 20,2±2,2 godine. Takmičarsko iskustvo, posmatrano kroz broj borbi takmičara u kojima su učestvovali u prethodnom periodu iznosilo je 30,42±26,2 borbe. Dizajn istraživanja je uključivao tri kvantitativna merenja. Aparat kojim je izvršeno merenje frekvencije srca u toku istraživanja je pulsni oksimetar (Prizma).

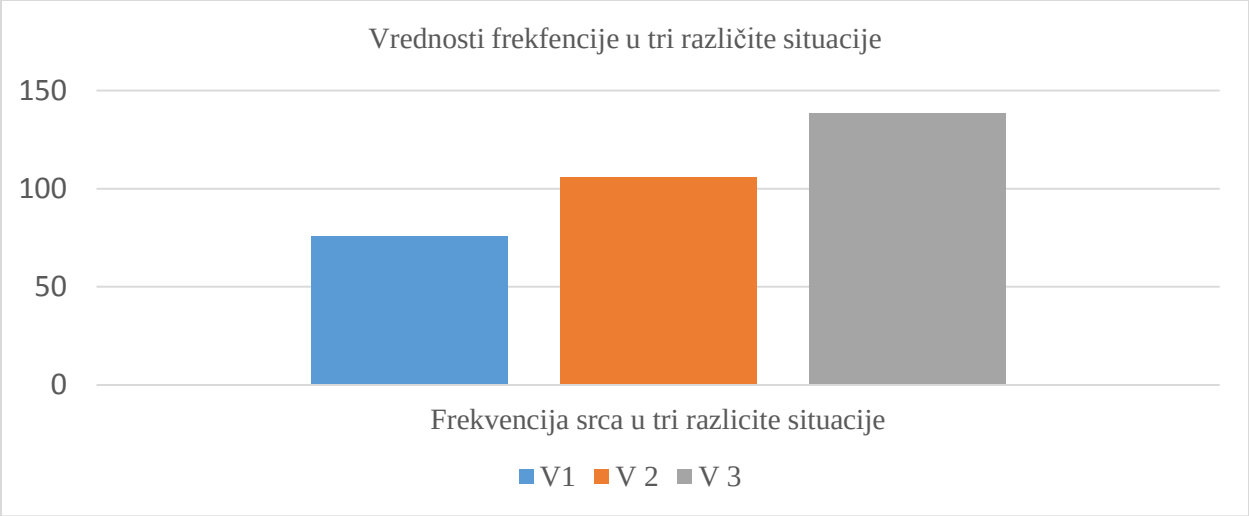
Praćene su vrednosti frekvancije srca u tri situacije i to:

1. Pre zagrevanja na treningu (V1)
2. Pre zagrevanja na takmičenju (V2) i
3. Pre početka borbe (pre stavljanja rukavica i neposrednog ulaska na tatami ili u ring) (V3)

Frekvencija srca merena pre zagrevanja na treningu, predstavlja prvu varijablu (V1). Takođe, frekvencija srca merena pre zagrevanja na takmičenju, predstavlja drugu varijablu (V2). Kod varijabli V1 i V2 nije bilo fizičke aktivnosti pre merenja. Treću varijablu predstavljaju vrednosti frekvencije srca koje su merene pre početka borbe (pre stavljanja rukavica i neposrednog ulaska na tatami ili u ring,V3). Ispitanici kod varijable (V3) podvrgnuti su 15-minutnom opterećenju, kojeg su činile vežbe za povećanje gipkosti kao i rad na fokuserima. Cilj 15-minutnog opterećenja bio je neophodna priprema za borbu. Konkretan redosled opterećenja realizovan je kroz program vežbi za razvoj gipkosti u trajanju od 3 minuta i 2 minuta rada na fokuserima (ponavljanje 3 puta bez pauze). Rad na fokuserima sadržao je 6 napada u toku jedne minute, koje su činili dva udarca rukama i jedan udarac nogom u kombinaciji. Sve tehnike je u toku jednog minuta su ravnomerno raspoređene u šest celina po deset sekundi. Ispitanici pre merenja treće varijable su mirovali 5 min (poslednjih pet minuta pred ulazak u borbu) i nakon toga, odnosno neposredno pred ulazak u ring je izmerena treća varijabla (V3, frekvencija srca pre stavljanja rukavica ulaska na tatami ili u ring).

Rezultati i diskusija

Prosečana frekvencija srca ispitanicima pre zagrevanja na treningu bila je (V1) je M= 75,6 ud/min, dok je ostvarena maksimalna vrednost isnosila MAX=101 ud/min, a minimalna MIN=60 ud/min. Standardna devijacija je bila SD= 9,5. Prosečna frekvencija srca je pre zagrevanja na takmičenju (V2) bila 105,6 ud/min, dok je maksimalna vrednost dostigla 126 ud/min, a minimalna 78 ud/min. Standardna devijacija je isnosila 12,78. Približavajući se nadalje takmičarskoj aktivnosti, tačnije neposrednom momentu pre stavljenja rukavica i pre ulaska u ring ili na tatami odnosno u borbu (V3), prosečne vrednosti frekvencije srca bile su 138,6 ud/min. Maksimalne vrednost je iznosila 162 ud/min, a minimalna 102 ud/min. Standardna devijacija je bila 16,7.



Legenda: Na grafikonu br.1 prikazane su prosečne vrednosti sve tri varijable
Frekvencija srca pre zagrevanja na treningu (V1)
Frekvencija srca pre zagrevanja na takmičenju (V2) i
Frekvencija srca pre početka borbe (pre stavljanja rukavica i neposrednog ulaska na tatami ili u ring) (V3)

Tabela 1. Prikazane su srednje, maksimalne i minimalne vrednosti kao i standardna devijacija za sve tri varijable

Frekvencija srca (ud/min)	Pre zagrevanja na treningu V1	Pre zagrevanja na takmičenju V2	Pre borbe V3 (pre stavljanja rukavica i pre ulaska na tatami ili na ring)
Srednja vrednost (M)	75,6	105,6	138,6
Maksimum (MAX)	101	126	162
Minimum (MIN)	60	78	102
Standardna devijacija (SD)	9,5	12,8.	16,7.

Analizom dobijenih rezultata utvrđeno je da se vrednosti frekvencije srca od situacije pre zagrevanja na treningu (V1), preko situacije pre zagrevanja na takmičenju (V2) do situacije pre stavljanja rukavica i neposrednog ulaska u borbu na takmičenju(V3) povećavaju. Iako su ispitanici bili u relativnom mirovanju (5 minutni odmor bez fizičke aktivnosti) uoči ulaska u borbu, vrednosti frekvencije srca su nastavile sa porastom (V3), odnosno dostigle su veće vrednosti u odnosu na predhodne varijable (V1 i V2). Sa približavanjem takmičarskoj situaciji i takmičarskim uslovima, vrednosti frekvencije srca su bile više.

Dobijeni rezultati potvrđuju trend predhodnih istraživanja savate i kik boks boraca gde su praćene vrednosti frekvencije srca. U radu iz 2010. godine (Gavrilović, Mudrić, Ćirković, 2010), na uzorku isključivo savate boraca primećena je slična tendencija. U navedenom istraživanju utvrđene su vrednosti frekvencije srca prilikom jednominutnog standardizovanog oporavka između rundi u tri različite situacije, odnosno pri radu na džaku, pri sparingu i pri takmičenju. Približavanjem takmičarskoj situaciji i takmičarskim uslovima, vrednosti frekvencije srca su bile više, odnosno oporavak između rundi je bio manje efikasan. U radu gde su praćene vrednosti frekvencije srca, na uzorku isključivo kik boksera(Gavrilovic, Petrović, Dopsaj, Kasum, Pajić, Koprivica, 2016), takođe je

utvrđivan oporavak u toku jednominutnog odmora između rundi, praćen preko frekvencije srca. Dobijeni rezultati su približni rezultatima istraživanja iz 2010, koje je sprovedeno na uzorku savate boraca. I rezultati ovog istraživanja su potvrdili da je oporavak manje efikasan u uslovima koji su više približavaju takmičarskim uslovima.

Zaključak

Praćenjem navedene tri situacije, utvrđeno je da su vrednosti frekvencije srca niže pre zagrevanja na treningu u odnosu situaciju pre zagrevanja na takmičenju, dok su najviše vrednosti dostignute pre same takmičarske aktivnosti. Takmičarska vežba (takmičenje) predstavlja najvažniju vrstu pripreme za sportistu (Koprivica, 2001), ali nosi sa sobom opterećenje viših vrednosti u odnosu na stanje u kojem se takmičar nalazi prilikom boravka na treningu u klupskim uslovima. Da bi se postigla adaptacija takmičara na specifične takmičarske uslove, posmatrano kroz praćenje frekvencije srca, neophodno je približiti fiziološko stanje takmičara u uslovima treninga, fiziološkom stanju koje ga očekuje na takmičenju. Preporučene aktivnosti koje mogu pozitivno uticati na navedenu adaptaciju su: promena sparing partnera, promena mesta treninga, skraćivanje pauze između rundi, korišćenje takmičarke opreme i slično. Treninge sa kraćom pauzom između rundi (u odnosu na standardizovanu pauzu), koje se realizuju sa ciljem imitiranja takmičarskog opterećenja, poželjno je upražnjavati najviše dva puta nedeljno. Neophodno je i da navedena opterećenja budu praćena treninzima nižeg inteziteta. (Janssen, 2001)

Literatura

Brković, S. (2007). Osnove savate taktike. Beograd: SIA.

Ćirković, Z., Jovanović, S., Kasum, G. (2010) Borenja, Beograd: Univerzitet u Beogradu FSFV.

Gavrilović, D., Mudrić, M., Ćirković, M. (2010). Merenje srčanog odgovora nakon trenažnog i takmičarskog opterećenja kod boraca u savateu, *Zbornik radova, Međunarodna naučna konferencija-Fizička aktivnost za svakoga,* 354-357.

Gavrilovic, D., Petrović, A., Dopsaj, M., Kasum, G., Pajić, Z., Koprivica, V. (2016): Work and rest peak harte rate variability reponse during the different tehnical and taktical situations of elite kickboxers, *International Journal of Performance Analysis in Sport*, 16, 96-110.

Gavrilović, D. (2019) Srpski sportisti u velikom ratu, Beograd: SIA.

Janssen, P. (2001). Lactate threshold training, Windsor: Human Kinetics.

Jotić, M (2019). Kik boks, osnovni trenerski priručnik, Novi Sad: SIA.

Ilić, N. (2006) Fiziologija sporta, Beograd: SIA.

Koprivica, V. (2001). Osnove sportskog treninga, Beograd: SIA.

Nikolajević, D. (1914). Boks francuski i engleski, Beograd: Biblioteka fizičkog vaspitanja.

KINESIOLOGICAL ENGAGEMENT IN SMOKING AND NON-SMOKING STUDENTS

Nikola Batistić[1], Marijana Čavala[1], Nenad Rogulj[1], Petra Rajković Vuletić[1], Željko Kovačević[2]
[1] University of Split, Faculty of Kinesiology, Split, Croatia
[2] University of Split, Department of Health Studies, Split, Croatia

Introduction

Physical activity, of low or high intensity, is recommended for 60 minutes or more on daily basis. It has a positive impact on general health well-being, particularly on the musculoskeletal and cardiovascular systems. Apart from the positive impact on the development and shape of muscles, physical activity, primarily the one with external loading, influences the development of the skeleton and skeletal density. Higher skeletal density is extremely important at adult age since it lowers the risk of fractures at that age. It also influences physical health by releasing endorphins, neurotransmitters generated by the hypothalamus, which make us feel content and happy. The physical activity enables us to maintain appropriate body mass and improves our physical appearance. Further on, physically active people have a lower risk of developing certain conditions such as cardiovascular conditions and type 2 diabetes which are conditions primarily developed by adults, but there are more and more young obese people due to an unbalanced diet and insufficient physical activity. Engagement in physical activity is significantly important, but it is essential to be aware of its three elements: flexibility and power exercises, aerobic physical activity in addition to their frequency and intensity. The student population has a number of characteristics distinguishing them from the rest of the population, though they undergo specific health issues such as issues concerning obesity, mental health, addictions, reproductive health… It has been frequently observed that young people are a part of the population given not so much attention compared to children and the old population. The majority of contemporary young people acquire so-called "bad habits" which refer to issues such as non-sleeping, over-consumption of alcohol and cigarettes, marihuana, and other narcotics. Due to their mental development which is not completed and the growing pressure imposed by society, young people are more subjected to risky behavior, so they experiment with drugs. Such behavior presents their juvenile lifestyle in contemporary culture and media. Young people, the student population included, are frequently in contact with narcotics, from the socially accepted ones such as alcohol and cigarettes to the illegal ones such as marihuana, and cocaine. Smoking and physical inactivity are strongly related to a deterioration in overall health status and are among the most important modifiable risk factors for chronic disease and premature death. The latest Health Behaviour in School-aged Children (HBSC) study focusing on adolescent health and well-being has revealed that levels of cigarette smoking are worryingly high, particularly among 15-year-olds. In this age group, 15% of adolescents report having smoked a cigarette at least once in the past 30 days and nearly 1 in 3 mentioned having tried smoking (27% of girls and 29% of boys) (WHO, 2020). There is also some weak evidence of differential gender effects for the relationship between smoking and physical activity (Pitsavos et al., 2005; Kvaavik et al., 2004; Lockery & Stanford, 1996; Aaron et al., 1995). Young people in Croatia more frequently use tobacco products than their European peers. The differences in percentages between young people in

Croatia and Europe are significant, with 41% in favor of Croatia, and 28% in favor of other European countries. Although the percentage of young people consuming cigarettes in Croatia is much higher, the number of those consuming marihuana is significantly lower. A number of researches have been conducted on this topic and it is evident that the potential reason for young people starting to smoke is the so-called "finding themselves" by beginning with the consumption of legal drugs, i.e. tobacco. Despite limitations, the majority of the articles reviewed suggest that levels of smoking and physical activity are inversely related (Kaczynski, et al., 2008). Young smokers' age is stretched from 19 to 24 with the majority of them not even knowing why they started smoking at first, while others give reasons such as social pressure and the feeling of being an adult (Perković and Čivljak, 2016).

The purpose of this study is to determine the kinesiological engagement of students regarding whether they consume tobacco products or not.

Based on this defined goal, we generated two partial goals:

- to determine the connection/difference between female smoking and non-smoking students with their frequency of recreational activity engagement
- to determine the connection/difference between female smoking and non-smoking students with their frequency in sports activity engagement.

Methods

Sample of respondents

The sample of respondents includes 135 female students from the Department of Health Studies and Medical Faculty of the University of Split in the academic year 2018/2019, of average age 21.41, involving 51 smoking and 84 non-smoking students.

Sample of variables

Sample of variables involves answers to questions about the frequency of being engaged into kinesiological activities and tobacco consumption. We have collected data for this research by assistance of School and University Medical Service through regular physical students' examination.

Kinesiological engagement was assessed by a questionnaire on the scale with 4 levels of kinesiological engagement extensity, separately for recreational or institutionalized sport activities: no activity, activity extended to 1-2 hours per week, activity extended to 3-4 hours per week and activity extended to 5 or more hours per week.

Smoking habits of male/female respondents have been assessed by a questionnaire by separating smoking from non-smoking students.

Data processing methods

Kinesiological engagement is defined by a variable where no recreational activity is given 0, activity extended to 1-2 hours per week 1, activity extended to 3-4 hours per week 2 and activity extended to 5 or more hours per week is given 3 points.

Using percentage calculation, we came up with the values of percentage shares in the total number of female students who were smoking or non-smoking. Further on, from the total number of non-smoking students, we calculated percentage values depending on kinesiological recreational engagement, particularly for sport engagement.

Via chi - square test and Kruskal Wallis analysis, we analyzed connection or differences with relation to the degree of kinesiological engagement in female students regarding their consumption of tobacco products.

Results

Table 1 presents the total number of female students separated on those who consume tobacco products and those who do not. Numerical parameters are expressed via frequencies and percentage values. It is evident that out of the total number of female students included in this study, majority are non-smoking students (62.22%) while almost 38% consume tobacco products to a larger or smaller degree. Considering these are mostly young women, such result is optimistic and reveals that majority of students is aware of the fact smoking increases risks for numerous conditions. This may serve as one of the assumptions since the students attend University Department of Health Study and Medical Faculty, and it is well-known their profession encourages healthy lifestyle and promotes non-smoking.

For the same reasons we expect similar results in variables assessing frequency of kinesiological engagement. However, in physical activity engagement, whether recreational or sport, we obtained different results. Almost 60% of female students are not involved in any physical activity whatsoever, not even for recreational purposes. This data is shocking for this population and reveals it is essential to educate students more on the positive impacts of physical exercise on their health condition. Furthermore, in future studies, it would be preferable to obtain data on the reasons for such demotivation in recreation or sport activities in order to elaborate further discussion.

Table 1. The number of tobacco consumers and female students involved in some aspect of kinesiological activity with regard to the total number of female students (N=135)

	Tobacco consumption		**Kinesiological activities engagement frequency**	
	FREKV	%	FREKV	%
NO	84	62,22	79	58,52
YES	51	37,78	56	41,48

Table 2 presents frequencies and percentage shares of female students engaged in kinesiological activities. They are separated into 4 categories: students who never take part in any kinesiological activities, those who are engaged 1-2 hours per week, 3-4 hours per week, and those who are engaged 5 or more hours per week. Further on, according to these sub-samples, they are divided even more precisely on the criterion of whether they use tobacco products on smokers and non-smokers.

By a more specific insight, it is evident that there are more those who are not engaged in any recreational activities among non-smokers than smokers. Analyzing students who are engaged in recreational content, one may conclude that regardless of the fact they are smokers or not, they are mostly engaged for 1-2 hours per week, which is a very short time in a single week. Those who are engaged for 3-4 hours per week or 5 or more hours per week have a very low percentage.

The chi-square test and Kruskal Wallis test for difference analysis reveal there are differences between smoking and non-smoking students in kinesiological activity on recreational level. This difference is reflected in variable revealing a student is never engaged in any kinesiological activity. The difference is in favour of non-smokers, i.e. there are far more non-smokers not engaged in recreation than smokers. Further on, there are much more smokers than non-smokers in 1-2 hours per week engagement. It is likely that students consuming tobacco compensate for their vice by being more kinesiologically engaged.

Generally speaking, even students who are never engaged in recreational activity and those who do it only 1-2 hours per week, make up for over 80% from the total number regardless of smoking. We may thus conclude that the majority of students are not or are very little engaged into recreational contents which is disturbing.

There should be another study to reveal if the cause of non-engagement into recreational activities of students lies in the fact that students' standard is quite low and some recreational activities require substantial sum of money, thus making it a topic for another future study.

Table 2. The kinesiological engagement frequency and differences regarding tobacco consumption

Kinesiological engagement frequency	**non-smokers (n=84)**		**smokers (n=51)**			**Kruskal- Wallis**	
	N	%	n	%	χ^2 test	H	p
never	32	38,10	7	13,73	9,67*	5,5	0,02*
1-2 hours per week	39	46,43	35	68,63			
3-4 hours per week	9	10,71	7	13,73			
5h or more per week	4	4,76	2	3,92			

Table 3 presents frequencies and percentages of female students engaged in a certain sport. They are separated into 4 categories; students who are never engaged in any sports, those who are engaged 1-2 hours per week, 3-4 hours per week, and those who are engaged 5 or more hours per week.

Furthermore, according to these sub-samples, they are even more precisely separated according to the criterion whether using tobacco products or not on smokers and non-smokers.

In sport engagement, in both smokers and non-smokers, there is a large percentage of those who are never engaged in any sport activities, about 29%. Those who are engaged 1-2 hours per week make the majority (47-49%). About 15% are engaged 3-4 hours per week and about 5-7% are engaged 5 or more hours per week. It is evident that values in smokers and non-smokers are nearly the same which is also confirmed by chi-square test and by Kruskal Wallis test which does not reveal statistically significant difference among sub-samples in sport kinesiological activity engagement frequency.

It may be assumed that students enrolling faculty change their habits, majority quit doing sports they were engaged in since elementary school. At a younger age, children are under parental influence who encourage them to take up a certain sport activity since they have a greater need to move at this age. Starting university, they become more independent, frequently they leave their hometown and these may also be reasons to change their kinesiological engagement since they need some time to adapt to a new town and new environment.

Table 3. Table presentation of sport engagement frequency regarding tobacco consumption

Sport kinesiological engagement frequency	non-smokers (n=84)		smokers (n=51)			Kruskal- Wallis	
	N	%	n	%	χ^2 test	H	p
never	25	29,76	15	29,41	0,1	0,01	0,94
1-2 hours per week	40	47,62	25	49,02			
3-4 hours per week	13	15,48	8	15,69			
5h or more per week	6	7,14	3	5,88			

Conclusion

This study has revealed that the majority of female students at the Department of Health Study and Medical Faculty of the University of Split are not inclined towards smoking or kinesiological activity engagement. Smoking is a non-desirable habit and is one of the leading risk factors in numerous conditions thus such results in this population are positive, corroborating that students in this profession are well-informed about the negative impact of smoking on their health.

However, the fact that students are not or, as in most cases, are just minimally or insufficiently engaged in kinesiological activities, is disturbing. Such findings put demands in front of kinesiologists to direct future researches towards more detailed insights as to what may be the causes for this and to conduct studies on a larger number of students in order to bring general conclusions and possibly make an impact on this fact.

From various reasons that may be listed for insufficient kinesiological engagement in this population, being smokers or non-smokers, our focus should be on the undeveloped awareness on the significance of physical exercising for health, so our task as kinesiologists should be developing habits of physical exercising in children as well as educating them about its significance for the quality of human lives.

References

Aaron, D. J., Dearwater, S. R., Anderson, R., Olsen, T., Kriska, A. M., & Laporte, R. E. (1995). Physical activity and the initiation of high-risk health behaviors in adolescents. Medicine & Science in Sports & Exercise.

Kaczynski, A. T., Manske, S. R., Mannell, R. C., & Grewal, K. (2008). Smoking and physical activity: a systematic review. American journal of health behavior, 32(1), 93-110.

Kvaavik, E., Meyer, H. E., & Tverdal, A. (2004). Food habits, physical activity and body mass index in relation to smoking status in 40–42 year old Norwegian women and men. Preventive medicine, 38(1), 1-5.

Lockery, S. A., & Stanford, E. P. (1996). Physical activity and smoking: gender comparisons among older African American adults. Journal of Health Care for the Poor and Underserved, 7(3), 232-251.

Perković, D., Čivljak, M. (2016). Stavovi mladih korisnika Facebooka iz Hrvatske o pušenju duhana. Sestrinski glasnik, 21(2), 117-124.

Pitsavos, C., Panagiotakos, D. B., Lentzas, Y., & Stefanadis, C. (2005). Epidemiology of leisure-time physical activity in socio-demographic, lifestyle and psychological characteristics of men and women in Greece: the ATTICA Study. BMC public health, 5(1), 1-9.

World Health Organization. Smoking still a core challenge for child and adolescent health reveals WHO report, June 2020.

IS THERE A RELATIVE AGE EFFECT IN CROATIAN GYMNASTICS?

Sunčica Delaš Kalinski[1], Ana Kezić[1], Alen Miletić[1]
[1] University of Split, Faculty of Kinesiology, Split, Croatia

Introduction

Although in men's artistic gymnastics (MAG) there is a large number of top gymnasts on individual apparatus, the most valued achievements in MAG include those obtained in all-around events (exercising/competing on all six apparatus): floor, pommel horse, rings, vault, parallel bars, and horizontal bar. In order to be successful in performing skills on all those apparatuses at an elite level, development and higher levels of strength and comprehensive control of the body are required. According to Gualdi-Russo, Gruppioni, Gueresi, Belcastro & Marchesini (1992) and Dallas, Zacharogiannis & Paradisis (2013) those requirements are closely related to adequate body build, and age (Andreev, 2015). Previous studies show that gymnasts' somatotypes are mostly identified as ectomorphic mesomorph (predominantly mesomorphy and ectomorphy rather than endomorphy) and balanced mesomorph (predominantly mesomorphy; endomorphy and ectomorphy are lower and equal or do not differ by more than one-half of a somatotype unit; Carter & Health, 1990; Raschka, 2006). The mesomorphic component is more pronounced in athletes with a higher-level skill in the sport.

Age, (chronological age) has been a subject of debate for years in artistic gymnastics and has largely been associated with the minimum chronological age required to participate in competitions of the highest levels, organized by the International Gymnastics Federation (FIG). The reason for discussing the minimum chronological age was primarily related to Women's Artistic Gymnastics (due to a number of physical and psychological problems associated with intensive training of gymnasts from an early age that have been established in several studies (Jelaska, Delas Kalinski & Crnjak, 2017). Although they were mostly not the focus of those debates, male gymnasts, like female gymnasts, are also characterized by lower physical growth, later biological maturation and a slower growth rate than normal population (Malina, 2014).

With the aim of protecting the musculoskeletal development of exercisers, prolonging their careers, preventing "burnout" and reducing injuries (Eagleman, Rodenberg & Lee, 2014), over the past three decades FIG has increased the minimum chronological age required to participate in competitions in its organization: from the minimum required age of 14 (valid before 1981), over minimum required age of 15 in the period from 1981 to 1997, to the minimum required age of 16 since 1997 (Delas Kalinski, Jelaska & Knezevic, 2017).

Chronological and biological age have been seen and analyzed together for the last few decades through the phenomenon of relative age effect (RAE). The relative age effect (RAE) is a phenomenon whereby the chronological age-grouping of children and adolescents can lead to an overrepresentation of athletes born earlier in the year within a cohort. As known, both in sport and in education systems, children and adolescents are frequently grouped together based on chronological age. However, within this type of grouping there can be nearly 12 months difference between the oldest and youngest, leading to a variation in cognitive (Cobley, Baker, Wattie & McKenna, 2009), physical (Silva et al., 2010) and emotional (Lewis, 1993) development. These

developmental advantages may manifest in a number of ways including: stature, mass and speed (McCunn, Weston, Hill, Johnston & Gibson, 2017), greater muscular strength and aerobic power (Balyi, Way & Higgs, 2013). Ultimately, in many team sports this results in a selection bias towards relatively older athletes, which provides enhanced access to coaching and resources, further exacerbating the effect (Cobley et al., 2018).

Not many studies of RAE have been conducted in artistic gymnastics. Some of them have been conducted on national levels (Baxter-Jones, 1995; Baker, Janning, Wong, Cobley & Schorer, 2014; Hancock, Starke & Ste-Marie, 2015); and some on elite male (Delas Kalinski, Jelaska & Knezevic, 2017) and elite female gymnasts (Hancock et al., 2015; Delas Kalinski, Jelaska & Atikovic, 2018). In all those studies null RAE effect has been determined. However, whilst previous studies haven't determined RAE within a sport, there are some emerging evidences of atypical distributions of RAE in inter-sport differences (Langham-Walsh, Gottwald & Hardy, 2021), attributed towards delayed-maturation needed for success.

The aim of this study was to determine the existence of RAE between and within Croatian male and female gymnasts.

Method

The sample of respondents included male and female gymnasts (192 male and 651 female) who participated in the official National competitions organized by the Croatian Gymnastics Federation in 2019. The sample of variables was represented by the dates of birth of the competitors (they were collected from the official bulletins of the competition). In order to analyze the presence of the RAE effect, traditional classification of birth dates into four quartiles/quarters of the calendar year was used: Q1: January – March; Q2: April - June; Q3: July-September and Q4: October – December (Côté, Macdonald, Baker & Albernethy, 2006; Delorme, Boiche & Raspaud, 2010; Delorme, Chalabaev & Raspaud, 2011; Albuquerque et al., 2012, 2013). The Chi-square ($\chi 2$) test was applied to identify the differences between the frequencies of the gymnast's date of birth belonging to a certain quartile of the calendar year.

Results and discussion

The dates of birth of Croatian male and female gymnasts, who competed in 2019, were divided into four quartiles (Q1-Q4). The range of frequencies of date of birth of male gymnasts were from 45 (Q4) to 51 (Q3), while in female gymnasts' frequencies was from 134 (Q4) to 225 (Q2). From the above, gender differences in popularity of this sport in Croatia are obvious.

By analyzing the determined frequencies, no significant differences between quartiles were found for male gymnasts ($p=0.93$) nor for the female gymnasts ($p=0.31$). The obtained results confirm previous research conducted in different parts of the world, which found either the absence of RAE among gymnasts (Hancock, Starke, & Ste-Marie, 2015) or they found a negative RAE (the highest frequencies of birth dates were determined in the last quartile of the calendar year).

Table 1 Descriptive statistical parameters of chronological age and Chi-square test of frequencies of date of birth of Croatian gymnasts (by gender)

	gender	Q	N	Mean	Min	Max	SD	Skew	Kurt	χ2	p
Cronological age	M	Q1	46	14.47	9.2	27.19	4.18	1.44	2.01	0.47	0.93
	M	Q2	46	15.1	9.92	35.98	4.7	2.44	8.55		
	M	Q3	51	13.97	9.54	30.62	4.78	1.81	3.4		
	M	Q4	45	14.89	8.45	32.36	4.74	1.51	2.97		
	F	Q1	140	13.85	8.21	26.11	3.01	0.68	0.96	3618	0.31
	F	Q2	163	13.79	7.78	32.98	3.4	1.27	5.57		
	F	Q3	152	13.8	7.7	26.63	3.29	0.97	1.53		
	F	Q4	134	13.42	8.49	22.48	2.94	0.65	0.14		

Legend: M – male gymnasts, F – female gymnasts, Q – belonging to the date of birth of a particular quartile of a calendar year, N – frequencies of gymnasts in certain quartile, Mean - arithmetic mean of chronological age, Min - minimum chronological age value, Max - maximum value of chronological age, SD - standard deviation of chronological age, Skew - Skewness (measure of the asymmetry of the distribution of results), Kurt - Kurtosis (measure of roundness of the distribution of results), χ2 – Chi squared test between frequencies determined in individual quartiles, p – level of significance of Chi squared test

The reason for the obtained results can be found in the characteristics of this sport, partly through the complexity of the skills which are needed to be learned/competed, from the younger age categories throughout older age categories, up to significantly higher complexity of the skills of elite levels gymnasts of the oldest age categories. As known, some of the factors that influence motor learning process are complexity and number of practices of the learned skill: more complex skills need more practice, accordingly more time, to reach the highest levels of acquisition. Long learning processes and huge number of trials, according to the results obtained, obviously are not correlated or dependent on the belongings of date of birth to the certain quartile of the year. Longevity and quality of performing and competing on the highest level was the topic of some researchers conducted in artistic gymnastics. Studies concluded that the prime ages for the success of both men's and women's gymnasts may be extended beyond the age of 20 (Kerr et al., 2015; Baker-Ruchti et al., 2017; Atikovic, Kalinski & Cuk, 2017) and that one of the factors that contributes to that is the open-ended gymnastics Code of points (CoP), which allows older gymnasts to increase the difficulty values, especially artistry (Kerr et al., 2015; Kalinski, 2017; Jelaska, Kalinski & Crnjak, 2017; Kalinski, 2017). Therefore, extending the career of competitors is an important strategy for teams that aspire for medals in international competitions because senior gymnasts enjoy a longer period of deliberate practice that is essential to achieving Olympic quality performances (Kalinski, 2017; Jelaska, Kalinski & Crnjak, 2017; Kalinski, 2017; He, Oca & Zhang, 2020) and have potentially better capacities to express themselves artistically than younger gymnasts (Kerr et al., 2015; Baker-Ruchti et al., 2017). The shorter career of Chinese gymnasts, compared to the age of medalists' teams at Rio 2016, was one of the reasons why Team China suffered its worst performance in artistic gymnastics at these Olympics (He, Oca & Zhang, 2020).

Chronological age of the analyzed male gymnasts was in the range 8.45 – 35.98 years, and according to the values of the distribution parameters, it can be generally concluded that in each quartile of this distribution results were generally negatively leptocurtic (most of the values of the chronological age were homogenized around lower values). The same is mostly expressed in the

subgroup of male gymnasts born in the second quartile (Q2); subgroup with the highest values of chronological age of the entire sample.

Female gymnasts who competed in 2019 had a chronological age in the range of 7.70 – 32.98 years, and according to the values of the results distribution parameters (Skew and Kurt), it can be generally concluded that these are distributions of results that do not deviate from the normal distribution of results.

Conclusion

Due to the non-determination of significant differences in frequencies between groups of differently ranked male and female competitors, at both regional and national championships, it was concluded that the relative age effect (RAE) is not present in Croatian gymnastics. Because null RAE and opposite RAE were found in many previous studies conducted on different word-wide national level gymnasts and high-level gymnasts, obtained result lead to conclude that Croatian coaches, as well as coaches all around the world are aware of the longevity and complexity of gymnastics training and because of that do not consider the birth date exclusively when doing the selection of future gymnasts.

References

Andreev, P. (2015). Age analysis of the Olympic medal holders-men in artistic gymnastics for the period 1960-2012. *Activities in Physical Education and Sport*, *5*(2), 138-143.

Atikovic, A., Kalinski, S.D. & Cuk, I. (2017). Age trends in artistic gymnastic across World Championships and the Olympic Games from 2003 to 2016. *Science of Gymnastics Journal*, *9*, 251-263.

Atikovic, A., Kalinski, S.D. & Cuk, I. (2017). Change the gymnastics minimum age requirements and the changes that have occurred in major competitions in women's artistic gymnastics. *Acta Kinesiologica*, *11*, 80-88.

Balyi, I., Way, R., & Higgs, C. (2013). *Long-term athlete development*. Human Kinetics.

Barker-Ruchti, N., Kerr, R., Schubring, A., et al. (2017). Gymnasts are like wine, they get better with age": becoming and developing adult women's artistic gymnasts. *Quest*, *69*, 348-365.

Barnsley, R., Thompson, A., & Barnsley, P. (1985). Hockey success and birthdate: the relative age effect. *J Can Assoc Heal Phys Educ Recreat*, *51*(8), 23-28.

Carter, J.E.L. & Heath, B.H. (1990). *Somatotyping—development and applications*. Cambridge Studies in Biological Anthropology. Cambridge-NewYork-Port Chester-Melbourne-Sydney: Cambridge University Press.

Cobley, S., Abbott, S., Dogramaci, S., Kable, A,, Salter, J., Hintermann, M., et al. (2018). Transient relative age effects across annual age groups in national level Australian swimming. *J Sci Med Sport*, *21*(8), 839-845.

Cobley, S., Baker, J., Wattie, N., & McKenna, J. (2009). Annual age-grouping and athlete development: A meta-analytical review of relative age effects in sport. *Sport Med*, *39*(3), 235-256.

Delas Kalinski, S., Jelaska, I., & Knezevic, N. (2017). Age effects among elite male gymnasts. *Acta kinesiologica,* **11** (2), 84-89.

Gualdi-Russo, E., Gruppioni, G., Gueresi, P., Belcastro, M.G., & Marchesini, V. (1992). Skinfolds and body composition of sports participants. *J Sports Med Phys Fitness*, *32*(3), 303-313.

He, J., Oca, J., & Zhang, L. (2020). Why Team China suffered its worst performance in artistic gymnastics at Rio 2016? *International Journal of Sports Science & Coaching*, *15*.

Jelaska, I., Kalinski, S.D., & Crnjak, T. (2017). Chronological age among Olympic women's artistic gymnastics. Does it really matter? *Acta Kinesiologica, 11*, 108–116.

Kalinski, S.D. (2017). Elite female gymnasts at two Olympic Games-quality or luck? *Science of Gymnastics Journal*, *9,* 153-164.
Kalinski, S.D., Jelaska, G., & Atikovic, A. (2017). Elite female vault finals from 2008–2016. *Acta Kinesiologica*, *11*: 62-66.
Kerr, R., Barker-Ruchti, N., Schubring, A., et al. (2015). Coming of age: towards best practice in women's artistic gymnastics. *Land Environment and People Research Report*, *37*. New Zealand: Lincoln University.
Lewis, M., & Haviland, J.M. (1993). *Handbook of emotions*. New York: Guildford Press.
McCunn, R., Weston, M., Hill, J.K.A., Johnston, R.D., & Gibson, N.V. (2017). Influence of physical maturity status on sprinting speed among youth soccer players. *J Strength Cond Res*, *31*(7), 1795-801.
Raschka, C. (2006). *Sportanthropologie: Leitfaden der modernen, vergleichchenden Sportanthropologie, Sportanthropometrie und trainingsrelevanten Konstitutionbiologie*. Köln: Sportverlag Strauss.
Silva, C.E., Moreira Carvalho, H., Gonçalves, C.E., Figueiredo, A.J., Elferink-Gemser, M.T., Philippaerts, R.M., et al. (2010). Growth, maturation, functional capacities and sport-specific skills in 12–13 year-old- Basketball players. *J Sports Med Phys Fitness*, *50*(2), 174-181.

PHYSIOLOGY, SPORTS MEDICINE AND EXERCISE MEDICINE, BIOMECHANICS

FIZIOLOGIJA, SPORTSKA MEDICINA I MEDICINA VEŽBANJEM, BIOMEHANIKA

Introductory lecture

INJURIES SUSTAINED DURING SPORTS ACTIVITIES AS OCCUPATIONAL INJURIES

Aleksandra Popović[1]
[1] University of Belgrade, Faculty of Sport and Physical Education, Belgrade, Serbia

Introduction

Injuries in sports (sports injuries) occur due to the action of an external force on the body or parts of the body or as a result of internal damage due to overexertion during sports activities. These injuries can occur during regular exercise, training, competitions and during recreational activities at any age in persons participating in organized or unorganized sports activities (les lesions sportives, French, Sport - verletzungen, German, athletic injuries, sport injuries , English) (Bošković, 2006).

Sports injuries can occur not only in people who engage in various sports activities, whether it is a physical activity carried out with the aim of improving one's own health or when it comes to professional athletes. They can also be caused by professional activities which are not related to sports. These injuries can cause a shorter or longer interruption of physical and sports activities and affect the overall quality of life of the injured person in terms of the ability to work and provide the income necessary to cover living costs. This problem is highlighted when people who are professionally involved in sports have such injuries as a result of their sports activities in a situation when they are not protected by various forms of health insurance that would cover the costs of treatment and common living expenses. Professionals in sports who are employed in various public and private institutions and companies such as sports trainers, physical education teachers, physiotherapists, fitness and military instructors as well as persons who organize recreational activities of workers in factories and companies employees may also have difficulties recognizing injuries resulting from their professional sports activities as work- related injuries.

The occurrence of sports injuries in persons whose profession includes the performance of sports activities is possible because they are involved not only in the implementation of the training process, but also in the performance of other activities such as various outdoor and indoor activities, lifting and moving sports equipment, lifting athletes (e.g. in gymnastics, after falls, when providing first aid). These activities can lead to overexertion and sports injuries. When providing first aid, they may come into contact with blood and body fluids, which may pose a risk to their health. In addition, they are exposed to strong psychological stress, especially in the school environment or at mass sports events where they often have to organize sports activities and take care of a large number of athletes at the same time (Bureau of Labor Statistics, Occupational Outlook Handbook, 2014).

Several studies have been conducted around the world that have shown the presence of various injuries and conditions in sports professionals that can be recognized as work injuries.

The results of several different studies conducted in the USA showed that stress, burnout syndrome and exhaustion are a widespread phenomenon among sports professionals (DeFreese, JD. & Mihalik, JP., 2016; Campbel et al., 1985; Capel, SA., 1990; Hendrix et al., 2000; Brumels, K. & Beach, A., 2008). A survey conducted in Taiwan on a sample of 107 sports coaches showed that almost half of the respondents had some kind of injury related to their professional activities: the most common injuries were the lower back (42%), fingers (38%) and shoulder injury (26%). These injuries were classified as overexertion syndrome (68%), sprain (30%) or tendinitis (24%) (Ju, YY et al., 2011). In various researches, it has been observed that sports injuries occurred in sports activities are rarely reported as work injuries (Cromie et al., 2002) and that athletes, trainers, physiotherapists are often self-medicate (Darraugh et al., 2009). Research published in 2018. and conducted during 2012. in the USA on a sample of 247 sports trainers showed that the most common injuries were in the trunk area (lower back injury - 25.9%), followed by the hand and fingers (8.9%) and the knee injury (8.5%). The most common were traumatic injuries of muscles, tendons, ligaments and joints (76.9%), while bone injuries and open wounds were less common. Injuries were caused by body movements, overexertion and repeated movements (52.2%), contacts with objects, equipment, other people (23.5%), and to a lesser extent injuries were caused by slips, trips or falls. Half of the injured trainers changed their routine at work due to sports injuries in a certain period of time, they moved and lifted heavy equipment less, avoided risky movements and activities that could provoke injury aggravation. Although half of the respondents received medical assistance due to their sports-related injuries, less than a quarter of those injured sought some kind of monetary compensation as compensation for their work-related injury (Kucera et al., 2018).

Such research, which would define the prevalence and incidence of injuries in sports that can be defined as injuries at work among athletes, sports coaches and other sport professionals has not been carried out in Serbia yet. However, this does not mean that there are no such injuries in our population who is professionally engaged in sports. The number of athletes and especially professionals in sports has increased significantly in recent years in Serbia, especially due to the growing number of fitness clubs. Although there are still no legal regulations related exclusively to sports injuries, by using the existing legal regulations related to injuries at work, it is possible to determine in athletes and sports professionals their temporary or permanent inability to perform sports activities. On the basis of injury severity they can receive compensation for treatment costs within the framework of health and social insurance.

The paper presents the legislation of the Republic of Serbia on work – related injuries as well as possibility to apply it to sport injuries in order to recognize it as occupational injuries occurring among athletes, athletic trainers, coaches, physical education teachers and other persons whose professional activity includes sports activities.

Discussion

Legislation relating to occupational injuries

Injuries occurred during the performance of professional activities are considered work-related injuries.

A work-related injury, in terms of the Law on Health Insurance, is any injury, illness or death resulting from an accident at work, or as a consequence of any unexpected or unplanned event, including an act of violence caused by work or related to work that has led to an injury,

illness or death of the insured that occurred immediately or within a period of 12 months from the date of the injury occurred at work.

A work-related injury shall be determined on the basis of a Report of a Workplace Injury (injury list) which is under direct or indirect control of the employer and which shall be submitted to the Republic Health Insurance Fund, or its parent branch to exercise the rights arising from the compulsory health insurance in accordance with this law.

The Serbian Law on Occupational Health and Safety stipulates that the employer is obliged to provide employees with work at the workplace and in the work environment where occupational health and safety have been implemented. In the event of an injury in the workplace due to unusual and unpredictable circumstances beyond the employer's control or due to an exceptional event whose consequences, despite all efforts, could not have been avoided, the employer shall not be liable within the meaning of this law.

According to the same law, a workplace is a space intended for performing work with the employer (in the facility or outdoors as well as on temporary and mobile construction sites, facilities, devices, vehicles, etc.) in which the employee stays or has access to during work and which is under the direct or indirect control of the employer.

A work-related injury is considered to be an injury that occurred in the workplace, i.e. in the area where the employee stays or has access to during work, not only at the time of performing work but also during all other activities in order to carry out the work under the employment contract or performing work on any other basis with the employer, which is under the direct or indirect control of the employer (all working and auxiliary premises and all facilities controlled by the employer). If an injury occurs during a daily rest, for example, during coffee or lunch breaks in working hours, in the workplace, it shall be considered a work-related injury. Also, should an injury occur in the space where the employee stays or has an access to during work, and it is a space that is under the control of the employer and such an injury occurs during a break, it shall have the character of a work-related injury, as well. If an injury occurs during a coffee or lunch break but in an area that is beyond the control of the employer, such an injury will not have the character of an occupational injury within the meaning of the Law on Health Insurance.

The employer is obliged to, immediately and no later than within 24 hours from the time of occurrence, report orally and in writing, to the competent labour inspection authority and the competent body for internal affairs any fatal, collective or severe work-related injury, occupational injury due to which the employee is unable to work for at least 3 consecutive days. The employer has to report also a dangerous phenomenon that could endanger the safety and health of the employees.

The employer is obliged to submit a report on the work-related injury that occurred in the workplace to the employee who suffered the injury. The report on a work-related injury shall contain data on the employer, on the person designated by the employer for occupational health and safety, on the employee who suffered an occupational injury, on the immediate supervisor of the injured, on the workplace and jobs of the injured and data on the occupational injury. The report on the work-related injury also contains data on the eyewitness, time and place of the occurrence of the occupational injury, as well as the findings and opinion of the doctor or physician who first examined the injured person.

The report on the work – related injury shall be filled in, using the prescribed form, in 5 copies. The employer shall fill in the report immediately, and no later than within 24 hours from the moment when it was established that there was an occupational injury occurred in the workplace, directly entering all the data in the appropriate form.

After entering all the data in the prescribed form, the employer shall, without delay and no later than 24 hours from the time of data entry, submit all 5 copies of the report to the health institution where the injured person was examined, in order to obtain and enter the medical report findings. The doctor who examined the injured person shall enter all the data and medical opinion within 2 days from the day when the injured person was admitted to the health care institution. He/She shall submit the completed report to the employer, without delay, and no later than the next day.

The report, which contains all the prescribed data including the doctor's opinion and findings of the health institution where the injured person had a medical treatment, is now complete. The employer should submit it within two days from the day of its completion to the branch of the Republic Health Insurance Fund where the injured person exercises their rights determined by the health insurance regulations.

The branch of the Republic Health Insurance Fund shall certify all five copies of the report, of which it shall keep one copy of the report for its own needs, and the remaining copies shall be returned to the employer.

The employer shall keep one copy of the certified report for its own needs, deliver one copy of the report to the injured employee immediately, and no later than two days after its receipt, one copy of the report shall be delivered to the branch of Republic fund for pension and disability insurance. One copy shall also be submitted to the Ministry of Labour - the Directorate for Occupational Health and Safety.

The first-instance medical commission of that branch shall estimate if that injury has been a work – related one according to the occupational Injury Report submitted by the employer to the branch of the Republic Health Insurance Fund. It is possible to file an objection against the assessment of the first-instance medical commission to the second-instance medical commission of the branch.

The length of a temporary incapacity for work (sick leave) shall be assessed by a professional medical body of the Republic Health Insurance Fund (RHIF) according to the medical rules and standards for determining a temporary incapacity for work.

The right to compensation for damages after an injury at work is exercised by the employee on the basis of the Law on Mandatory Health Insurance, the Law on Labour and Pension and Disability Insurance.

Based on the Labour Law, an employee who has suffered an injury at work is entitled to 100% of the average salary earned in the previous 12 months before the month when the temporary inability to work occurred during the period of sick leave. By law, this payment cannot be less than the minimum income.

Based on the Law on Pension and Disability Insurance, in the case of physical damage caused by an injury at work, an employee can obtain compensation for physical damage or the right to a disability pension in the event that there has been a complete loss of working ability that cannot be removed by treatment or medical rehabilitation.

The Republic of Serbia has a legislation of sports consisted on four laws. These are: Law on Sports, Law on Prevention of Violence and Misbehaviour at Sports Events, Law on Prevention of Doping in Sports and Law on Public Ski Resorts.

At the moment, there is no legal regulation in Serbia where an injury caused by sports activities could be considered as injury at work.

Injuries sustained during sports activities that can be considered occupational injuries

Injuries incurred during sports activities, according to the requirements of the Law on Pension and Disability Insurance can be estimated as occupational, work - related injuries in the following cases:

- Athlete was injured while he was performing sports for which he has been provided proper insurance (a professional athlete); the injury has been caused by a short-term mechanical or physical action, sudden changes in body position, sudden damage to the body or by changes in the physiological state of the organism;
- Athlete suffered an injury on a regular trip from the apartment to the place where he performs sports activities (sports field, sports hall, swimming pool, etc.);
- Athlete got an injury while participating in rescue or defence operations against natural disasters or accidents, military exercises, work camps and sports preparations, etc.;
- Injuries occurred during sports activities as part of recreation (Serbian laws: Zakon o radu RS, Zakon o zdravstvenom osiguranju RS, Zakon o bezbednosti i zdravlju na radu RS)

Problems pertaining to assessing whether injuries sustained during sports activities can be considered an occupational injury

The main problem for experts who have to determine whether an injury occurred during sports activities can be considered an occupational injury is the lack of relevant documents. The basic act and source of data on work – related injuries is a Work Injury Report (injury list). The Insurance and Pension Commission shall make a final decision whether a reported sports injury is a work – related injury and it is mostly based on the Work Injury report (injury list). Such detailed document does not exist in sports.

The existing Injury Report for sports injuries (Figure 1) filled out by a sports medicine specialist is not specific and detailed enough compared to the Work Injury Report filled out by an occupational medicine specialist when it comes to other work-related injuries. That is why the legal documents valid in sports should introduce an "**Report on Sports Injury"** similar to the one valid for occupational injuries.

Name and surname:
Date of Birth:
JMBG:
LBO:
Booklet number:
Service: Examination by a doctor specialized in sports medicine
Review date:

FINDINGS AND OPINION	
DIAGNOSIS	
ANAMNESIS	
PHYSICAL EXAMINATION	
THERAPY	
ADDITIONAL DIAGNOSTICS	
CONTROL MEDICAL CHECK UP	

Figure 1. Injury report filled out by a sports medicine specialist

Conclusion

Injuries sustained by sports activities (sports injuries) can in some cases be considered as work-related injuries both for athletes who are professionally engaged in sports, as well as in sports professionals - athletic trainers, coaches, physical education teachers, physiotherapists, fitness and military instructors and people who organize recreational activities for factory workers and company employees.

Sport injuries should be documented in a similar manner as work-related injuries, which would fulfill all legal requirements for their verification by the competent The Insurance and Pension Commission.

Republic Health Insurance Fund (RHIF) is making a final decision over the existence of an injury at work according to Injury report and other appropriate medical documentation, which is obligatory for all authorities that decide on the legal consequences of an occupational injury, including the determination of temporary or permanent inability to work and appropriate material compensation.

Because of that legal procedure, it is necessary to regulate the introduction of the "Report on Sports Injury" which, along with other relevant documentation, would allow a sports injury to be recognized as a work injury by RHIF, which would enable injured athletes and professionals in sports to be properly insured and taken care of if they had not previously been provided with health and social insurance. This would also cover the costs of their treatment and the minimum cost of living for this group of athletes and professionals in sports while they are unable to work.

References

Banović D. (2006). Povrede u sportu. Beograd: Medicinska knjiga.

Bureau of Labor Statistics. Occupational Outlook Handbook (2014). 2014 – 15. Washington, DC: US Department of Labor.

DeFreese JD, Mihalik JP. (2016). Work-based social interactions, perceived stress, and workload incongruence as antecedents of athletic traine burnout. J Athl Train.; 51(1),28–34.

Campbell D, Miller MH, Robinson WW. (1985).The prevalence of burnout among athletic trainers. Athl Train J Natl Athl Train Assoc.; 20(2),110–113.

Capel SA. (1990). Attrition of athletic trainers. Athl Train J Natl Athl Train Assoc. 25(1),34–39.

Hendrix AE, Acevedo EO, Hebert E. (2000).An examination of stress and burnout in certified athletic trainers at Division I-A universities. J Athl Train.; 35(2),139–144.

Brumels K, Beach A. (2008).Professional role complexity and job satisfaction of collegiate certified athletic trainers. J Athl Train.; 43(4),373–378.

Ju YY, Cheng HY, Hsieh YJ, Fu LL. (2011).Work-related musculoskeletal disorders in athletic trainer. J Occup Rehabil.;21(2),190–198.

Cromie JE, Robertson VJ, Best MO. (2002).Work-related musculoskeletal disorders and the culture of physical therapy. Phys Ther.;82(5), 459–472.
Darraugh AR, Huddleston W, King P. (2009).Work-related musculoskeletal injuries and disorders among occupational and physical therapists. Am J Occup Ther.;63(3),351–362.
Kucera KL. Lipscomb HJ. Roos KG Dement JM Hootman JM (2018).Work-related injury and menagement strategies among certified athletic trainers. Journal of Athletic Training;53(6),606–618
Zakon o radu. „Službeni glasnik“ RS broj 24/2005, 61/2005, 54/2009, 32/2013, 75/2014, 13/2017.
Zakon o zdravstvenom osiguranju. „Službeni glasnik“ RS br. 23 od 03. Aprila 2019.god.
Zakon o bezbednosti i zdravlju na radu. „Službeni glasnik“ RS 101/2005, 91/2015 i 113/2017.

Uvodno predavanje

POVREDE NASTALE TOKOM SPORTSKIH AKTIVNOSTI KAO POVREDE NA RADU

Aleksandra Popović[1]
[1] Univerzitet u Beogradu, Fakultet sporta i fizičkog vaspitanja, Beograd, Srbija

Uvod

Povrede u sportu (*sportske povrede*) nastaju zbog delovanja spoljne sile na telo ili delove tela ili kao posledica unutrašnjih oštećenja zbog prenaprezanja u toku sportskih aktivnosti. Ove povrede mogu nastati u toku vežbanja, na treninzima, takmičenjima i tokom rekreativnih aktivnosti u svakom životnom dobu kod osoba koje učestvuju u organizovanim ili neorganizovanim sportskim aktivnostima (les lesions sportives, franc., Sport – verletzungen, nem., athletic injuries, sport injuries, engl.) (Bošković, 2006).

Sportske povrede mogu nastati ne samo tokom bavljenja različitim sportskim aktivnostima, bilo da se radi o fizičkoj aktivnosti koja se sprovodi u cilju unapređenja i poboljšanja sopstvenog zdravlja ili u sklopu bavljenja profesionalnim sportom, kao i tokom obavljanja radnih i profesionalnih aktivnosti koje nisu u vezi sa sportom. Ove povrede mogu dovesti ne samo do kraćeg ili dužeg prekida fizičkih i sportskih aktivnosti već to može uticati i na ukupni kvalitet života povređene osobe. Ona može biti u dužem vremenskom periodu onemogućena da radi što čak može ugroziti i egzistenciju te osobe. Poseban problem u tom smislu mogu predstavljati povrede osoba koje se profesionalno bave sportom i koje su nastale tokom njihove sportske aktivnosti a koje pri tom nisu zaštićene različitim oblicima zdravstvenog osiguranja kojima bi se pokrili troškovi lečenja i obezbedili minimalni egzistencijalni uslovi. Profesionalci u sportu koji su zaposleni u različitim državnim i privatnim institucijama i firmama kao što su treneri sporta, profesori fizičkog vaspitanja, fizioterapeuti, fitnes i vojni instruktori kao i osobe koje organizuju rekreativne aktivnosti radnika u fabrikama i kompanijama mogu takođe imati poteškoća prilikom priznavanja povreda nastalih tokom njihovih profesionalnih, sporskih aktivnosti kao povreda na radu.

Pojava sportskih povreda kod osoba čija profesija podrazumeva i obavljanje sportskih aktivnosti je moguća zbog toga što su oni uključeni ne samo u sprovođenje trenažnog procesa već i u obavljanje drugih aktivnosti kao što su različite aktivnosti na otvorenom i u zatvorenom prostoru, podizanje i pomeranje sportske opreme, dizanje sportista (npr. u gimnastici, posle padova, prilikom ukazivanja prve pomoći). Ove aktivnosti mogu dovesti do prenaprezanja i nastanka sportskih povreda. Prilikom pružanja prve pomoći mogu doći u kontakt sa krvlju i telesnim tečnostima što može predstavljati rizik po njihovo zdravlje. Osim toga, izloženi su i jakom psihološkom stresu, posebno u školskoj sredini ili na masovnim sportskim događajima gde često moraju istovremeno da organizuju sportske aktivnosti i da brinu o velikom broju sportista (Bureau of Labor Statistics, Occupational Outlook Handbook, 2014).

U svetu je sprovedeno više istraživanja koja su pokazala prisustvo različitih povreda i stanja kod profesionalaca u sportu koja mogu biti prepoznata kao povrede na radu.

Rezultati više različitih istraživanja sprovedenih u SAD je pokazalo da su stres, sindrom sagorevanja i istrošenost raširena pojava među sportskim profesionalcima (DeFreese, JD. & Mihalik, JP., 2016; Campbel et al., 1985; Capel, SA., 1990; Hendrix et al., 2000; Brumels, K. & Beach, A., 2008). Istraživanje sprovedeno na Tajvanu na uzorku od 107 sportskih trenera je pokazalo da je gotovo polovina ispitanika imala neku povredu koja je bila povezana sa njihovim profesionalnim aktivnostima: najčešće su povređivali donji deo leđa (42%), prste (38%) i rame (26%) a povrede su bile klasifikovane kao sindrom prenaprezanja (68%), istegnuće (30%) ili tendinitis (24%) (Ju, YY et al., 2011). U različitim istraživanjima je uočeno da se sportske povrede u okviru sportskih aktivnosti i rehabilitacije retko prijavljuju kao povrede na radu (Cromie et al., 2002) i da se sportisti, treneri, fizioterapeuti često sami leče (Darraugh et al., 2009). Istraživanje koje je objavljeno 2018. god. a sprovedeno tokom 2012.god. u SAD na uzorku od 247 sportskih trenera je pokazalo da su najčešće povrede bile u predelu trupa (donji deo leđa – 25.9%), zatim šaka i prsti (8,9%) i koleno (8,5%). Najčešće su bile traumatske povrede mišića, tetiva, ligamenata i zglobova (76,9%) dok su povrede kostiju i otvorene rane bile ređe zastupljene. Do nastanka povreda su dovodili pokreti tela, prenaprezanje i ponavljani pokreti (52,2%), kontakti sa objektima, opremom, drugim osobama (23,5%) a u manjoj meri su povrede nastale zbog okliznuća, saplitanja ili padova. Polovina povređenih trenera je zbog sportskih povreda u određenom vremenskom periodu promenilo svoju rutinu na poslu, manje su pomerali i dizali tešku opremu, izbegavali su rizične pokrete i aktivnosti koje bi mogle da dovedu do njihovog pogoršanja. Iako je polovina ispitanika zbog svojih povreda izazvanih sportskom aktivnošću dobila medicinsku pomoć, manje od četvrtine povređenih je tražilo neku vrstu novčane nadoknade kao kompenzacije za povredu na radu (Kucera et al., 2018).

Ovakva istraživanja koja bi definisala prevalencu i incidencu povreda u sportu koje se mogu definisati kao povrede na radu, kako kod sportista tako i kod sportskih trenera i ostalih profesionalaca u sportu nisu do sada sprovođena u našoj zemlji. Međutim, to ne znači da takvih povređivanja nema kod naše populacije koja se profesionalno bavi sportom, s obzirom da se i u našoj zemlji broj sportista a pogotovu profesionalaca u sportu značajno povećao tokom poslednjih godina, posebno zbog sve većeg broja fitnes klubova. Iako još uvek ne postoje zakonski propisi koji se odnose na sportske povrede, korišćenjem postojeće zakonske regulative koja se odnosi na povrede na radu moguće je na osnovu težine povreda utvrditi kod sportista i profesionalaca u sportu njihovu privremenu ili trajnu nemogućnost obavljanja sportskih aktivnosti na osnovu kojih mogu da dobiju nadoknadu troškova lečenja u okviru zdravstvenog i socijalnog osiguranja.

U radu je prikazana zakonska regulativa Republike Srbije koja se primenjuje prilikom priznavanja povreda na radu nastalih usled profesionalnih aktivnosti kao i mogućnost njene primene u cilju priznavanja sportskih povreda nastalih tokom obavljanja profesionalnih aktivnosti kao povreda na radu.

Diskusija

Zakonska regulativa kod povreda na radu

Povrede nastale tokom obavljanja profesionalnih aktivnosti se smatraju povredom na radu. Povreda na radu prema Zakonu o zdravstvenom osiguranju je svaka povreda, oboljenje ili smrt

nastala kao posledica nesreće na poslu, odnosno kao posledica svakog neočekivanog ili neplaniranog događaja, uključujući i akt nasilja koji je nastao usled rada ili je povezan sa radom koji je doveo do povrede, oboljenja ili smrti osiguranika koja je nastupila odmah ili u periodu od 12 meseci od dana nastanka povrede na radu. Povreda na radu utvrđuje se na osnovu *izveštaja o povredi na radu* (*povredna lista*) koji je pod neposrednom ili posrednom kontrolom poslodavca i koja se dostavlja Republičkom fondu za zdravstveno osiguranje, odnosno matičnoj filijali radi ostvarivanja prava iz obaveznog zdravstvenog osiguranja u skladu sa ovim zakonom.

Zakonom o bezbednosti i zdravlju na radu određeno je da je poslodavac dužan da zaposlenima obezbedi rad na radnom mestu i u radnoj okolini u kojima su sprovedene mere bezbednosti i zdravlja na radu, pa u slučaju nastanka povrede na radu zbog neuobičajenih i nepredvidljivih okolnosti koje su izvan kontrole poslodavca ili zbog izuzetnog događaja čije se posledice uprkos svim nastojanjima nisu mogle izbeći, poslodavac nije odgovoran u smislu ovog zakona. Prema istom zakonu radno mesto je prostor namenjen za obavljanje poslova kod poslodavca (u objektu ili na otvorenom kao i na privremenim i pokretnim gradilištima, objektima, uređajima, saobraćajnim sredstvima i sl.) u kojem zaposleni boravi ili ima pristup u toku rada a koji je pod neposrednom ili posrednom kontrolom poslodavca.

Povredom na radu smatra se *povreda koja se dogodila na radnom mestu*, odnosno u prostoru u kojem zaposleni boravi ili ima pristup u toku rada i to ne samo u momentu obavljanja rada već i prilikom obavljanja svih drugih aktivnosti u cilju izvršavanja poslova iz ugovora o radu ili obavljanju rada po bilo kom osnovu kod poslodavca, a koje je pod neposrednom ili posrednom kontrolom poslodavca (svim radnim i pomoćnim prostorijama i svim objektima koje kontroliše poslodavac). Ukoliko se povreda dogodi tokom dnevnog odmora, tj. pauze tokom radnog dana, na radnom mestu, odnosno u prostoru u kome zaposleni boravi ili ima pristup tokom rada, a radi se o prostoru koji je pod kontrolom poslodavca i takva povreda za vreme pauze ima karakter povrede na radu. Međutim ako povreda nastane tokom korišćenja prava na pauzu tj. dnevnog odmora, ali u prostoru koji je van kontrole poslodavca, takva povreda nema karakter povrede na radu u smislu Zakona o zdravstvenom osiguranju.

Poslodavac je dužan da odmah a najkasnije u roku od 24 časa od nastanka, usmeno i u pismenoj formi prijavi *nadležnoj inspekciji rada i nadležnom organu za unutrašnje poslove* svaku smrtnu, kolektivnu ili tešku povredu na radu, povredu na radu zbog koje zaposleni nije sposoban za rad više od 3 uzastopna dana, kao i opasnu pojavu koja bi mogla da ugrozi bezbednost i zdravlje zaposlenih.

Izveštaj o povredi na radu koja se dogodi na radnom mestu poslodavac je dužan da dostavi zaposlenom koji je pretrpeo povredu. Izveštaj o povredi na radu sadrži podatke o poslodavcu, o licu određenom za bezbednost i zdravlje na radu kod poslodavca, o zaposlenom koji je pretrpeo povredu na radu, o neposrednom rukovodiocu povređenog, o radnom mestu i poslovima povređenog i podatke o povredi na radu. Izveštaj o povredi na radu pored navedenog sadrži podatke o očevicu, vremenu i mestu nastupanja povrede na radu kao i nalaz i mišljenje lekara koji je prvi pregledao povređenog.

Izveštaj o povredi na radu (povredna lista) popunjava se na propisanom obrascu u 5 primeraka. Izveštaj popunjava poslodavac tako što odmah, a najkasnije u roku od 24 časa od časa saznanja da je došlo do povrede na radu, u odgovarajući obrazac neposredno upisuje sve podatke. Nakon što upiše sve podatke na propisanom obrascu, poslodavac bez odlaganja a najkasnije u roku

od 24 časa od časa upisa podataka, svih 5 primeraka izveštaja dostavlja zdravstvenoj ustanovi u kojoj je izvršen pregled povređenog radi unošenja u sadržinu izveštaja nalaza i mišljenje lekara, odnosno zdravstvene ustanove. Lekar koji je pregledao povređenog upisuje nalaz i mišljenje u roku od 2 dana od dana njegovog prijema i popunjen izveštaj dostavlja poslodavcu, bez odlaganja, a najkasnije narednog dana. Izveštaj u kome su upisani svi propisani podaci i nalaz i mišljenje lekara, odnosno zdravstvene ustanove, poslodavac u roku od dva dana od dana prijema popunjenog izveštaja dostavlja filijali Republičkog fonda za zdravstveno osiguranje kod koje povređeni ostvaruje prava utvrđena propisima o zdravstvenom osiguranju.

Filijala Republičkog fonda za zdravstveno osiguranje overava svih 5 primeraka izveštaja, od kojih zadržava jedan primerak izveštaja za svoje potrebe, a ostale primerke vraća poslodavcu.

Poslodavac jedan primerak overenog izveštaja zadržava za svoje potrebe, jedan primerak izveštaja dostavlja zaposlenom odmah, a najkasnije u roku od dva dana od njegovog prijema, jedan primerak izveštaja dostavlja filijali Republičkog fonda za penzijsko i invalidsko osiguranje i jedan primerak dostavlja Ministarstvu nadležnom za rad – Upravi za bezbednost i zdravlje na radu.

Na osnovu izveštaja o povredi na radu koji poslodavac dostavlja filijali Republičkog fonda za zdravstveno osiguranje, prvostepena lekarska komisija te filijale daje ocenu da je utvrđena povreda na radu. Protiv ocene prvostepene lekarske komisije moguće je uložiti prigovor drugostepenoj lekarskoj komisiji filijale. Dužinu privremene sprečenosti za rad (bolovanja) ocenjuje stručno medicinski organ Republičkog fonda za zdravstveno osiguranje (RFZO), odnosno matične filijale na osnovu medicinskog – doktrinarnih standarda za određivanje privremene sprečenosti za rad.

Pravo na naknadu štete posle povrede na radu zaposleni ostvaruje na osnovu Zakona o obaveznom zdravstvenom osiguranju, Zakona o radu i penzijskog i invalidskog osiguranja. Na osnovu Zakona o radu zaposleni koji je pretrpeo povredu na radu ima za vreme bolovanja pravo na 100% prosečne zarade ostvarene u prethodnih 12 meseci pre meseca kada je nastupila privremena sprečenost za rad. Po zakonu, ova isplata ne može biti manja od minimalnog dohotka.

Na osnovu Zakona o penzijskom i invalidskom osiguranju u slučaju telesnog oštećenja prouzrokovanog povredom na radu zaposleni može da ostvaruje naknadu za telesno oštećenje ili pravo na invalidsku penziju u slučaju da je nastao potpuni gubitak radne sposobnosti koji se ne može otkloniti lečenjem ili medicinskom rehabilitacijom.

Republika Srbija je oblast sporta uredila sa četiri zakona. To su: Zakon o sportu, Zakon o sprečavanju nasilja i nedoličnog ponašanja na sportskim priredbama, Zakon o sprečavanju dopinga u sportu i Zakon o javnim skijalištima.

U ovom trenutku *ne postoji zakonska regulativa gde bi povreda izazvana sportskim aktivnostima mogla da se smatra povredom na radu*.

Mogućnosti primene postojeće zakonske regulative na sportske povrede

Dosadašnja iskustva iz oblasti sporta ukazuju da na osnovu važeće zakonske regulative povrede nastale zbog sportskih aktivnosti mogu se razmatrati kao povrede na radu u sledećim slučajevima:

- Povreda sportiste kod obavljanja sportova na osnovu kojih je osiguran (sportista profesionalac) a povreda je prouzrokovana kratkotrajnim mehaničkim ili fizičkim dejstvom, naglim promenama položaja tela, iznenadnim oštećenjem tela ili drugim promenama fiziološkog stanja organizma.

- Povreda sportiste koju pretrpi na redovnom putu od stana do mesta gde obavlja sportske aktivnosti (sportski teren, sportska sala, bazen, itd.).
- Povreda sportiste koju pretrpi učestvujući u akcijama spasavanja ili odbrane od elementarnih nepogoda ili nesreća, na vojnoj vežbi, radnom kampu i sportskim pripremama, itd.
- Povrede nastale zbog obavljanja sportskih aktivnosti u sklopu rekreacije (Zakon o radu RS, Zakon o zdravstvenom osiguranju RS, Zakon o bezbednosti i zdravlju na radu RS)

Postojeća zakonska regulativa često ne prepoznaje sportske povrede koje mogu nastati tokom obavljanja profesionalnih aktivnosti kao povrede na radu zbog nepotpune medicinske dokumentacije. Postojeća Prijava o povredi (slika 1.) koju popunjava specijalista sportske medicine nije dovoljno detaljna u poređenju sa Izveštajem o povredi na radu koju popunjava specijalista medicine rada kada su u pitanju druge povrede na radu. Zbog toga bi u pravna dokumenta koja važe u sportu trebalo uvesti „Prijavu o povredi“ sličnu onoj koja važi za povredu radnika.

Ime i prezime:
Datum rođenja:
JMBG:
LBO:
Broj knjižice:
Usluga: Pregled lekara specijaliste medicine sporta
Datum pregleda:

NALAZ I MIŠLJENJE	
DIJAGNOZA	
ANAMNEZA	
FIZIKALNI PREGLED	
TERAPIJA	
DODATNA DIJAGNOSTIKA	
KONTROLA	

Slika 1. Prijava o povredi koju popunjava specijalista sportske medicine

Zaključak

Povrede izazvane sportskim aktivnostima (sportske povrede) mogu se u pojedinim slučajevima smatrati kao povrede na radu kod sportista koji se profesionalno bave sportom kao i kod profesionalaca u sportu - sportskih trenera, profesora fizičkog vaspitanja, fizioterapeuta, fitnes i vojnih instruktora i osoba koje organizuju rekreativne aktivnosti radnika u fabrikama i kompanijama.

Povrede treba dokumentovati na sličan način kao što se to radi kada su u pitanju povrede zaposlenih čime bi se ispunili svi zakonski uslovi za njihovu verifikaciju kod nadležnih komisija zdravstvenog i penzijsko – invalidskog osiguranja;

Neophodno je zakonski regulisati uvođenje „Prijave o sportskoj povredi“ koja bi uz ostalu relevantnu dokumentaciju omogućilo da se sportska povreda prizna kao povreda na radu.

Konačnu odluku o postojanju povrede na radu donose organi penzijsko – invalidskog osiguranja na osnovu Izveštaja o povredi (povredne liste) i druge odgovarajuće dokumentacije.

Njihova odluka je merodavna za sve organe koji odlučuju o pravnim posledicama povrede na radu, uključujući naknadu za telesno oštećenje ili pravo na invalidsku penziju u slučaju da je nastao potpuni gubitak radne sposobnosti koji se ne može otkloniti lečenjem ili medicinskom rehabilitacijom, što je posebno značajno za one sportiste i profesionalce u sportu koji nemaju zdravstveno i socijalno osiguranje.

Literatura

Banović D. (2006). Povrede u sportu. Beograd: Medicinska knjiga.

Bureau of Labor Statistics. Occupational Outlook Handbook (2014). 2014 – 15. Washington, DC: US Department of Labor.

DeFreese JD, Mihalik JP. (2016). Work-based social interactions, perceived stress, and workload incongruence as antecedents of athletic traine burnout. J Athl Train.; 51(1),28–34.

Campbell D, Miller MH, Robinson WW. (1985). The prevalence of burnout among athletic trainers. Athl Train J Natl Athl Train Assoc.; 20(2),110–113.

Capel SA. Attrition of athletic trainers. Athl Train J Natl Athl Train Assoc. 1990; 25(1):34–39.

Hendrix AE, Acevedo EO, Hebert E. (2000). An examination of stress and burnout in certified athletic trainers at Division I-A universities. J Athl Train.; 35(2),139–144.

Brumels K, Beach A. (2008).Professional role complexity and job satisfaction of collegiate certified athletic trainers. J Athl Train.; 43(4),373–378.

Ju YY, Cheng HY, Hsieh YJ, Fu LL.(2011).Work-related musculoskeletal disorders in athletic trainer. J Occup Rehabil.;21(2),190–198.

Cromie JE, Robertson VJ, Best MO. (2002).Work-related musculoskeletal disorders and the culture of physical therapy. Phys Ther.;82(5),459–472.

Darraugh AR, Huddleston W, King P. (2009).Work-related musculoskeletal injuries and disorders amongoccupational and physical therapists. Am J Occup Ther.;63(3),351–362.

Kucera KL. Lipscomb HJ. Roos KG Dement JM Hootman JM (2018).Work-related injury and menagement strategies among certified athletic trainers. Journal of Athletic Training;53(6),606–618

Zakon o radu. „Službeni glasnik“ RS broj 24/2005, 61/2005, 54/2009, 32/2013, 75/2014, 13/2017.

Zakon o zdravstvenom osiguranju. „Službeni glasnik“ RS br. 23 od 03. Aprila 2019.god.

Zakon o bezbednosti i zdravlju na radu. „Službeni glasnik“ RS 101/2005, 91/2015 i 113/2017.

ACUTE EFFECTS OF MYOFASCIAL ROLLER MASSAGE, STATIC AND DYNAMIC STRETCHING ON THE VERTICAL JUMP OF YOUNG VOLLEYBALL PLAYERS

Nevena Vukadinović[1] , Anastasija Krejović[1] , Goran Nešić[1] , Nikola Majstorović[1] , Kristina Nikolić[1]

[1] University of Belgrade , Faculty of Sport and Physical Education, Belgrade, Serbia

Introduction

Modern training practice within the immediate preparation for volleyball efforts shows that there are dominantly present warm-up models that include exercises for the development of mobility, combined with a dynamic segment of athletic exercises of running, jumping, and quick changes of direction. The warm-up models used in the introductory and preparatory part of the training are static, dynamic stretching and myofascial massage with a roller, a method that is increasingly used in the world of sports and recreation.

Static stretching can be defined as a slow, gradual and controlled lengthening of a muscle, where the end range is held passively for a period of time (Van Gelder & Bartz, 2011). A study conducted by (Power, Behm et al., 2004) suggests that static stretching of the quadriceps muscle results in a significant increase in ROM and a decrease in the strength of the treated muscle, i.e. the longer the stretching time, the lower the stiffness of the muscle-tendon unit. The stiffness of this unit is responsible for force transmission (muscle-tendon-bone), which means that longer static stretching can reduce sprinting-jumping activity (Šarić, Lisica, 2016). Findings suggest that static stretching can impair force production for up to 120 minutes, where it is recommended that activities involving maximal strength be avoided for at least 120 minutes prior to performance. Some studies have shown that acute static stretching can reduce strength and negatively affect muscle performance during jumping and sprinting (Cramer et al., 2005; Fletcher, Jones, 2004; Nelson et al., 2005).

Dynamic stretching is defined by the National Strength and Conditioning Association (NSCA) as a functional stretching exercise that uses sport-specific movements to prepare the body for activity. Strength and conditioning experts are increasingly practicing and recommending the use of dynamic stretching as the best way to prepare athletes for the physical demands of their sport. Although there are many variations of dynamic stretching, they are usually exercises that are applied during movement, such as squats and lunges that are often combined with running that involve forward, lateral and directional movement (MCMillian et al., 2006). Researchers have shown that dynamic stretching lowers lactate concentration, improves thermoregulatory efficiency, and improves sprint and vertical jump performance (Bartlett, Warren, 2002; Gray et al., 2002; Knudson et al., 2001).

Myofascial release is a massage technique that affects sports performance by reducing fibrous adhesions that occur between layers of fascia/connective tissue. These fibrous adhesions are thought to be caused by injuries, muscle imbalances, over-recruitment of muscle fibers, overworked muscles, repetitive microtrauma, and inflammation (Behara, Jacobson, 2017). Foam rolling mimics myofascial release techniques and is often used by therapists, athletes, and the general public to increase range of motion (ROM) (Sullivan, Silvey, Button , & Tramp; Behm, 2013). Myofascial roller massage is one of the most popular methods of self-myofascial release, where the

athlete uses his body weight and applies pressure to the muscle while using the roller (Kalichman & Ben, 2017). A study conducted by (Pişirici, Ekiz, İlhan, 2020; Richman, Tyo, Nicks, Clayton, 2019) shows that the application of myofascial massage with a roller led to a statistically significant increase in jump performance. Hsuan Su et al showed a statistically significant increase in flexibility after myofascial roller massage, compared to static and dynamic stretching. Lower body muscle strength improved significantly after rolling and dynamic stretching, while no changes were observed after static stretching. The authors report that myofascial roller massage is more effective than static and dynamic stretching in acutely increasing muscle flexibility and strength and recommend its use as part of a warm-up in healthy young adults.

By reviewing the literature, it can be seen that the area dealing with the different impact of myofascial massage, static and dynamic stretching on performance and vertical jump in volleyball has not been sufficiently researched, while their application is not fully supported by empirical data. In the study by Šarić and Lisica (2016), recommendations are valid that static stretching before sports activity should not be longer than 30 seconds, Popleka and Pivovarniček (2018) recommend for further research efforts that the testing be performed in a shorter period of time on the same day. Considering that, the aim of this research is to determine the influence of myofascial roller massage, static and dynamic stretching on the vertical jump of young volleyball players.

Methods

The research was conducted in the hall of the Faculty of Sports and Physical Education, the sample of respondents consisted of 24 young volleyball players aged 13-15 years, divided into four groups of 6 subjects, who performed a different type of treatment on each experimental day, namely: dynamic stretching, static stretching , myofascial massage and one group was control (no treatment). The dependent variable that was observed was the height of the vertical jump, which was assessed using the Sargent test. The testing was carried out over a period of two weeks, three times a week, where in the introductory part of the training, the subjects performed low-intensity running for 5 minutes, after which the initial testing was carried out through three jumps with a break of 1 minute on the Sargent test, then 8 minutes of experimental treatment, followed by final vertical jump height testing. Immediately before participating in the research, the respondents were given all the information, explanations and answers to the questions related to the research.

Static stretching protocol

The static stretching protocol included active stretching of 4 muscle groups of the lower part of the body Table 1. Active stretching was performed on the muscles: plantar flexors, posterior box, hip extensors. The subjects performed static stretching through 2 sets of 30 seconds each for 4 muscle groups, where each leg was stretched individually. The total duration of the static stretching protocol is 480 seconds.

Table 1. Static stretching exercises

Exercises	Method of performance
Calf muscle stretching	With the hands resting on the wall in a slightly straddling position, the back leg is extended while the front leg is bent at the knee joint, by pulling the knee towards the wall the calf muscles are stretched. Alternate left and right leg.
Quadriceps stretch from a kneeling position	In the kneeling position, one leg is extended in front, grab the leg with the hand and pull it up until you feel a stretch in the muscle. Alternate left and right leg.
Lying hamstring stretch	From the lying position, one leg is raised, while the other is on the floor. Pull the leg towards you with your hands.
Gluteus muscle stretching	From a lying position, bend one leg and then cross the other leg over so that the lower leg of the other leg rests on top of the first leg. From this position, grab the left lower leg and pull it towards you. Alternate left and right leg.

Dynamic Stretch Protocol

The dynamic stretching protocol involved stretching the same muscle groups as in the static stretching protocol (Table 1). The exercises were performed at a distance of 18 m, in order to simulate the length of the volleyball court. Subjects performed dynamic stretching through three sets with a 20 s break between sets, in order to ensure identical time as in the first protocol.

Table 2. Dynamic stretching exercises

Exercises	Method of performance
Walking on tiptoes	Walking on tiptoe during movement.
Quadriceps stretch in the balance position	In the position of support on one leg, grab the leg by the shin with your hand and take the scale in that position.
Walking hamstrings kicks	From a hop, step forward with one leg in movement
Dynamic hip abductor stretching	From a hop, step forward with one leg in movement

Myofascial massage protocol

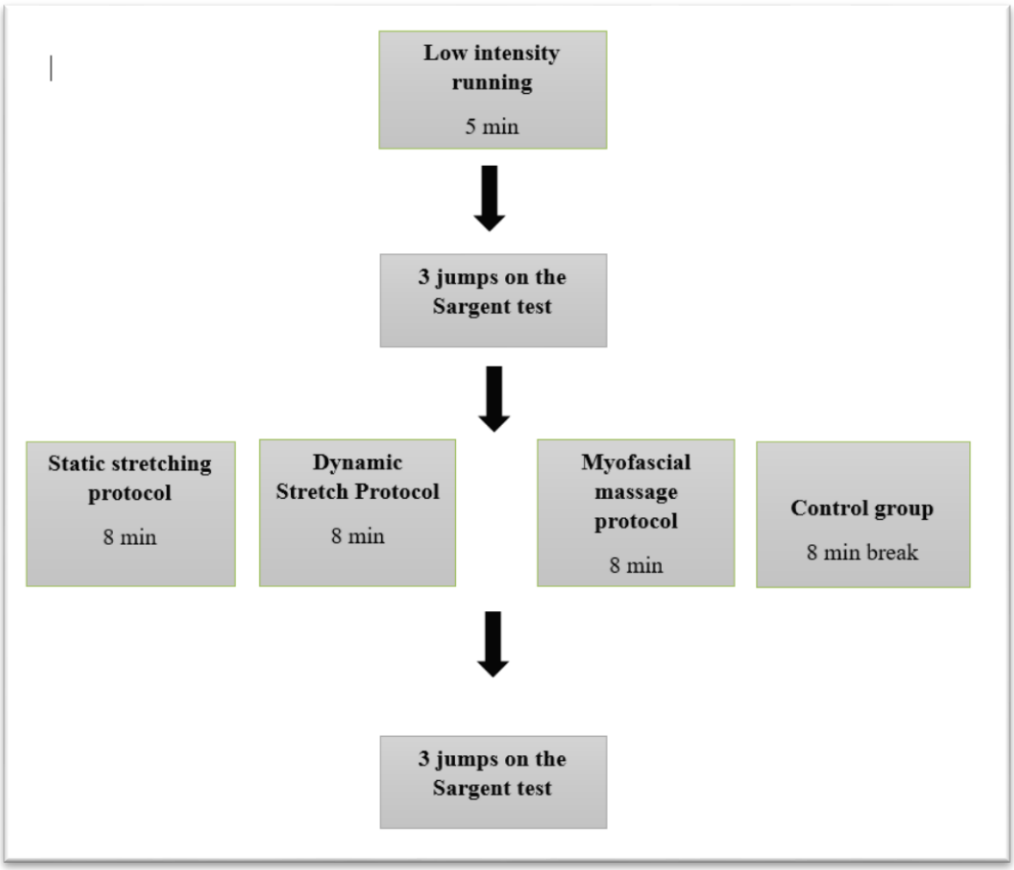
The myofascial massage protocol included roller massage of the same muscle groups as in the previous two protocols. The subjects used roller massage for 2 series of 30 seconds on each muscle region.

Table 3. Myofascial massage exercises with a roller

Exercises	Method of performance
Application of myofascial massage in the area of calf muscles	From a lying position on your back, rest your lower leg on the roller, press your body weight on the roller and perform body movements forwards and backwards.
Application of myofascial massage in the area of the back muscles	From a lying position on your back, rest your upper leg on the roller, press the roller with your body weight and perform body movements forwards and backwards.
Application of myofascial massage in the area of the front loggia muscles	From a lying position on your chest, rest your upper leg on the roller, press the roller with your body weight and perform body movements forwards and backwards.
Application of myofascial massage in the area of the gluteal region	From a sitting position, place the roller under the gluteal muscles , one leg is placed on the shin of the other leg, put pressure on the roller with your body weight and perform body movements forwards and backwards.

Subjects from the control group, together with the other groups, performed low-intensity running for 5 minutes before the start of the protocol, followed by 8 minutes of rest.

- Outline of the research:



Results

The basic descriptive statistics of the morphological variables are shown in Table 3, measured before the start of testing. Where the variables body height with an average value (165.5±7.2), maximum values (178cm) and minimum values (155cm), body mass with an average value (62.2.5±4.7), maximum values (70.2kg) and minimum values (53.4kg), body mass index with average value (18.8±1.1), maximum values (21.7) and minimum values (17.3) and reaching height with average value (215.6.5±8.5), maximum values (233 cm) and minimum values (202 cm).

Table 3. Basic descriptive statistics of morphological variables

VARIABLES	AS	SD	MAX	MIN
BM	165.5	7.2	178	155
BH	62.2	4.7	70.2	53.4
BMI	18.8	1.1	21.7	17.3
RH	215.6	8.5	233	202

Legend: BM – body mass; BH – body height; BMI – body mass index; RH – reaching height; AS – arithmetic mean; SD – standard deviation; Min. – the smallest value of the result; Max. – the highest value of the result.

The average values of the height of the vertical jump in the pretest and posttest are shown in Table 4, where the value of the height of the jump in the pretest after the dynamic protocol was (34.92±4.91) and the posttest (36.03±7.37), after the static stretching of the value in the pretest (33.83±5.96) and in the posttest (32.36±6.29), after myofascial roller massage values in the pretest (33.7±4.86) and in the posttest (33.46±4.56) and in the control group in the pretest (33.14±4.28) and posttest (32.33±4.6).

Table 4. Basic descriptive statistics of vertical jump height values in pretest and posttest

GROUP	DYNAMIC STRETCHING		STATIC STRETCHING		MYOFASCIAL MASSAGE		CONTROL GROUP	
TIME	Pretest	Posttest	Pretest	Posttest	Pretest	Posttest	Pretest	Posttest
	37	37	36	36	37	37	36	36
MEAN	34.92	36.03	33.83	32.36	33.7	33.46	33.14	32.33
STD	4.91	7.37	5.96	6.29	4.86	4.56	4.28	4.6

Table 5 shows the differences in jump height values after applying the protocol, using factor analysis of variance (between-within). Using an adequate statistical procedure, the results show that there are no significant differences after the application of the dynamic stretching protocol (p=0.102), myofascial massage (p=0.718) and the control group (p=0.239), while there are significant differences after the application of the static stretching protocol (p= 0.033). The difference in the mean values (Mean difference) before and after the treatment of dynamic stretching is (1,108 cm), static stretching (-1,472 cm), myofascial roller massage (-0,243 cm) and in the control group (-0,806 cm).

Table 5. Differences in vertical jump height values measured before and after treatment

Group	Mean Difference	Sig.
Dynamic stretching	1.108	0.102
Static stretching	-1.472*	0.033
Myofascial massage	-0.243	0.718
Control group	-0.806	0.239

Figure 1 shows a graphical representation of the average vertical jump value before and after treatment.

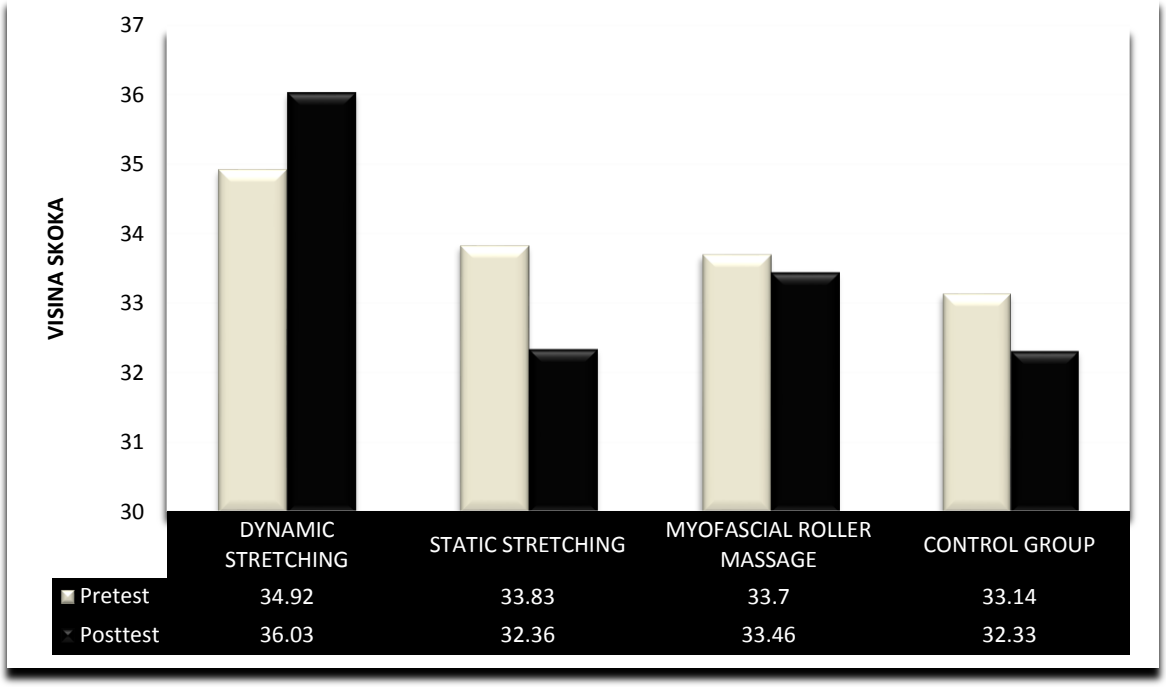


Figure 1. Average values of vertical jump height in the pretest and posttest

Discussion

To determine the difference in the effects of the protocol (myofascial roller massage, dynamic and static stretching) on the vertical jump of young volleyball players, the results obtained by testing 24 subjects aged 13-15 years were used. Based on Table 3, the subjects had a normal distribution of body height and mass. The average value and the highest value of the body mass index (BMI) result were within normal limits, while the lowest value of the result was slightly lower, that is, values below the average.

Table 5 shows the differences between the groups, where static stretching shows statistically significant differences (p=0.03). Which indicates that it has a negative effect on the values of the height of the vertical jump, on the basis of which one of the hypotheses that were set at the very beginning of the research is confirmed in accordance with the objective. In addition to the results obtained by determining the differences between the groups and whether these

differences are statistically significant, the absolute difference in the mean values between the groups is shown, which explains the amount by which the experimental intervention changed the outcome on average compared to the control group. The results show that a change occurred after the application of static stretching, where the vertical jump height value decreased by (1,472 cm). It is evident that there is a pronounced trend in dynamic stretching (it is not statistically significant, but the difference in mean values is noticeable + 1.1 cm improvement), while in the control group the vertical jump decreased by (0.806 cm) and in the myofascial group it decreased by (0.243 cm), indicating negligibly slightly worse results after treatment. During the testing, individuals showed positive changes after the dynamic stretching protocol, which is indicated by the mean differences shown in Table 5. It is assumed that the obtained results are not statistically significant due to the small sample of respondents. The experiment was conducted under controlled conditions, where each protocol was explained in detail before application and controlled during the application itself by an expert, however, it was not possible to control the pressure on the muscle itself during the myofascial massage protocol, given that the subjects were aged (13 -15) years, inexperience and inadequate application of the roller can be the reason for the absence of significant differences between the initial and final measurements. Figure 1 shows the mean values in the pre-test and post-test for each protocol individually. It is noticeable that in the mean values after dynamic stretching, there was a change in the direction of increase in vertical jump after treatment, while after static stretching, myofascial massage and the control group, vertical jump height values decreased.

The vertical jump, because of the explosive strength of the lower limbs, is an important motor skill in the volleyball game, it permeates through various technical-tactical elements such as the slam, block, service and raising the ball. Based on the results of this study, static stretching should not be used as a form of warming up athletes in the introductory-preparatory part of training, because it reduces the height of the vertical jump, which is the most common, almost (55%) (Čeliković, 2021) in relation to the presence of other moving structures during matches. Recommendations are to include dynamic stretching as part of the warm-up before a game or training session, both based on the results of absolute values and based on the relevant literature. In this experiment, myofascial massage with a roller did not show significant changes in the height of the vertical jump, so the impact of it should be examined in more detail, considering that modern literature shows significant benefits that occur after its application, as well as its increasingly frequent application in the practice of athletes and recreational athletes.

Research of this type requires a larger number of respondents, in order to obtain more significant results and the possibility to safely use these conclusions in sports practice. Given that the experiment was conducted on female respondents aged (13-15), this research can be a starting point for some future research (growth, competition ranking, in relation to playing positions). Recommendations for further research efforts are to increase the number of subjects, extend the treatment time (from 30s to 60s), increase the number of exercises in each protocol and enable pressure control during myofascial roller massage.

Conclusion

The findings of this study show that there is no significant difference between dynamic stretching and myofascial massage, so they do not affect the increase in vertical jump height. However, a statistically significant difference was observed after static stretching (p=0.033), where the vertical jump height values decreased by (1.5 cm), which indicates that static stretching has a negative effect on the vertical jump of young volleyball players. The assumption is that the number of respondents was too small for the observed changes to be statistically significant. For further research efforts, it is recommended that the testing and implementation of the treatment be carried out on more subjects, for a longer period of time, as well as with the presence of a greater number of exercises in the protocols, which would contribute to a more significant effect of the observed treatments.

References

Bartlett, MJ, Warren, PJ (2002). Effect of warming up on knee proprioception before sporting activity. No. J. Sports Med. 36:132–134.

Bandy, WD, Irion JM, Briggler M. (1997). The effect of time and frequency of static stretching on flexibility of the hamstring muscles. Phys Ther. ;77 (10):1090-6. doi : 10.1093/ptj/77.10.1090. PMID: 9327823.

Behara, B., & Jacobson, BH (2017). Acute Effects of Deep Tissue Foam Rolling and Dynamic Stretching on Muscular Strength, Power, and Flexibility in Division I Linemen. *Journal of strength and conditioning research*, *31* (4), 888–892.

Cramer, JT, Housh, TJ, Weir, JP, Johnson, GO, Coburn, JW, Beck, TW (2005). The acute effects of static stretching on peak torque , mean power output, electromyography, and mechanomyography. Eur J Appl Physiol 93: 530–539.

Cui, J., Blaha, C., Moradkhan, R., Gray, KS and Sinoway, LI (2006), Muscle sympathetic nerve activity responses to dynamic passive muscle stretch in humans. The Journal of Physiology, 576: 625-634.

Čeliković, A. (2021). Proposal of a fitness program in volleyball for younger female cadets (Doctoral dissertation, University of Zagreb. Faculty of Kinesiology).

Fletcher, IM, Jones, B. (2004). The effect of different warm-up stretch protocols on 20-meter sprint performance in trained rugby union players. J Strength Cond Res 18:885–888.

Gray, SC, Devito, G. , Nimmo , MA, (2002). Effect of active warm up on metabolism prior to and during intense active exercise. Med. Sci. Sports Exerc. 34:2091–2096. in 2002

Hsuan, Su., Nai-Jen Chang, Wen-Lan Wu, Lan-Yuen Guo, and I-Hua Chu. (2016). Acute Effects of Foam Rolling, Static Stretching, and Dynamic Stretching During Warm-ups on Muscular Flexibility and Strength in Young Adults. Journal of Sport Rehabilitation

Kalichman, L., & Ben David, C. (2017). Effect of self-myofascial release on myofascial pain, muscle flexibility, and strength: A narrative review. *Journal of bodywork and movement therapies*, *21* (2), 446–451.

Knudson, D., Bennett, K., Corn, R. , Leick D., Smith, C. (2001). Acute effects of stretching are not evident in the kinematics of the vertical jump. J. Strength Cond. Res. 15:98–101.

Lisica, D., Šarić, J. (2016). Acute and chronic effects of static and dynamic stretching on sprinting and jumping performance. Faculty of Kinesiology, University of Zagreb.

McMillian, DJ, Moore, JH, Hatler, BS, Taylor, DC (2006). Dynamic vs. static-stretching warm up: The effect on power and agility performance. Army MEDDAC, Heidelberg, Germany; 2U.S. Army-Baylor Journal of Strength and Conditioning Research, 20(3), 492–499. National Strength & Conditioning Association University Doctoral Physical Therapy Program, US Army Medical Department Center and School, Fort Sam Houston, Texas 78234; 3Keller Army Community Hospital, West Point, New York 10996.

Nelson, AG, Kokkonen, J., and Arnall, DA (2005) Acute muscle stretching inhibits muscle strength endurance performance. J Strength Cond Res19: 338–343, 2005.

Power, K., Behm, D., Cahill, F., Carroll, M., Young, W. (2004) An acute bout of static stretching: effects on strength and jumping performance. Med Sci Sports Exerc. 36(8):1389-96.

Popelka, J., Pivovarnicek, P. (2018). Department of Physical Education and Sports, Faculty of Arts, Matej Bel University, Slovak Republic.

Pişirici, P., Ekiz, MB and İlhan, CA (2020). Investigation of the acute effect of myofascial release techniques and dynamic stretch on vertical jump performance in recreationally active individuals. Journal of Physical Education and Sport, 20(3), 1569-1579.
Richman, ED, Tyo, BM, & Nicks, CR (2019). Combined Effects of Self-Myofascial Release and Dynamic Stretching on Range of Motion, Jump, Sprint, and Agility Performance. *Journal of strength and conditioning research, 33* (7), 1795–1803.
Sullivan, KM, Silvey, DB, Button, DC, Behm, DG (2013). Roller-massager application to the hamstrings increases sit-and-reach range of motion within five to ten seconds without performance impairments. Int J Sports Phys Ther. 8(3):228–36.
Simic L., Sarabon N., Markovic G. (2013). Does pre-exercise static stretching inhibit maximal muscular performance? A meta-analytical review. Scand J Med Sci Sports. ;23 (2):131-48.
Van Gelder, Leonard H; Bartz, Shari D. (2011) The Effect of Acute Stretching on Agility Performance. Journal of Strength and Conditioning Research 25(11) :p 3014-3021|

AKUTNI EFEKTI MIOFASCIJALNE MASAŠE ROLEROM, STATIČKOG I DINAMIČKOG RASTEZANJA NA VERTIKALNI SKOK MLADIH ODBOJKAŠICA

Nevena Vukadinović[1], Anastasija Krejović[1], Goran Nešić[1], Nikola Majstorović[1], Kristina Nikolić[1]

[1] Univerzitet u Beogradu, Fakultet sporta i fizičkog vaspitanja, Beograd, Srbija

Uvod

Savremena trenažna praksa u okviru neposredne pripreme za napore u odbojci pokazuje da su dominantno prisutni modeli zagrevanja koji uključuju vežbe za razvoj mobilnosti, u kombinaciji sa dinamičkim segmentom atletskih vežbi trčanja, poskoka i brzih promena pravaca. Modeli zagrevanja koji se koriste u uvodno-pripremnom delu treninga jesu statičko, dinamičko rastezanje i miofascijalna masaža rolerom, metoda koja se primenjuje sve češće u svetu sporta i rekreacije.

Statičko rastezanje se može definisati kao sporo, postepeno i kontrolisano izduživanje mišića, pri čemu se krajnji opseg drži pasivno tokom određenog vremenskog perioda (Van Gelder & Bartz, 2011). Studija koju su sproveli (Power, Behm i sar., 2004) sugeriše da statičko rastezanje mišića kvadricepsa rezultira značajnim povećanjem ROM-a i smanjenjem snage mišića koji je tretiran, odnosno što je vreme rastezanja duže to će krutost mišićno tetivne jedinice biti manja. Krutost ove jedinice odgovorna je za prenos sile (mišić-tetiva-kost) što znači da duže statičko rastezanje može umanjiti sprintersko-skakačku aktivnost (Šarić, Lisica, 2016). Nalazi sugerišu da statičko rastezanje može narušiti proizvodnju sile do 120 minuta, gde su preporuke da aktivnosti koje uključuju ispoljavanje maksimalne snage se izbegavaju najmanje 120 minuta pre izvođenja. Neka istraživanja su pokazala da akutno statičko rastezanje može smanjiti snagu i negativno uticati na performanse mišića tokom skakanja i sprinta (Cramer i sar., 2005; Fletcher, Jones, 2004; Nelson i sar., 2005).

Dinamičko rastezanje je definisano od strane Nacionalne asocijacije za snagu i kondicioniranje (NSCA) kao funkcionalna vežba istezanja koja koristi pokrete specifične za sport da pripremi telo za aktivnost. Stručnjaci iz oblasti snage i kondicije sve više praktikuju i preporučuju korišćenje dinamičkog rastezanja, kao najbolji način da se sportisti pripreme za fizičke zahteve njihovog sporta. Iako postoje mnoge varijacije dinamičkog rastezanja, obično su to vežbe koje se primenjuju u toku kretanja, kao npr. čučnjevi i iskoraci koji se često kombinuju sa trčanjem koji uključuju kretanje napred, bočno i sa promenom smera kretanja (MCMillian I sar., 2006). Istraživači su pokazali da dinamičko rastezanje snižava koncetraciju laktata, poboljšava efikasnost termoregulacije i poboljšava performanse sprinta i vertikalnog skoka (Bartlett, Warren, 2002; Gray i sar., 2002; Knudson i sar., 2001).

Miofascijalno oslobađanje jeste tehnika masaže koja utiče na povećanje sportskih performansi, tako što se redukuju fibrozne adhezije koje se javljaju između slojeva fascije/vezivnog tkiva. Smatra se da su ove fibrozne adhezije izazvane povredama, neravnotežom u mišićima, prekomernim angažovanjem mišićnih vlakana, preopterećenim mišićima, ponavljajućim mikrotraumama i upalom (Behara, Jacobson, 2017). Upotrebom penastog valjka oponašaju se tehnike miofascijalnog oslobađanja, pa ih često koriste terapeuti, sportisti i opšta javnost za

povećanje opsega pokreta (ROM) (Sullivan, Silvey, Button,& Tramp; Behm, 2013). Miofascijalna masaža rolerom je jedna od najpopularnijih metoda samo-miofascijalnog oslobađanja, gde sportista koristi svoju telesnu težinu i dozira pritisak na mišić prilikom upotrebe rolera (Kalichman & Ben, 2017). Studija koju su sproveli (Pişirici, Ekiz, İlhan, 2020; Richman, Tyo, Nicks, Clayton, 2019) pokazuje da je primena miofascijalne masaže rolerom dovela do statistički značajnog povećanja performansi skoka. Hsuan Su i saradnici su pokazali statistički značajno povećanje fleksibilnosti nakon miofascijalne masaže rolerom, u poređenju sa statičkim i dinamičkim rastezanjem. Snaga mišića donjeg dela tela se značajno poboljšala nakon primene rolera i dinamičkog rastezanja, dok nakon statičkog rastezanja nisu primećene nikakve promene. Autori navode da je miofascijalna masaža rolerom efikasnija od statičkog i dinamičkog rastezanja u akutnom povećanju fleksibilnosti i snage mišića i preporučuju njihovu upotrebu kao deo zagrevanja kod zdravih mladih odraslih osoba.

Pregledom literature može se uvideti da oblast koja se bavi različitim uticajem miofascijalne masaže, statičkog i dinamičkog rastezanja na performanse i vertikalni skok u odbojci nije dovoljno istražena, pritom njihova primena nije u potpunosti potkrepljena emiprijskim podacima. U studiji Šarić i Lisica (2016) važe preporuke da statičko rastezanje pre sportske aktivnosti ne bude duže od 30 sekundi, Popleka i Pivovarniček (2018) za dalje istraživačke napore preporučuju da se testiranje obavi u kraćem vremenskom periodu istog dana. Obzirom na to cilj ovog istraživanja jeste utvrđivanje uticaja miofascijalne masaže rolerom, statičkog i dinamičkog rastezanja na vertikalni skok mladih odbojkašica.

Metode

Istraživanje je sprovedeno u sali Fakulteta sporta i fizičkog vaspitanja, uzorak ispitanika činile su 24 mlade odbojkašice uzrasta (13-15 godina) podeljene u četiri grupe po 6 ispitanica, koje su svakog eksperimentalnog dana sprovodile drugu vrstu tretmana i to: dinamičko rastezanje, statičko rastezanje, miofascijalnu masažu i jedna grupa je bila kontrolna (bez tretmana). Zavisna varijabla koja je posmatrana jeste visina vertikalnog skoka, koja je procenjivana uz pomoć Sargent testa. Testiranje je sprovedeno u periodu od dve sedmice, tri puta sedmično, gde su ispitanice u uvodnom delu treninga izvodile trčanje niskog intenziteta u trajanju od 5 minuta, nakon čega je sprovedeno inicijalno testiranje kroz tri skoka sa pauzom od 1 minuta na Sargent testu, zatim 8 minuta eksperimentalnog tretmana, nakon čega je usledilo finalno testiranje visine vertikalnog skoka. Neposredno pre uključivanja u istraživanje ispitanicima su date sve informacije, objašnjenja i odgovori na pitanja koja se tiču istraživanja.

Protokol statičkog rastezanja

Protokol statičkog rastezanja uključivao je aktivno rastezanje 4 mišićne grupe donjeg dela tela Tabela 1. Aktivno rastezanje se vršilo na mišićima: plantarni fleksori, zadnja loža, ekstenzori kuka. Ispitanici su vršili statičko rastezanje kroz 2 serije po 30 sekundi 4 mišićne grupe, gde se svaka noga rastezala pojedinačno. Ukupno trajanje protokola statičkog rastezanja je 480 sekundi.

Tabela 1. Vežbe statičkog rastezanja

Vežbe	Način izvođenja
Rastezanje misića lista	Rukama oslonjenim na zidu u poziciji blago raskoračnog stava, zadnja noga se opruža dok je prednja savijena u zglobu kolena, privlačenjem kolena ka zidu vrši se rastezanje mišića lista. Naizmenično leva i desna noga.
Rastezanje kvadricepsa iz klečećeg položaja	U klečećem položaju ispruži se jedna noga ispred, uhvati se rukom noga povlačeći je nagore dok se ne oseti rastezanje u mišiću. Naizmenično leva i desna noga.
Rastezanje zadnje lože iz ležećeg položaja	Iz ležećeg položaja jedna noga je podignuta, dok je druga na podu. Rukama povlačiti nogu prema sebi.
Rastezanje mišića gluteusa	Iz ležećeg položaja, saviti jednu nogu, a zatim prekrstiti drugu nogu preko, tako da potkolenica druge noge leži na prvoj. Iz tog položaja uhvatiti levu potkolenicu i povlačiti ka sebi. Naizmenično leva i desna noga.

Protokol dinamičkog rastezanja

Protokol dinamičkog rastezanja uključivao je rastezanje istih mišićnih grupa kao u protokolu statičkog rastezanja (Tabela 1). Vežbe su se izvodile na distanci od 18m, kako bi se simulirala dužina odbojkaškog terena. Ispitanici su ivzodili dinamičko rastezanje kroz tri serije sa pauzom od 20 s između serija, kako bi se obezbedilo identično vreme kao u prvom protokolu.

Tabela 2. Vežbe dinamičkog rastezanja

Vežbe	Način izvođenja
Hodanje na prstima	U toku kretanja hodanje na prstima.
Rastezanje kvadricepsa u položaju vage	U položaju oslonca na jednoj nozi, uhvatiti rukom nogu za potkolenicu i izvesti vagu u tom položaju.
Prednoženje u kretanju	Iz poskoka prednožiti jednom nogom u kretanju.
Odnoženje u kretanju	Iz poskoka odnožiti jednom nogom u kretanju.

Protokol miofascijalne masaže

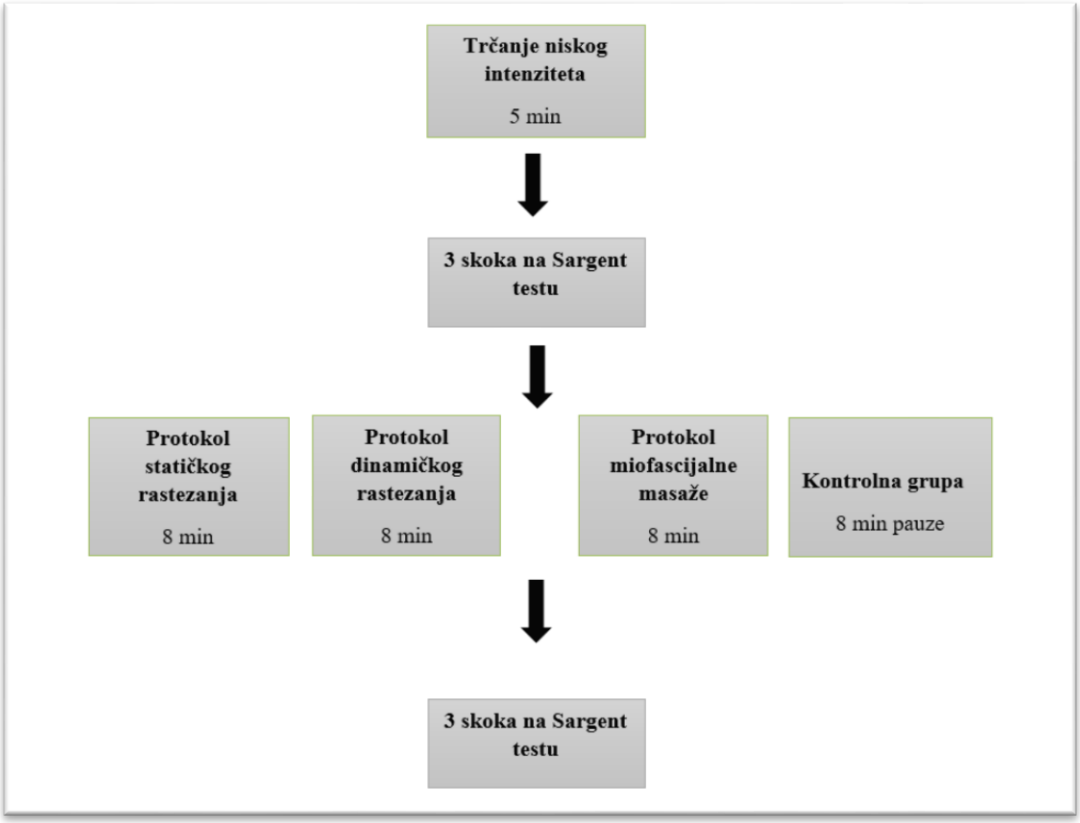
Protokol miofascijalne masaže uključivao je masažu rolerom istih mišićnih grupa kao i u prethodna dva protokola. Ispitanici su koristili masažu rolerom 2 serije po 30 sekundi na svaku mišićnu regiju.

Tabela 3. Vežbe miofascijalne masaže rolerom

Vežbe	Način izvođenja
Primena miofascijalne masaže u predelu mišića lista	Iz ležećeg položaja na leđima osloniti potkolenicu na roler, vršiti težinom tela pritisak na roler i izvoditi pokrete telom napred – nazad.
Primena miofascijalne masaže u predelu mišića zadnje lože	Iz ležećeg položaja na leđima osloniti natkolenicu na roler, vršiti težinom tela pritisak na roler i izvoditi pokrete telom napred – nazad.
Primena miofascijalne masaže u predelu mišića prednje lože	Iz ležećeg položaja na grudima osloniti natkolenicu na roler, vršiti težinom tela pritisak na roler i izvoditi pokrete telom napred – nazad.
Primena miofascijalne masaže u predelu glutealne regije	Iz sedećeg položaja postaviti roler ispod mišića gluteusa,jedna noga se postavlja na potkolenicu druge noge, vršiti težinom tela pritisak na roler i izvoditi pokrete telom napred – nazad.

Ispitanici iz kontrolne grupe su zajedno sa ostalim grupama pre početka protokola izvodila trčanje niskog intenziteta u trajanju od 5 minuta, nakon čega je sledilo 8 minuta odmora.

- Nacrt istraživanja:



Rezultati

Osnovna deskriptivna statistika morfoloških varijabli koje su izmerene pre početka testiranja prikazana je u Tabeli 3., gde su prikazane varijable telesna visina sa prosečnom vrednošću (165.5±7.2), maksimalnim vrednostima (178cm) i minimalnim vrednostima (155cm), telesna masa sa prosečnom vrednošću (62.2.5±4.7), maksimalnim vrednostima (70.2kg) i minimalnim vrednostima (53.4kg), bodi mas indeks sa prosečnom vrednošću (18.8±1.1), maksimalnim vrednostima (21.7) i minimalnim vrednostima (17.3) i dohvatna visina sa prosečnom vrednošću (215.6.5±8.5), maksimalnim vrednostima (233 cm) i minimalnim vrednostima (202 cm).

Tabela 3. Osnovna deskriptivna statistika morfoloških varijabli

VARIJABLE	AS	SD	MAX	MIN
TV	165.5	7.2	178	155
TM	62.2	4.7	70.2	53.4
BMI	18.8	1.1	21.7	17.3
DV	215.6	8.5	233	202

Legenda: TM – telesna masa; TV – telesna visina; BMI – bodi mas indeks; DV – dohvatna visina; AS – aritmetička sredina ; SD – standardna devijacija; Min. – najmanja vrednost rezultata; Maks. – najveća vrednost rezultata.

Prosečne vrednosti visine vertikalnog skoka u pretestu i posttestu su prikazane u Tabeli 4., gde je vrednost visine skoka u pretestu nakon dinamičkog protokola bila (34.92±4.91) i posttestu (36.03±7.37), nakon statičkog rastezanja vrednosti u pretestu (33.83±5.96) i u posttestu (32.36±6.29), nakon miofascijalne masaže rolerom vrednosti u pretestu (33.7±4.86) i u posstestu (33.46±4.56) i u kontrolnoj grupi u pretestu (33.14±4.28) i posttestu (32.33±4.6).

Tabela 4. Osnovna deskriptivna statistika vrednosti visine vertikalnog skoka u pretestu i posttestu

Grupa	DINAMIČKO RASTEZANJE		STATIČKO RASTEZANJE		MIOFASCIJALNA MASAŽA		KONTROLNA GRUPA	
VREME	Pretest	Posttest	Pretest	Posttest	Pretest	Posttest	Pretest	Posttest
	37	37	36	36	37	37	36	36
MEAN	34.92	36.03	33.83	32.36	33.7	33.46	33.14	32.33
STD	4.91	7.37	5.96	6.29	4.86	4.56	4.28	4.6

U Tabeli 5. su prikazane razlike vrednosti visine skoka nakon primene protokola, korišćenjem Faktorske analize varijanse (between-within). Primenom adekvatne statističke procedure rezultati pokazuju da ne postoje značajne razlike nakon primene protokola dinamičkog rastezanja (p=0.102), miofascijalne masaže (p=0.718) i kontrolne grupe (p=0.239), dok postoje značajne razlike nakon primene protokola statičkog rastezanja (p=0.033). Razlika u srednjim vrednostima (Mean difference) pre i nakon tretmana dinamičkog rastezanja je (1.108 cm), statičkog rastezanja (-1.472 cm), miofascijalne masaže rolerom (-0.243 cm) i u kontrolnoj grupi (-0.806 cm).

Tabela 5. Razlike u vrednostima visine vertilanog skoka izmerene pre i nakon tretmana

Grupa	Mean Difference	Sig.
Dinamičko rastezanje	1.108	0.102
Statičko rastezanje	-1.472*	0.033
Miofascijalna masaža	-0.243	0.718
Kontrolna grupa	-0.806	0.239

Figura 1 pokazuje prosečne vrednosti vertikalnog skoka pre i nakon tretmana.

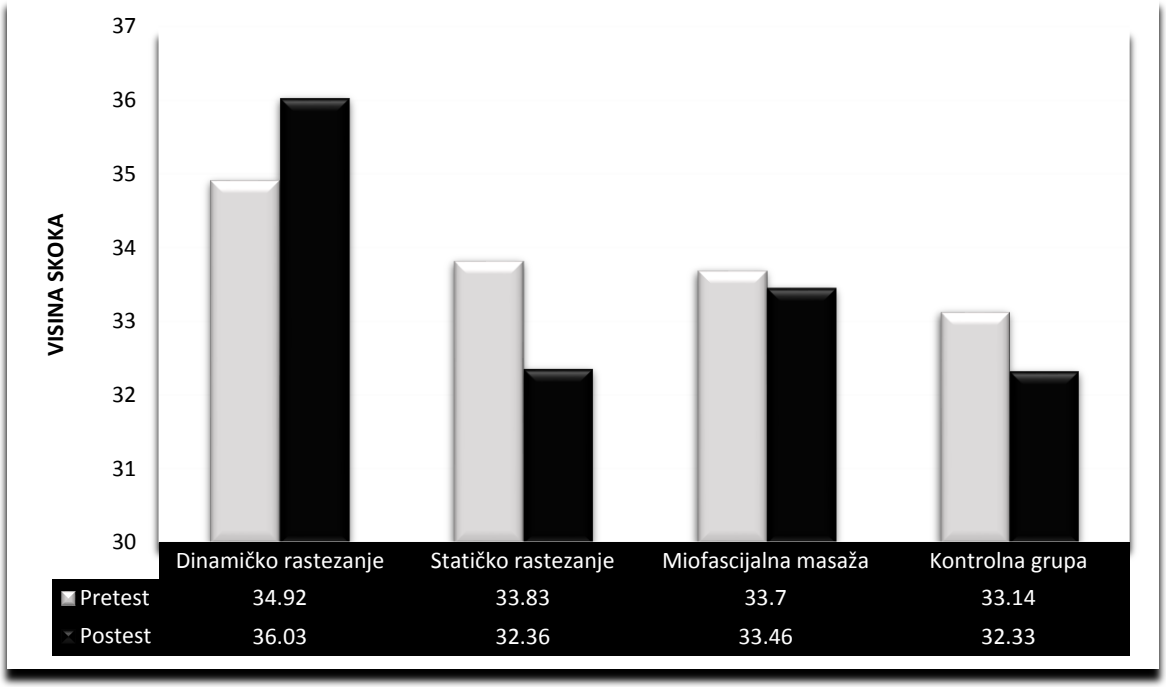


Figura 1. Prosečne vrednosti visine vertikalnog skoka u pretestu i posttestu

Diskusija

Za utvrđivanje razlike efekata protokola (miofascijalne masaže rolerom, dinamičkog i statičkog rastezanja) na vertikalni skok mladih odbojkašica, korišćeni su rezultati dobijeni testiranjem 24 ispitanika 13-15 godina. Na osnovu Tabele 3. ispitanici su imali normalnu raspodelu telesne visine i mase. Prosečna vrednost i najveća vrednost rezultata bodi mas indeksa (BMI) se kretala u normalnim granicama, dok najmanja vrednost rezultata je iznosila nešto niže vrednosti, odnosno vrednosti ispod proseka.

U Tabeli 5. su prikazane razlike između grupa, gde statičko rastezanje pokazuje statistički značajne razlike (p=0.03). Što ukazuje na to da utiče negativno na vrednosti visine vertikalnog skoka, na osnovu toga se potvrđuje jedna od hipoteza koje su postavljene na samom početku istraživanja u skladu sa ciljem. Pored dobijenih rezultata utvrđivanjem razlika između grupa i da li su te razlike statistički značajne, prikazana je i apsolutna razlika srednjih vrednosti između grupa kojom se objašnjava količina za koju je eksperminetalna intervencija u proseku promenila ishod u

poređenju sa kontrolnom grupom. Rezultati pokazuju da se desila promena nakon primene statičkog rastezanja, gde je vrednost visine vertikalnog skoka opala za (1.472 cm). Evidentno je da postoji izražen trend kod dinamičkog rastezanja (nije statistički značajno, ali je razlika u srednjim vrednostima primetna + 1.1cm poboljšanje), dok u kontrolnoj grupi vertkalni skok je opao za (0.806 cm) i u miofascijalnoj grupi opao za (0.243 cm), što ukazuje na zanemarljivo neznatno lošije rezultate posle tretmana. Pojedinci prilikom testiranja su pokazali pozitivne promene nakon protkola dinamičkog rastezanja, što ukazuju i prikazane srednje razlike u Tabeli 5., pretpostavke su da dobijeni rezultati nisu statistički značajni zbog malog uzorka ispitanika. Eksperiment je sproveden u kontrolisanim uslovima, gde je svaki protokol detaljno objašnjen pre primene i kontrolisan u toku same primene od strane stručnog lica, međutim nije bila moguća kontrola samog pritiska na mišić tokom protokola miofascijalne masaže, s obzirom na to da su ispitanice uzrasta (13-15) godina, neiskustvo i neadekvatna primena rolera može biti razlog nepostojanja značajnih razlika između inicjalnog i finalog merenja. Na Figuri 1. su prikazane srednje vrednosti u pretestu i posttestu za svaki protkol pojedinačno. Primetno je da u srednjim vrednostima nakon dinamičkog rastezanja se desila promena u smeru porastu vertikalnog skoka nakon tretmana, dok nakon statičkog rastezanja, miofascijalne masaže i kontrolne grupe vrednosti visine vertikalnog skoka su opale.

Vertikalni skok, kao rezultat eksplozivne snage donjih ekstremiteta, važna je motorička sposobnost u odbojkaškoj igri, prožima se kroz različite tehničko-taktičke elemente kao što su smeč, blok, servis i dizanje lopte. Na osnovu rezultata ove studije statičko rastezanje ne treba koristiti kao vid zagrevanja sportista u uvodno-pripremnom delu treninga, jer smanjuje visinu vertikalnog skoka koji je najzastupljeniji, gotovo (55%) (Čeliković, 2021) u odnosu na prisustvo ostalih kretnih struktura u toku utakmice. Preporuke su da se dinamičko rastezanje uvrsti kao deo zagrevanja pre utakmice ili treninga, kako na osnovu rezultata apsolutnih vrednosti, tako i na osnovu relevantne literature. Miofascijalna masaža rolerom u ovom eksperimentu nije pokazala značajne promene visine vertikalnog skoka, s tim treba detaljnije ispitati uticaj iste, obzirom da savremena literatura pokazuje značajne benefite koje se javljaju nakon njene primene, kao i sve učestalija primena u praksi sportsita i rekreativaca.

Istraživanje ovakvog tipa zahteva uzrokovanje većeg broja ispitanika, kako bi se dobili značajniji rezultati i mogućnost da se ovi zaključci sa sigurnošću korsite u sportskoj praksi. S obzirom da je eksperiment sprovođen nad ispitanicima ženskog pola uzrasta (13-15) godina, ovo istraživanje može biti polazna osnova za neko buduće istraživanje (urast, rang takmičenja, u odnosu na igračke pozicije). Preporuke za dalje istraživačke napore jesu da se pored većeg broja ispitanika, produži vreme tretmana (sa 30s na 60s), poveća broj vežbi u svakom protokolu i omogućavanje kontrole pritiska za vreme miofascijalne masaže rolerom.

Zaključak

Nalazi ove studije pokazuju da nema značajne razlike između dinamičkog rastezanja i miofascijalne masaže, dakle ne utiču na povećanje visine vertikalnog skoka. Međutim primećena je statistički značajna razlika nakon statičkog rastezanja ($p=0.033$), gde su vrednosti visine vertikalnog skoka opale za (1.5 cm), što ukazuje da statičko rastezanje utiče negativno na vertikalni skok mladih odbojkašica. Pretpostavka je da je broj ispitanika bio isuviše mali da bi se uočene promene pokazale statistički značajnim. Za dalje istraživačke napore, preporuke su da se testiranje

i sprovođenje tretmana sprovodi na više ispitanika, duži vremenski period, kao i uz prisustvo većeg broja vežbi u protokolima, što bi doprinelo i značajnijem efektu posmatranih tretmana.

Literatura

Bartlett, MJ, Warren, PJ (2002). Effect of warming up on knee proprioception before sporting activity. No. J. Sports Med. 36:132–134.

Bandy, WD, Irion JM, Briggler M. (1997). The effect of time and frequency of static stretching on flexibility of the hamstring muscles. Phys Ther. ;77 (10):1090-6. doi : 10.1093/ptj/77.10.1090. PMID: 9327823.

Behara, B., & Jacobson, BH (2017). Acute Effects of Deep Tissue Foam Rolling and Dynamic Stretching on Muscular Strength, Power, and Flexibility in Division I Linemen. *Journal of strength and conditioning research*, *31* (4), 888–892.

Cramer, JT, Housh, TJ, Weir, JP, Johnson, GO, Coburn, JW, Beck, TW (2005). The acute effects of static stretching on peak torque , mean power output, electromyography, and mechanomyography. Eur J Appl Physiol 93: 530–539.

Cui, J., Blaha, C., Moradkhan, R., Gray, KS and Sinoway, LI (2006), Muscle sympathetic nerve activity responses to dynamic passive muscle stretch in humans. The Journal of Physiology, 576: 625-634.

Čeliković, A. (2021). Proposal of a fitness program in volleyball for younger female cadets (Doctoral dissertation, University of Zagreb. Faculty of Kinesiology).

Fletcher, IM, Jones, B. (2004). The effect of different warm-up stretch protocols on 20-meter sprint performance in trained rugby union players. J Strength Cond Res 18:885–888.

Gray, SC, Devito, G. , Nimmo , MA, (2002). Effect of active warm up on metabolism prior to and during intense active exercise. Med. Sci. Sports Exerc. 34:2091–2096. in 2002

Hsuan, Su., Nai-Jen Chang, Wen-Lan Wu, Lan-Yuen Guo, and I-Hua Chu. (2016). Acute Effects of Foam Rolling, Static Stretching, and Dynamic Stretching During Warm-ups on Muscular Flexibility and Strength in Young Adults. Journal of Sport Rehabilitation

Kalichman, L., & Ben David, C. (2017). Effect of self-myofascial release on myofascial pain, muscle flexibility, and strength: A narrative review. *Journal of bodywork and movement therapies*, *21* (2), 446–451.

Knudson, D., Bennett, K., Corn, R. , Leick D., Smith, C. (2001). Acute effects of stretching are not evident in the kinematics of the vertical jump. J. Strength Cond. Res. 15:98–101.

Lisica, D., Šarić, J. (2016). Acute and chronic effects of static and dynamic stretching on sprinting and jumping performance. Faculty of Kinesiology, University of Zagreb.

McMillian, DJ, Moore, JH, Hatler, BS, Taylor, DC (2006). Dynamic vs. static-stretching warm up: The effect on power and agility performance. Army MEDDAC, Heidelberg, Germany; 2U.S. Army-Baylor Journal of Strength and Conditioning Research, 20(3), 492–499. National Strength & Conditioning Association University Doctoral Physical Therapy Program, US Army Medical Department Center and School, Fort Sam Houston, Texas 78234; 3Keller Army Community Hospital, West Point, New York 10996.

Nelson, AG, Kokkonen, J., and Arnall, DA (2005) Acute muscle stretching inhibits muscle strength endurance performance. J Strength Cond Res19: 338–343, 2005.

Power, K., Behm, D., Cahill, F., Carroll, M., Young, W. (2004) An acute bout of static stretching: effects on strength and jumping performance. Med Sci Sports Exerc. 36(8):1389-96.

Popelka, J., Pivovarnicek, P. (2018). Department of Physical Education and Sports, Faculty of Arts, Matej Bel University, Slovak Republic.

Pişirici, P., Ekiz, MB and İlhan, CA (2020). Investigation of the acute effect of myofascial release techniques and dynamic stretch on vertical jump performance in recreationally active individuals. Journal of Physical Education and Sport, 20(3), 1569-1579.

Richman, ED, Tyo, BM, & Nicks, CR (2019). Combined Effects of Self-Myofascial Release and Dynamic Stretching on Range of Motion, Jump, Sprint, and Agility Performance. *Journal of strength and conditioning research, 33* (7), 1795–1803.

Sullivan, KM, Silvey, DB, Button, DC, Behm, DG (2013). Roller-massager application to the hamstrings increases sit-and-reach range of motion within five to ten seconds without performance impairments. Int J Sports Phys Ther. 8(3):228–36.

Simic L., Sarabon N., Markovic G. (2013). Does pre-exercise static stretching inhibit maximal muscular performance? A meta-analytical review. Scand J Med Sci Sports. ;23 (2):131-48.

Van Gelder, Leonard H; Bartz, Shari D. (2011) The Effect of Acute Stretching on Agility Performance. Journal of Strength and Conditioning Research 25(11) :p 3014-3021

REHABILITATION AFTER ANTERIOR CRUCIATE LIGAMENT INJURY OF THE KNEE: ETIOLOGY, LOADING CRITERIA AND RETURN TO SPORT

Igor Zlatović[1], Igor Ranisavljev[1], Branka Marković[1], Marko Ćosić[1]
[1] University of Belgrade, Faculty of Sport and Physical Education, Belgrade, Serbia

Introduction

The anterior cruciate ligament (ACL) is an intra-articular structure essential for normal knee function (Hernández, 2010). Sports activities involving complex movements such as zigzagging and pivoting account for approximately 70% of acute ACL injuries (Hernández, 2006). Early diagnosis, comprehensive rehabilitation programs and prevention protocols are critical in managing this condition (Hernández, 2010). Today, sports rehabilitation specialists decide on the type of exercises that need to be prescribed, when to start them in the rehabilitation process, based on their experience and interpretation of the condition. Different interpretations lead to more questions, which in turn lead to more original ones, ie. "original" articles. The results of new research develop and modify existing protocols. ACL rehabilitation protocols may differ in approaches, but what remains the same is the outcome that each sports medicine specialist is trying to achieve. General goals before returning to sports activities are control of pain and swelling, full range of motion, elimination of muscle atrophy, normal gait, return to work for non-athletes, return of physical abilities to pre-injury level and even above, recovery of proprioception, return self-confidence and overcoming kinesiophobia. When all these goals are achieved, the athlete can return to sports activities (Saka, 2014). Rehabilitation professionals should be discouraged from using strict timelines and protocols when treating patients after ACL reconstruction. Before returning to sport, specific objective quantitative and qualitative criteria must be met. Time since surgery should not be the only consideration. Rehabilitation specialist should consider tissue healing, any accompanying procedures, patellofemoral joint strength and patient's goals in developing a structured rehabilitation program. As the client progresses through the rehabilitation program, the rehabilitation specialist should continuously and appropriately challenge the patient based on his goals, strength level, degree of healing and task performance (Cavanaugh, 2017).

Anatomy and biomechanics

ACL is a collagen structure that is approximately 38 mm long and 10 mm wide. The ligament has a broad base of initial attachment, located on the anterior intercondylar region of the tibia with an insertion on the posteromedial aspect of the lateral femoral condyle. It is divided into 2 main bundles, anteromedial (rigid in flexion) and posterolateral (rigid in extension) (DeFrate, 2004). However, it functions as a continuum of individually inserted fibers with a variable shaft and constant length, tensioning the different components at different angles of the range of motion, making it an isometric knee stabilizer. Forces on ACL are greatest at the last 30° of extension and under several passive conditions such as anterior translation of the tibia, internal rotation, and valgus stress (DeFrate, 2004). Thus, the ACL serves as the primary static stabilizer of the knee, resisting anterior translation of the tibia, controlling and limiting internal rotation of the tibia. The main supply of oxygen and nutrients comes from the middle genicular artery, which branches from

the popliteal artery (Hernández, 2010; Brown, 2004). It is innervated by the posterior articular nerve, a direct branch of the tibial nerve (Brown, 2004; Kennedy, 1976) that supplies mechanoreceptors and nociceptors located in the subsynovial layer near the insertion of the ACL (Schultz, 1984; Reider, 2003). Grigg (Grigg, 1994) showed that initiation of the reflex arc by mechanoreceptors and muscle spindles occurs faster than by nociceptors. This finding suggests a possible protective role of the ACL in maintaining joint stability by reflex muscle activation (Lephart, 1997).

Neuromuscular imbalances

Four neuromuscular imbalances are more often observed in sports in women than in men. The first observed neuromuscular imbalance is the tendency towards ligament dominance in women. Women show a tendency to allow stress on ligaments, which precedes muscle activation when absorbing ground reaction forces. Typically during a single-leg landing, turn, or deceleration, as often occurs during an ACL injury, the athlete allows the ground reaction force to control the direction of motion of the lower extremity joints, particularly the knee joint. Lack of dynamic muscle control of the joint leads to increased valgus position, increased force and high torque acting on the knee and ACL (Hewett, 2010). The second imbalance is called quadriceps muscle dominance. With quadriceps dominance, female athletes preferentially activate the knee extensors over the flexors during movement to stabilize the knee joint, which reflects and emphasizes the strength and coordination imbalance between these muscles (Hewett, 2010). The third imbalance is limb dominance. Limb dominance is an imbalance in the muscle strength and coordination of one leg relative to the other, with one limb often showing greater strength and coordination. Extremity dominance can place both the weaker and stronger limb at increased risk of ACL injury. The weaker limb is threatened by its inability to redistribute forces and moments, while the stronger limb may be exposed to large forces and torques due to increased dependence, especially in sports situations when a large muscle force is generated (Hewett, 2010). A final imbalance often seen in female athletes is trunk dominance. Trunk dominance is characterized by an increased movement of the body's center of gravity, due to the absence of neuromuscular control, during one-legged landing, turning or deceleration (Zazulak, 2007; Hewett, 2009). These potentially correctable neuromuscular imbalances may reduce dynamic knee stability in women and lead to a gender bias when discussing the risk of ACL injury (Zazulak, 2007; Yoo, 2010; Hewett, 1996; Huston, 1996).

Mechanisms of injury

The goal of understanding the mechanism of ACL injury is to implement preventive strategies. The number of variables that an athlete must respond to in team sports may explain the higher incidence of injuries in sports such as football, American football, and basketball (Boden, 2000). ACL rupture is most often the result of a rapid deceleration of the lower extremities associated with a strong quadriceps contraction, change in direction, or a landing with mild knee hyperextension. The non-contact mechanism of injury is the most common, occurring in up to 70% of cases (Hernández, 2006; Brown, 2004; Arendt, 1999; Uhorchak, 2003), especially in women. There are several well-documented risk factors for non-contact ACL injury (Chappell, 2007; Hewett, 2013; Noyes, 2014; Powers, 2010). Specific movements such as deceleration (35%), landing (31%), acceleration (13%) and falling backwards (4%) have been identified as mechanisms of injury in

athletes (Boden, 2000). Many of these risk factors are easily identified through functional and clinical evaluation and can be corrected through education and a dedicated exercise program. Contact (traumatic) mechanisms of injury, usually associated with valgus stress, occur less frequently, with a reported frequency of 28% in some studies (Boden, 2000). However, traumatic ACL injury can often occur with meniscal and medial collateral ligament injuries (Hernández, 2006). Possible factors associated with sustaining a second ACL injury are incomplete or inadequate rehabilitation; premature return to sports (especially when the patient is not physically and mentally ready), as well as engaging in physical activities that are too advanced for the patient's level of recovery (Wilk, 2015).

Principles and protocols of rehabilitation

The general goals of rehabilitation after an ACL injury are to reduce the risk of damage to the secondary structures of the knee, restore full range of motion, restore lower extremity and core muscle strength, improve neuromuscular control, and return to pre-injury functional levels. These goals are achieved through a progressive rehabilitation program divided into a preoperative, acute, recovery and a functional phase. The program can be applied to the treatment of patients who do not undergo surgery or those who are treated with surgical reconstruction (Amy, 2008). After ACL reconstruction, under the direction of an orthopedic surgeon, a rehabilitation specialist is responsible for returning the patient to pre-injury functional level. Postoperative rehabilitation programs have changed dramatically over the past few decades. Strict protocols based on time since surgery have been replaced by criteria-based guidelines. These guidelines follow a progression in which selective criteria are met prior to advancement in the program (Cavanaugh, 2017). Functional progression was defined by Kegerreis as an ordered sequence of activities that enables the acquisition or re-acquisition of skills required for the safe and efficient performance of athletic endeavors (Kegerreis, 1983). In other words, the patient should master a simple activity before moving on to a more demanding one. Programs are individualized, where some patients will be ready to progress more quickly than others. Biological factors such as revascularization and maturation of the graft, as well as fixation techniques, are also considered to ensure safe progression through the rehabilitation program.

It is important to start rehabilitation preoperatively whenever possible. It is necessary to reduce swelling, inflammation and pain, restore normal range of motion, normalize gait and prevent muscle atrophy before surgery. The goal is to achieve tissue homeostasis (Wilk, 2012). Full range of motion is restored preoperatively to reduce the risk of postoperative arthrofibrosis (Shelbourne, 1991). Education and critical aspects of preoperative rehabilitation inform and prepare the patient for surgery and postoperative rehabilitation. For a successful outcome, the preoperative phase may require several weeks (≈3) (Shelbourne, 1991; Meighan, 2003). Patients who undergo a preoperative rehabilitation program progress more easily through a postoperative rehabilitation program, especially in the earlier stages (Wilk, 2012). In the *acute phase* of rehabilitation, the goals are to reduce pain and swelling, achieve full extension in the joint, mobilize the patella to reduce post-surgical scarring, and early weight-bearing. An important precaution at this stage is to avoid heavy loads on the knee in the last 30° of extension to reduce stress on the ACL, secondary structures of the knee or the ligamentous graft (Hernández, 2010). In the recovery phase, the goals are to achieve full range of motion, gain control of the quadriceps muscle, work on

the hip muscles as well as other core muscles, improve proprioception and balance, and finally, integrate functional activities in the 3 planes of motion. Precautions include avoiding rotational stress on the knee prior to initial incorporation of the graft into the bone, which occurs at approximately week 4. for bone-patellar tendon-bone grafts and between weeks 8.-12. for hamstring allografts; returning to sports before the graft matures and neuromuscular control of the lower extremities is achieved. Running is usually allowed about 3-4 months after surgery, and sports activities begin 4-6 months after reconstruction. Exercising in water can be an integral component of this phase of rehabilitation due to the beneficial effect of hydrostatic pressure on the joints, reduced load on the joints due to buoyancy and resistance to water, which enables the transition to functional activities (Becker, 2009). In the functional phase of rehabilitation, the goals are to strengthen the complete kinetic chain, work on strength and return to sports. At this point, a re-injury prevention program is being introduced that combines strength, flexibility and neuromuscular training with sport-specific techniques. Functional bracing after ACL reconstruction is not routinely performed. Patients who choose nonoperative treatment, who progress slowly in a rehabilitation program, feel unstable upon returning to a specific sporting activity, or express a desire for additional protection when returning to competition should be offered the option of a functional brace. These orthoses provide a subjective feeling of protection, but do not provide significant rotational control of the knee when exposed to high forces and speeds during sports activities (Chew, 2007).

Range of motion

After ACL reconstruction, achieving full range of motion in the knee should be achieved as soon as possible. Loss of extension results in abnormal arthrokinematics of the tibiofemoral and patellofemoral joints. This in turn leads to abnormal articular cartilage contact pressure and quadriceps inhibition (Harner, 1992; Shelbourne, 2009; Benum 1982). The most important reported reason for low scores on patient self-report tests is the absence of normal knee extension and flexion (Shelbourne, 2009). Achieving full springing should ideally be achieved before surgery. Treatment strategies used to achieve full extension include prolonged static-passive stretches. Superior patellofemoral joint mobilizations are used to promote knee extension (Fulkerson, 1990). Sleeping with the joint brace locked while the knee is in extension is used to encourage extension and discourage the formation of a flexion contracture during the night. Full extension is one of several important criteria that must be met for a patient to safely dispose of a crutch after surgery. Exercises to facilitate flexion begin immediately after reconstruction. Achieving 120° flexion should be achieved 4 weeks after surgery and full symmetrical flexion is achieved by 12 weeks. Strategies used to further progress flexion range of motion include heel sliding, active-assisted exercise and bicycle ergometer riding (Schwartz, 1991). Mobilizations of the patellofemoral joint inferiorly promote an increase in knee flexion(Fulkerson, 1990).

Weight-bearing

After ACL reconstruction with a bone-patellar ligament-bone graft, self-weight bearing is first partial (50 %) using crutches and then transferred without crutches to the threshold of tolerance. Independent movement in water (pool or underwater treadmill) can be used to gradually increase the load and develop a normal gait pattern. Walking in chest-deep water results in a 60-75 % weight reduction, while walking in waist-high water contributes to a 40-50 % weight reduction (Bates, 1996; Harrison, 1992).

In general practice, postoperative prostheses are not used in many patients. They are used only in the first 2 weeks in patients who have difficulty regaining confidence or are temperamentally conservative and anxious (Saka, 2014). The postoperative prosthesis is initially locked at 0° for independent movement and protection of the operated joint. The prosthesis is discontinued when quadriceps control is demonstrated by the patient's ability to perform straight leg raise, without lag or complaints of pain. Crutches are then discontinued, after successful demonstration of normal non-analgic gait (Tyler, 1998).

Swelling control and muscle strengthening

Reestablishing quadriceps control is an early goal of postoperative rehabilitation. Controlling postoperative effusion helps discourage quadriceps inhibition. Spencer et al. have identified that mechanoreceptors in the joint capsule respond to changes in tension and in turn inhibit the motor neurons supplying the quadriceps muscle fibers (Spencer, 1984). Therapeutic interventions used include the use of commercial apparatus that provides simultaneous cooling and compression and quadriceps activation exercises. If the patient has difficulty inducing a contraction, an electrical muscle stimulator can be used in conjunction with an active quadriceps contraction to produce a better muscle contraction. A number of studies (Delitto, 1988; Wigerstad-Lossing, 1988; Snyder-Mackler, 1991; Snyder-Mackler, 1995; Hasegawa, 2011) have shown an earlier return of quadriceps strength after reconstruction using electrical stimulation, while others have not (Sisk, 1987; Wright, 2008).

Once the criteria of normal muscle activation and normal non-analgic gait are met, closed kinetic chain (CKC) exercises within a pain-free range of motion are introduced, as these activities have been shown to reduce stress on the ACL (Bynum, 1995; Wilk, 1996; Ohkoshi, 1991; Henning, 1985; Lutz, 1993; Yack, 1993). Strengthening the quadriceps is one of the main postulates of rehabilitation programs after injury and reconstruction. Quadriceps weakness has been shown to persist up to 2 years after surgery and to correlate with knee function during activities such as walking (Risberg, 1999; Lewek, 2002). Limited evidence now shows that open kinetic chain exercises (OKC) within the 90°–0° range of motion will not compromise graft laxity (Mikkelsen, 2000; Hooper, 2001; Morrissey, 2002). With a 0°–130° range of motion demonstration, OKC exercises begin with isometric quadriceps contractions at various joint angles ranging from 90° to 40°. Isometric exercises progress to isotonic exercises using progressive load dosing. After 3 months postoperatively, isotonic exercises are allowed in the full range of motion and further progress is achieved by introducing isokinetic exercises that use moderately high speeds. During this progression, the rehabilitation specialist should carefully monitor the patellofemoral joint for possible crepitations and complaints of pain (Cavanaugh, 2017). Two separate studies reported that coordinated coactivation of the hamstrings and quadriceps muscles may play a role in reducing the risk of primary injuries by reducing ligamentous stress (Griffin, 2000) and promoting normal landing mechanics (Ford, 2011). In a 2012 cross-sectional study, Begalle et al. reported that the most balanced coactivation ratios of the quadriceps and hamstring muscles were identified in the unilateral deadlift, lateral hop and mini-band side walk exercises, which can be safely used in post-injury rehabilitation programs (Begalle, 2012).

Table 1. Maximal ACL strain while performing various open and closed kinetic chain exercises (Heijne, 2004; Beynnon, 1998).

Rehabilitation exercises	**Peak stress at a certain angle**
Isometric knee extension from a sitting position (30 Nm)	4.4 % at 15°
Seated isotonic knee extension (45 Nm - 4.5 kg)	3.8 % at 10°
Lachman's test (150 N - 15 kg)	3.7 % at 30°
Squat with or without a load of 136 N - 13.6 kg	3.6 % - 4.0 % at 10°
Isotonic extension, without additional external resistance	2.8 % at 10°
Single leg box squat (tested at 30°, 50° and 70° flexion)	2.8 % at 30°
Step-up/down (at 30°, 50° and 70° flexion)	2.5 % - 2.7 % at 30°
Leg press with external load (40% of body weight)	2.1 % at 20°
Forward lunge (tested at 30°, 50° and 70° flexion)	1.9 % at 30°
Stationary bike	1.7 %

However, it should be noted that variations in squatting and lunging techniques can affect ACL strain (Beynnon, 1998; Escamilla, 2009; Escamilla, 2010; Farrokhi, 2008). For example, squatting and lunging with trunk tilt forward recruits the hamstring muscles, which helps unload the ACL by reducing anterior translation of the tibia to a greater extent than squatting and lunging with vertical trunk (Ohkoshi, 1991; Escamilla, 2010; Farrokhi, 2008). Also, the gluteal musculature has greater activation, which can help control the knee. Additionally, CKC exercises are used to train the neuromuscular control system. Specific neuromuscular control exercises designed to dynamically control valgus and varus moments in the knee include *front step-down, lateral step-down, as well as single-leg balance exercises* (Wilk, 2012).

Strength training alone does not reduce ACL injuries (Lehnhard, 1996), however when combined with plyometric training there is a significant reduction in injuries, particularly in female athletes (Hewett, 1999).

Neuromuscular training and proprioception

Although proprioception has been found to improve after ACL reconstruction, it does not reach pre-injury levels (Lephart, 1997). After reconstruction, afferent information is altered, leading to disruption of the neural pathway connecting the balance center and the base of support (Corrigan, 1992). This finding led to the theory that ACL reconstruction re-establishes static stability, but that dynamic stability is influenced by other elements such as knee proprioception, muscle strength, recruitment patterns, as well as fatigue (Ireland, 2002; Dugan, 2005; Wilk, 2003; Johansson, 1990). For these reasons, neuromuscular training and proprioception exercises are crucial in ACL injury rehabilitation. Neuromuscular training (NMT) programs have been shown to be superior to strength training programs alone in global knee function (Risberg, 2007).

Progression in rehabilitation to NMT occurs when the patient has no pain and swelling, when he achieves full range of motion and sufficient muscle strength of the lower extremities to participate in more dynamic weight-bearing exercises. During this phase, the patient continues to focus on increasing lower extremity and core muscle strength, but can now use tools such as more advanced variants of balance exercises, proprioception and cardiovascular conditioning (Paterno, 2017).

Progression to sport-specific training

Before progressing to the sport-specific phase of rehabilitation, the patient must demonstrate successful completion of the neuromuscular training phase, with no episodes of knee "giving way". In addition, the patient must have sufficient quadriceps and hamstring strength, as demonstrated by isokinetic strength symmetry of > 90% compared to the contralateral limb. Once these factors are achieved, the patient is ready to progress to the final phase of rehabilitation (Paterno, 2017). The final principle of ACL rehabilitation involves restoring function through training directed at specific aspects of the sport in which the athlete competes. Exercises such as cap/cone ranges, rope lunges, plyometrics and progressions in running and agility techniques can be modified for specific functional movement patterns associated with the patient's chosen sport.

Return to sport criteria after ACL injury and reconstruction

Time to return to sports after ACL injury, reconstruction, and rehabilitation is based on patient assessment and functional testing. Subjective rating scales, knee laxity testing, isokinetic testing, jump functionality testing, balance testing, and qualitative movement assessment are used to provide evidence in the decision-making process. Acceptable scores on these assessments are required for an athlete to safely return to sport (Cavanaugh, 2017). In addition, a complete clinical assessment should include the isokinetic strength ratio of the hamstrings and quadriceps muscles, as well as measurement of laxity. The most commonly used functional tests are the long jump, single leg triple jump, timed 6 m jumps and single leg long jumps. The results are compared to the uninjured leg and are indicators of strength and endurance. Valid recommendations for accurate test batteries to determine athletic return do not exist, but should include strength tests, jump tests, and video analysis to determine movement quality (van Melick, 2016; Panariello, 2016). In general, criteria used for return to sports activities include absence of pain or effusion, achievement of full range of motion, less than 3 mm difference between the healthy and injured leg on the KT-1000 test, negative lateral pivot shift test, symmetry of hamstring muscle strength, and quadriceps approximately 85%-100% of the uninjured leg, and the functional test battery ≥ 85% compared to the uninjured leg (Table 2).

Table 2. Return to sport criteria (Cascio, 2004)

1. Satisfactory clinical examination (absence of swelling and episodes of "giving way")
2. Achieving symmetrical range of motion in the knee joint
3. *KT-1000 difference in laxity between two extremities < 3 mm/ KT-2000 < 2.5 mm*
4. Isokinetic parameters
    - Bilateral comparison of m. quadriceps femoris (≥ 80%)
    - Quadriceps femoris torque/body mass ratio (≥ 65 %)
    - Quadriceps femoris/hamstring muscles ratio (> 66% in men, > 75% in women)
    - Degree of acceleration in 0.2 s (> 80 % of maximum quadriceps torque)
5. Functional jump tests (≥ 85% of the contralateral leg)
    - Hop for distance
    - Triple hop
    - 6 m timed hops
    - Crossover hops

After discharge from a formal rehabilitation program, the scope of athletic exposure needs to be modified. Several studies have shown deficits in muscle strength, kinesthetic sense and balance 6 months to 2 years after reconstruction (Paterno, 2014; Decker, 2004; Ernst, 2000; Mattacola, 2002). Return to sport 6 months after ACL surgery is therefore no longer the expected norm (Cavanaugh, 2017).

Conclusion

The ACL is essential for the static stability of the knee. It is usually injured during sports activities with a non-contact mechanism. Modifiable and non-modifiable risk factors predispose athletes (especially women) to ACL injuries. Early diagnosis and rehabilitation play an important role in the management of ACL injuries. Criteria such as pain, episodes of instability, injury to secondary structures and pre-injury activity level should be taken into account when deciding on a treatment modality. The surgery is usually recommended for young patients, elite athletes and individuals with active lifestyles. Rehabilitation protocols that include open and closed kinetic chain exercises are recommended after injury or surgical reconstruction. In addition to strength training, enough space should be left in the planning of training cycles for skill training, using neuromuscular training methods, which has a positive effect on the adoption of quality movement patterns that protect the ACL. After discharge from a formal rehabilitation program, it is necessary to modify the scope of sports exposure. Deficits in muscle strength, power, proprioception and balance are present 6 months to 2 years after reconstruction. Future research should focus on the modes of motor learning that will have the most effective effect in preventing ACL injuries, with an emphasis on modifiable risk factors. If we can prevent even one ACL injury, it's worth the effort. Only through education will we see a reduction in this terrible injury, which for some is often the end of a season or career.

References

Micheo, W., Hernández, L., & Seda, C. (2010). Evaluation, management, rehabilitation, and prevention of anterior cruciate ligament injury: current concepts. *PM & R: the journal of injury, function, and rehabilitation*, *2*(10), 935–944.

Hernández, L. M., Micheo, W. F., & Amy, E. (2006). Rehabilitation update for the anterior cruciate ligament injured patient: current concepts. *Boletin de la Asociacion Medica de Puerto Rico*, *98*(1), 62–72.

Saka T. (2014). Principles of postoperative anterior cruciate ligament rehabilitation. *World journal of orthopedics*, *5*(4), 450–459.

Cavanaugh, J. T., & Powers, M. (2017). ACL Rehabilitation Progression: Where Are We Now?. *Current reviews in musculoskeletal medicine*, *10*(3), 289–296.

Li, G., DeFrate, L. E., Sun, H., & Gill, T. J. (2004). In vivo elongation of the anterior cruciate ligament and posterior cruciate ligament during knee flexion. *The American journal of sports medicine*, *32*(6), 1415–1420.

Brown, J. R., & Trojian, T. H. (2004). Anterior and posterior cruciate ligament injuries. *Primary care*, *31*(4), 925–956.

Kennedy, J. C., Hawkins, R. J., Willis, R. B., & Danylchuck, K. D. (1976). Tension studies of human knee ligaments. Yield point, ultimate failure, and disruption of the cruciate and tibial collateral ligaments. *The Journal of bone and joint surgery. American volume*, *58*(3), 350–355.

Schultz, R. A., Miller, D. C., Kerr, C. S., & Micheli, L. (1984). Mechanoreceptors in human cruciate ligaments. A histological study. *The Journal of bone and joint surgery. American volume*, *66*(7), 1072–1076.

Reider, B., Arcand, M. A., Diehl, L. H., Mroczek, K., Abulencia, A., Stroud, C. C., Palm, M., Gilbertson, J., & Staszak, P. (2003). Proprioception of the knee before and after anterior cruciate ligament reconstruction. *Arthroscopy: the journal of*

arthroscopic & related surgery: official publication of the Arthroscopy Association of North America and the International Arthroscopy Association, *19*(1), 2–12.
Grigg, P. (1994). Peripheral Neural Mechanisms in Proprioception, *Journal of Sport Rehabilitation*, *3*(1), 2-17.
Lephart, S. M., Pincivero, D. M., Giraldo, J. L., & Fu, F. H. (1997). The role of proprioception in the management and rehabilitation of athletic injuries. *The American journal of sports medicine*, *25*(1), 130–137.
Hewett, T. E., & Johnson, D. L. (2010). ACL prevention programs: fact or fiction?. *Orthopedics*, *33*(1), 36–39.
Zazulak, B. T., Hewett, T. E., Reeves, N. P., Goldberg, B., & Cholewicki, J. (2007). Deficits in neuromuscular control of the trunk predict knee injury risk: a prospective biomechanical-epidemiologic study. *The American journal of sports medicine*, *35*(7), 1123–1130.
Hewett, T. E., Torg, J. S., & Boden, B. P. (2009). Video analysis of trunk and knee motion during non-contact anterior cruciate ligament injury in female athletes: lateral trunk and knee abduction motion are combined components of the injury mechanism. *British journal of sports medicine*, *43*(6), 417–422.
Hewett T. E. (2009). Prevention of noncontact ACL injuries in women: use of the core of evidence to clip the wings of a "Black Swan". *Current sports medicine reports,* 8(5), 219–221.
Yoo, J. H., Lim, B. O., Ha, M., Lee, S. W., Oh, S. J., Lee, Y. S., & Kim, J. G. (2010). A meta-analysis of the effect of neuromuscular training on the prevention of the anterior cruciate ligament injury in female athletes. *Knee surgery, sports traumatology, arthroscopy: official journal of the ESSKA*, *18*(6), 824–830.
Hewett, T. E., Stroupe, A. L., Nance, T. A., & Noyes, F. R. (1996). Plyometric training in female athletes. Decreased impact forces and increased hamstring torques. *The American journal of sports medicine*, *24*(6), 765–773.
Huston, L. J., & Wojtys, E. M. (1996). Neuromuscular performance characteristics in elite female athletes. *The American journal of sports medicine*, *24*(4), 427–436.
Boden, B. P., Griffin, L. Y., & Garrett, W. E., Jr (2000). Etiology and Prevention of Noncontact ACL Injury. *The Physician and sportsmedicine*, *28*(4), 53–60.
Arendt, E. A., Agel, J., & Dick, R. (1999). Anterior cruciate ligament injury patterns among collegiate men and women. *Journal of athletic training*, *34*(2), 86–92.
Uhorchak, J. M., Scoville, C. R., Williams, G. N., Arciero, R. A., St Pierre, P., & Taylor, D. C. (2003). Risk factors associated with noncontact injury of the anterior cruciate ligament: a prospective four-year evaluation of 859 West Point cadets. *The American journal of sports medicine*, *31*(6), 831–842.
Chappell, J. D., Creighton, R. A., Giuliani, C., Yu, B., & Garrett, W. E. (2007). Kinematics and electromyography of landing preparation in vertical stop-jump: risks for noncontact anterior cruciate ligament injury. *The American journal of sports medicine*, *35*(2), 235–241.
Hewett, T. E., Di Stasi, S. L., & Myer, G. D. (2013). Current concepts for injury prevention in athletes after anterior cruciate ligament reconstruction. *The American journal of sports medicine*, *41*(1), 216–224.
Noyes, F. R., & Barber-Westin, S. D. (2014). Neuromuscular retraining intervention programs: do they reduce noncontact anterior cruciate ligament injury rates in adolescent female athletes?. *Arthroscopy : the journal of arthroscopic & related surgery : official publication of the Arthroscopy Association of North America and the International Arthroscopy Association*, *30*(2), 245–255.
Powers C. M. (2010). The influence of abnormal hip mechanics on knee injury: a biomechanical perspective. *The Journal of orthopaedic and sports physical therapy*, *40*(2), 42–51.
Boden, B. P., Dean, G. S., Feagin, J. A., Jr, & Garrett, W. E., Jr (2000). Mechanisms of anterior cruciate ligament injury. *Orthopedics*, *23*(6), 573–578.
Wilk K. E. (2015). Anterior Cruciate Ligament Injury Prevention and Rehabilitation: Let's Get It Right. *The Journal of orthopaedic and sports physical therapy*, *45*(10), 729–730.
Amy E, Micheo W. Anterior cruciate ligament tear. In: Frontera WR, J Silver, T Rizzo, eds. (2008). Essentials of Physical Medicine and Rehabilitation, 2nd ed. *Philadelphia, PA: Saunders,* 307-314.
Kegerreis S. (1983). The construction and implementation of functional progressions as a component of athletic rehabilitation. *The Journal of orthopaedic and sports physical therapy*, *5*(1), 14–19.
Wilk, K. E., Macrina, L. C., Cain, E. L., Dugas, J. R., & Andrews, J. R. (2012). Recent advances in the rehabilitation of anterior cruciate ligament injuries. *The Journal of orthopaedic and sports physical therapy*, *42*(3), 153–171.
Shelbourne, K. D., Wilckens, J. H., Mollabashy, A., & DeCarlo, M. (1991). Arthrofibrosis in acute anterior cruciate ligament reconstruction. The effect of timing of reconstruction and rehabilitation. *The American journal of sports medicine*, *19*(4), 332–336.

Meighan, A. A., Keating, J. F., & Will, E. (2003). Outcome after reconstruction of the anterior cruciate ligament in athletic patients. A comparison of early versus delayed surgery. *The Journal of bone and joint surgery. British volume*, *85*(4), 521–524.

Becker B. E. (2009). Aquatic therapy: scientific foundations and clinical rehabilitation applications. *PM & R: the journal of injury, function, and rehabilitation*, *1*(9), 859–872.

Chew, K. T., Lew, H. L., Date, E., & Fredericson, M. (2007). Current evidence and clinical applications of therapeutic knee braces. *American journal of physical medicine & rehabilitation*, *86*(8), 678–686.

Harner, C. D., Irrgang, J. J., Paul, J., Dearwater, S., & Fu, F. H. (1992). Loss of motion after anterior cruciate ligament reconstruction. *The American journal of sports medicine*, *20*(5), 499–506.

Shelbourne, K. D., & Gray, T. (2009). Minimum 10-year results after anterior cruciate ligament reconstruction: how the loss of normal knee motion compounds other factors related to the development of osteoarthritis after surgery. *The American journal of sports medicine*, *37*(3), 471–480.

Benum P. (1982). Operative mobilization of stiff knees after surgical treatment of knee injuries and posttraumatic conditions. *Acta orthopaedica Scandinavica*, *53*(4), 625–631.

Fulkerson JP, Hungerford D. (1990). Disorders of the patellofemoral joint. *2nd ed. Williams & Wilkens: Baltimore*.

Schwartz, R. E., Asnis, P. D., Cavanaugh, J. T., Asnis, S. E., Simmons, J. E., & Lasinski, P. J. (1991). Short crank cycle ergometry. *The Journal of orthopaedic and sports physical therapy*, *13*(2), 95–100.

Bates A, Hanson N. (1996). The principles and properties of water. In: *Aquatic exercise therapy. Philadelphia: WB Saunders*, 1–320.

Harrison RA, Hilman M, Bulstrode S. (1992). Loading of the lower limb when walking partially immersed: implications for clinical practice. *Physiotherapy*, 78(3), 164-166.

Tyler, T. F., McHugh, M. P., Gleim, G. W., & Nicholas, S. J. (1998). The effect of immediate weightbearing after anterior cruciate ligament reconstruction. *Clinical orthopaedics and related research*, (357), 141–148.

Spencer, J. D., Hayes, K. C., & Alexander, I. J. (1984). Knee joint effusion and quadriceps reflex inhibition in man. *Archives of physical medicine and rehabilitation*, *65*(4), 171–177.

Delitto, A., Rose, S. J., McKowen, J. M., Lehman, R. C., Thomas, J. A., & Shively, R. A. (1988). Electrical stimulation versus voluntary exercise in strengthening thigh musculature after anterior cruciate ligament surgery. *Physical therapy*, *68*(5), 660–663.

Wigerstad-Lossing, I., Grimby, G., Jonsson, T., Morelli, B., Peterson, L., & Renström, P. (1988). Effects of electrical muscle stimulation combined with voluntary contractions after knee ligament surgery. *Medicine and science in sports and exercise*, *20*(1), 93–98.

Snyder-Mackler, L., Ladin, Z., Schepsis, A. A., & Young, J. C. (1991). Electrical stimulation of the thigh muscles after reconstruction of the anterior cruciate ligament. Effects of electrically elicited contraction of the quadriceps femoris and hamstring muscles on gait and on strength of the thigh muscles. *The Journal of bone and joint surgery. American volume*, *73*(7), 1025–1036.

Snyder-Mackler, L., Delitto, A., Bailey, S. L., & Stralka, S. W. (1995). Strength of the quadriceps femoris muscle and functional recovery after reconstruction of the anterior cruciate ligament. A prospective, randomized clinical trial of electrical stimulation. *The Journal of bone and joint surgery. American volume*, *77*(8), 1166–1173.

Hasegawa, S., Kobayashi, M., Arai, R., Tamaki, A., Nakamura, T., & Moritani, T. (2011). Effect of early implementation of electrical muscle stimulation to prevent muscle atrophy and weakness in patients after anterior cruciate ligament reconstruction. *Journal of electromyography and kinesiology : official journal of the International Society of Electrophysiological Kinesiology*, *21*(4), 622–630.

Sisk, T. D., Stralka, S. W., Deering, M. B., & Griffin, J. W. (1987). Effect of electrical stimulation on quadriceps strength after reconstructive surgery of the anterior cruciate ligament. *The American journal of sports medicine*, *15*(3), 215–220.

Wright, R. W., Preston, E., Fleming, B. C., Amendola, A., Andrish, J. T., Bergfeld, J. A., Dunn, W. R., Kaeding, C., Kuhn, J. E., Marx, R. G., McCarty, E. C., Parker, R. C., Spindler, K. P., Wolcott, M., Wolf, B. R., & Williams, G. N. (2008). A systematic review of anterior cruciate ligament reconstruction rehabilitation: part II: open versus closed kinetic chain exercises, neuromuscular electrical stimulation, accelerated rehabilitation, and miscellaneous topics. *The journal of knee surgery*, *21*(3), 225–234.

Bynum, E. B., Barrack, R. L., & Alexander, A. H. (1995). Open versus closed chain kinetic exercises after anterior cruciate ligament reconstruction. A prospective randomized study. *The American journal of sports medicine*, *23*(4), 401–406.

Wilk, K. E., Escamilla, R. F., Fleisig, G. S., Barrentine, S. W., Andrews, J. R., & Boyd, M. L. (1996). A comparison of tibiofemoral joint forces and electromyographic activity during open and closed kinetic chain exercises. *The American journal of sports medicine*, *24*(4), 518–527.

Ohkoshi, Y., Yasuda, K., Kaneda, K., Wada, T., & Yamanaka, M. (1991). Biomechanical analysis of rehabilitation in the standing position. *The American journal of sports medicine*, *19*(6), 605–611.

Henning, C. E., Lynch, M. A., & Glick, K. R., Jr (1985). An in vivo strain gage study of elongation of the anterior cruciate ligament. *The American journal of sports medicine*, *13*(1), 22–26.

Lutz, G. E., Palmitier, R. A., An, K. N., & Chao, E. Y. (1993). Comparison of tibiofemoral joint forces during open-kinetic-chain and closed-kinetic-chain exercises. *The Journal of bone and joint surgery. American volume*, *75*(5), 732–739.

Yack, H. J., Collins, C. E., & Whieldon, T. J. (1993). Comparison of closed and open kinetic chain exercise in the anterior cruciate ligament-deficient knee. *The American journal of sports medicine*, *21*(1), 49–54.

Risberg, M. A., Holm, I., Tjomsland, O., Ljunggren, E., & Ekeland, A. (1999). Prospective study of changes in impairments and disabilities after anterior cruciate ligament reconstruction. *The Journal of orthopaedic and sports physical therapy*, *29*(7), 400–412.

Lewek, M., Rudolph, K., Axe, M., & Snyder-Mackler, L. (2002). The effect of insufficient quadriceps strength on gait after anterior cruciate ligament reconstruction. *Clinical biomechanics (Bristol, Avon)*, *17*(1), 56–63.

Mikkelsen, C., Werner, S., & Eriksson, E. (2000). Closed kinetic chain alone compared to combined open and closed kinetic chain exercises for quadriceps strengthening after anterior cruciate ligament reconstruction with respect to return to sports: a prospective matched follow-up study. *Knee surgery, sports traumatology, arthroscopy: official journal of the ESSKA*, *8*(6), 337–342.

Hooper, D. M., Morrissey, M. C., Drechsler, W., Morrissey, D., & King, J. (2001). Open and closed kinetic chain exercises in the early period after anterior cruciate ligament reconstruction. Improvements in level walking, stair ascent, and stair descent. *The American journal of sports medicine*, *29*(2), 167–174.

Morrissey, M. C., Drechsler, W. I., Morrissey, D., Knight, P. R., Armstrong, P. W., & McAuliffe, T. B. (2002). Effects of distally fixated versus nondistally fixated leg extensor resistance training on knee pain in the early period after anterior cruciate ligament reconstruction. *Physical therapy*, *82*(1), 35–43.11.

Griffin, L. Y., Agel, J., Albohm, M. J., Arendt, E. A., Dick, R. W., Garrett, W. E., Garrick, J. G., Hewett, T. E., Huston, L., Ireland, M. L., Johnson, R. J., Kibler, W. B., Lephart, S., Lewis, J. L., Lindenfeld, T. N., Mandelbaum, B. R., Marchak, P., Teitz, C. C., & Wojtys, E. M. (2000). Noncontact anterior cruciate ligament injuries: risk factors and prevention strategies. *The Journal of the American Academy of Orthopaedic Surgeons*, *8*(3), 141–150.

Ford, K. R., Myer, G. D., Schmitt, L. C., Uhl, T. L., & Hewett, T. E. (2011). Preferential quadriceps activation in female athletes with incremental increases in landing intensity. *Journal of applied biomechanics*, *27*(3), 215–222.

Begalle, R. L., Distefano, L. J., Blackburn, T., & Padua, D. A. (2012). Quadriceps and hamstrings coactivation during common therapeutic exercises. *Journal of athletic training*, *47*(4), 396–405.

Heijne, A., Fleming, B. C., Renstrom, P. A., Peura, G. D., Beynnon, B. D., & Werner, S. (2004). Strain on the anterior cruciate ligament during closed kinetic chain exercises. *Medicine and science in sports and exercise*, *36*(6), 935–941.

Beynnon, B. D., & Fleming, B. C. (1998). Anterior cruciate ligament strain in-vivo: a review of previous work. *Journal of biomechanics*, *31*(6), 519–525.

Escamilla, R. F., Zheng, N., Imamura, R., Macleod, T. D., Edwards, W. B., Hreljac, A., Fleisig, G. S., Wilk, K. E., Moorman, C. T., 3rd, & Andrews, J. R. (2009). Cruciate ligament force during the wall squat and the one-leg squat. *Medicine and science in sports and exercise*, *41*(2), 408–417.

Escamilla, R. F., Zheng, N., Macleod, T. D., Imamura, R., Edwards, W. B., Hreljac, A., Fleisig, G. S., Wilk, K. E., Moorman, C. T., 3rd, Paulos, L., & Andrews, J. R. (2010). Cruciate ligament forces between short-step and long-step forward lunge. *Medicine and science in sports and exercise*, *42*(10), 1932–1942.

Farrokhi, S., Pollard, C. D., Souza, R. B., Chen, Y. J., Reischl, S., & Powers, C. M. (2008). Trunk position influences the kinematics, kinetics, and muscle activity of the lead lower extremity during the forward lunge exercise. *The Journal of orthopaedic and sports physical therapy*, *38*(7), 403–409.

Lehnhard, R.A., Lehnhard, H.R., Young, R., & Butterfield, S.A. (1996). Monitoring Injuries on a College Soccer Team: The Effect of Strength Training. *Journal of Strength and Conditioning Research, 10*, 115–119.

Hewett, T. E., Lindenfeld, T. N., Riccobene, J. V., & Noyes, F. R. (1999). The effect of neuromuscular training on the incidence of knee injury in female athletes. A prospective study. *The American journal of sports medicine*, *27*(6), 699–706.

Corrigan, J. P., Cashman, W. F., & Brady, M. P. (1992). Proprioception in the cruciate deficient knee. *The Journal of bone and joint surgery. British volume*, *74*(2), 247–250.

Ireland M. L. (2002). The female ACL: why is it more prone to injury?. *The Orthopedic clinics of North America*, *33*(4), 637–651.
Dugan S. A. (2005). Sports-related knee injuries in female athletes: what gives? *American journal of physical medicine & rehabilitation*, *84*(2), 122–130.
Wilk, K. E., Reinold, M. M., & Hooks, T. R. (2003). Recent advances in the rehabilitation of isolated and combined anterior cruciate ligament injuries. *The Orthopedic clinics of North America*, *34*(1), 107–137.
Johansson, H., Sjölander, P., & Sojka, P. (1990). Activity in receptor afferents from the anterior cruciate ligament evokes reflex effects on fusimotor neurones. *Neuroscience research*, *8*(1), 54–59.
Risberg, M. A., Holm, I., Myklebust, G., & Engebretsen, L. (2007). Neuromuscular training versus strength training during first 6 months after anterior cruciate ligament reconstruction: a randomized clinical trial. *Physical therapy*, *87*(6), 737–750.
Paterno M. V. (2017). Non-operative Care of the Patient with an ACL-Deficient Knee. *Current reviews in musculoskeletal medicine*, 10(3), 322–327.
van Melick, N., van Cingel, R. E., Brooijmans, F., Neeter, C., van Tienen, T., Hullegie, W., & Nijhuis-van der Sanden, M. W. (2016). Evidence-based clinical practice update: practice guidelines for anterior cruciate ligament rehabilitation based on a systematic review and multidisciplinary consensus. *British journal of sports medicine*, *50*(24), 1506–1515.
Panariello, R. A., Stump, T. J., & Maddalone, D. (2016). Postoperative rehabilitation and return to play after anterior cruciate ligament reconstruction. *Operative Techniques in Sports Medicine*, *24*(1), 35-44.
Cascio, B. M., Culp, L., & Cosgarea, A. J. (2004). Return to play after anterior cruciate ligament reconstruction. *Clinics in sports medicine*, *23*(3), 395–ix.
Paterno, M. V., Rauh, M. J., Schmitt, L. C., Ford, K. R., & Hewett, T. E. (2014). Incidence of Second ACL Injuries 2 Years After Primary ACL Reconstruction and Return to Sport. *The American journal of sports medicine*, *42*(7), 1567–1573.
Decker, M. J., Torry, M. R., Noonan, T. J., Sterett, W. I., & Steadman, J. R. (2004). Gait retraining after anterior cruciate ligament reconstruction. *Archives of physical medicine and rehabilitation*, *85*(5), 848–856.
Ernst, G. P., Saliba, E., Diduch, D. R., Hurwitz, S. R., & Ball, D. W. (2000). Lower extremity compensations following anterior cruciate ligament reconstruction. *Physical therapy*, *80*(3), 251–260.
Mattacola, C. G., Perrin, D. H., Gansneder, B. M., Gieck, J. H., Saliba, E. N., & McCue, F. C., 3rd (2002). Strength, Functional Outcome, and Postural Stability After Anterior Cruciate Ligament Reconstruction. *Journal of athletic training*, 37(3), 262–268.

REHABILITACIJA NAKON POVREDE PREDNJEG UKRŠTENOG LIGAMENTA KOLENA: ETIOLOGIJA, KRITERIJUMI ZA DOZIRANJE OPTEREĆENJA I POVRATAK SPORTU

Igor Zlatović[1], Igor Ranisavljev[1], Branka Marković[1], Marko Ćosić[1]
[1] Fakultet sporta i fizičkog vaspitanja, Univerzitet u Beogradu, Beograd, Srbija

Uvod

Prednji ukršteni ligament (ACL) je intraartikularna struktura neophodna za normalnu funkciju kolena (Hernández, 2010). Sportske aktivnosti koje uključuju složene pokrete kao što su cik-cak kretnje i pivotiranje čine približno 70% akutnih povreda ACL-a (Hernández, 2006). Rana dijagnoza, sveobuhvatni programi rehabilitacije i protokoli prevencije su kritični u upravljanju ovim stanjem (Hernández, 2010). Danas specijalisti sportske rehabilitacije odlučuju o vrsti vežbi koje je potrebno propisati, kada u procesu rehabilitacije da ih započnu na osnovu svog iskustva i tumačenja stanja. Različita tumačenja dovode do više pitanja, koja zauzvrat vode do originalnijih, tj. "izvornih" članaka. Rezultati novih istraživanja razvijaju i modifikuju postojeće protokole. Protokoli rehabilitacije ACL-a se mogu razlikovati u pristupima, ali ono što ostaje isto je ishod koji svaki specijalista sportske medicine pokušava da postigne. Opšti ciljevi pre povratka sportskim aktivnostima su kontrola bola i otoka, pun opseg pokreta, eliminacija atrofije mišića, normalan hod, povratak na posao za one koji nisu sportisti, povratak fizičkih sposobnosti na nivo pre povrede pa čak i za nivo iznad, obnavljanje propriocepcije, vraćanje samopouzdanja i prevazilaženje kineziofobije. Kada se svi ovi ciljevi ostvare, sportista se može vratiti sportskim aktivnostima (Saka, 2014). Stručnjake za rehabilitaciju treba obeshrabriti u upotrebi strogih vremenskih okvira i protokola kada leče pacijente nakon rekonstrukcije ACL-a. Pre povratka sportu potrebno je ispuniti specifične objektivne kvantitativne i kvalitativne kriterijume. Vreme od operacije ne bi trebalo da bude jedino razmatranje. Specijalista za rehabilitaciju treba da uzme u obzir zarastanje tkiva, sve prateće procedure, snagu patelofemoralnog zgloba i ciljeve pacijenta u izradi strukturiranog programa rehabilitacije. Kako klijent napreduje kroz rehabilitacioni program, specijalista za rehabilitaciju treba kontinuirano i prikladno da izaziva pacijenta na osnovu njegovih ciljeva, nivoa snage, stepena izlečenja i izvršenja datog zadatka (Cavanaugh, 2017).

Anatomija i biomehanika

ACL je kolagena struktura koja je približne dužine 38 mm i širine 10 mm. Ligament ima široku osnovu početnog pripoja, koja se nalazi na prednjoj interkondilarnoj oblasti tibije sa insercijom na posteromedijalnom aspektu lateralnog kondila femura. Podeljen je na 2 glavna snopa, anteromedijalni (rigidan u fleksiji) i posterolateralni (rigidan u ekstenziji) (DeFrate, 2004). Međutim, funkcioniše kao kontinuum vlakana koja se ubacuju pojedinačno sa promenljivom osovinom i konstantnom dužinom, zatežući različite komponente pod različitim uglovima opsega pokreta, čineći ga izometrijskim stabilizatorom kolena. Sile na ACL su najveće u poslednjih 30° ekstenzije i pod nekoliko pasivnih uslova kao što su prednja translacija tibije, unutrašnja rotacija i valgusni stres (DeFrate, 2004). Dakle, ACL služi kao primarni statički stabilizator kolena, odupirući se prednjoj translaciji tibije, kontrolišući i ograničavajući unutrašnju rotaciju tibije. Glavno

snabdevanje kiseonikom i hranljivim materijama dolazi iz srednje genikularne arterije, koja se grana od poplitealne arterije (Hernández, 2010; Brown, 2004). Inerviše ga zadnji zglobni nerv, direktna grana tibijalnog nerva (Brown, 2004; Kennedy, 1976), koji snabdeva mehanoreceptore i nociceptore koji se nalaze u subsinovijalnom sloju blizu insercije ACL-a (Schultz, 1984; Reider, 2003). Grigg (Grigg, 1994) je pokazao da se inicijacija refleksnog luka od strane mehanoreceptora i mišićnih vretena dešava brže od nociceptora. Ovaj nalaz sugeriše moguću zaštitnu ulogu ACL-a u održavanju stabilnosti zgloba refleksnom aktivacijom mišića (Lephart, 1997).

Neuromišićni disbalansi

Četiri neuromišićna disbalansa se u sportu češće primećuju kod žena nego kod muškaraca. Prvi uočeni neuromišićni disbalans je tendencija ka dominaciji ligamenata kod žena. Žene pokazuju tendenciju dopuštanja stresa na ligamente, što prethodi mišićnoj aktivaciji prilikom apsorpcije sila reakcije podloge. Obično tokom doskoka sa jednom nogom, okretanja ili usporavanja, kao što se često dešava tokom povrede ACL-a, sportistkinja dozvoljava sili reakcije podloge da kontroliše smer kretanja zglobova donjih ekstremiteta, posebno zgloba kolena. Nedostatak dinamičke mišićne kontrole zgloba dovodi do povećane valgus pozicije, povećane sile i visokog obrtnog momenta koji deluje na koleno i ACL (Hewett, 2010). Druga neravnoteža se naziva dominacija m. quadriceps femoris-a. Sa dominacijom kvadricepsa sportistkinje tokom kretanja prvenstveno aktiviraju ekstenzore kolena u odnosu na fleksore kako bi stabilizovale zglob kolena, što odražava i naglašava neravnotežu snage i koordinacije između ovih mišića (Hewett, 2010). Treći disbalans je dominacija ekstremiteta. Dominacija ekstremiteta je neravnoteža u mišićnoj snazi i koordinaciji jedne noge u odnosu na drugu, pri čemu jedan ekstremitet često pokazuje veću snagu i koordinaciju. Dominacija ekstremiteta može dovesti kako slabiji, tako i jači ekstremitet u povećan rizik od povrede ACL-a. Slabiji ekstremitet je ugrožen svojom nesposobnošću da preraspodeli sile i momente, dok jači ekstremitet može biti izložen velikim silama i obrtnim momentima usled povećane zavisnosti, naročito u sportskim situacijama kada se generiše velika mišićna sila (Hewett, 2010). Konačna neravnoteža koja se često primećuje kod sportistkinja je dominacija trupa. Dominaciju trupa karakteriše povećano kretanje težišta tela, usled odsustva neuromišićne kontrole, tokom doskoka sa jednom nogom, okretanja ili usporavanja (Zazulak, 2007; Hewett, 2009). Ovi potencijalno ispravljivi neuromišićni disbalansi mogu smanjiti dinamičku stabilnost kolena kod žena i dovesti do rodne pristrasnosti kada se govori o riziku od povrede ACL-a (Zazulak, 2007; Yoo, 2010; Hewett, 1996; Huston, 1996).

Mehanizmi povrede

Cilj razumevanja mehanizma povrede ACL-a je sprovođenje preventivnih strategija. Broj varijabli na koje sportista mora da odgovori u timskim sportovima može objasniti veću učestalost povreda u sportovima kao što su fudbal, američki fudbal i košarka (Boden, 2000). Ruptura ACL-a najčešće je rezultat rapidnog usporavanja donjih ekstremiteta povezanog sa snažnom kontrakcijom kvadricepsa, promene smera ili doskoka sa blagom hiperekstenzijom kolena. Beskontaktni mehanizam povrede je najčešći, javlja se u do 70% slučajeva (Hernández, 2006; Brown, 2004; Arendt, 1999; Uhorchak, 2003), a posebno kod žena. Postoji nekoliko dobro dokumentovanih faktora rizika za nastanak beskontaktne povrede ACL-a (Chappell, 2007; Hewett, 2013; Noyes, 2014; Powers, 2010). Specifična kretanja poput usporavanja (35%), doskoka (31%), ubrzanja

(13%) i pada unazad (4%) identifikovani su kao mehanizmi povrede kod sportista (Boden, 2000). Mnogi od ovih faktora rizika se lako mogu identifikovati kroz funkcionalnu i kliničku evaluaciju te se mogu korigovati kroz edukaciju i namenski program vežbanja. Kontaktni (traumatski) mehanizmi povrede, koji su obično povezani sa valgusnim stresom, javljaju se ređe, sa prijavljenom učestalošću u nekim studijama od 28% (Boden, 2000). Međutim, traumatska povreda ACL-a se često može javiti sa povredama meniskusa i medijalnog kolateralnog ligamenta (Hernández, 2006). Mogući faktori povezani sa dobijanjem druge povrede ACL-a su nepotpuna ili neodgovarajuća rehabilitacija; prevremeni povratak sportu (posebno kada pacijent nije fizički i psihički spreman), kao i bavljenje fizičkim aktivnostima koje su previše napredne za nivo postignutog oporavka pacijenta (Wilk, 2015).

Principi i protokoli rehabilitacije

Opšti ciljevi rehabilitacije nakon povrede ACL-a su smanjivanje rizika od oštećenja sekundarnih struktura kolena, ponovno uspostavljanje punog opsega pokreta, vraćanje mišićne jačine donjih ekstremiteta i mišića jezgra, poboljšanje neuromišićne kontrole i povratak na funkcionalne nivoe pre povrede. Ovi ciljevi se postižu progresivnim rehabilitacionim programom podeljenim na preoperativnu fazu, akutnu fazu, fazu oporavka i funkcionalnu fazu. Program se može primeniti na lečenje pacijenata koji nisu podvrgnuti operaciji ili onih koji se leče hirurškom rekonstrukcijom (Amy, 2008). Nakon rekonstrukcije ACL-a, pod rukovodstvom ortopedskog hirurga, specijalista za rehabilitaciju je odgovoran da vrati pacijenta na funkcionalni nivo pre povrede. Programi postoperativne rehabilitacije su se dramatično promenili u poslednjih nekoliko decenija. Strogi protokoli zasnovani na vremenu proteklom od operacije zamenjeni su smernicama zasnovanim na kriterijumima. Ove smernice prate progresiju u kojoj se ispunjavaju selektivni kriterijumi pre napredovanja u programu (Cavanaugh, 2017). Funkcionalnu progresiju je definisao Kegerreis kao uređen redosled aktivnosti koji omogućava sticanje ili ponovno sticanje veština potrebnih za bezbedno i efikasno izvođenje atletskih poduhvata (Kegerreis, 1983). Drugim rečima, pacijent treba da savlada jednostavnu aktivnost pre nego što pređe na zahtevniju. Programi su individualizovani, gde će neki pacijenti biti spremni da napreduju brže od drugih. Biološki faktori kao što su revaskularizacija i sazrevanje grafta, kao i tehnike fiksacije, takođe se razmatraju da bi se obezbedilo sigurno napredovanje kroz program rehabilitacije.

Značajno je početi rehabilitaciju preoperativno kada je to moguće. Neophodno je smanjiti otok, upalu i bol, vratiti normalan opseg pokreta, normalizovati hod i sprečiti atrofiju mišića pre operacije. Cilj je da se postigne homeostaza tkiva (Wilk, 2012). Puni opseg pokreta se obnavlja preoperativno kako bi se smanjio rizik od postoperativne artrofibroze (Shelbourne, 1991). Edukacija i kritični aspekti preoperativne rehabilitacije informišu i pripremaju pacijenta za hirurški zahvat i postoperativnu rehabilitaciju. Za uspešan ishod, preoperativna faza može da zahteva nekoliko nedelja (≈3) (Shelbourne, 1991; Meighan, 2003). Pacijenti koji su podvrgnuti programu preoperativne rehabilitacije lakše napreduju kroz program postoperativne rehabilitacije, posebno u ranijim fazama (Wilk, 2012). U akutnoj fazi rehabilitacije, ciljevi su smanjenje bola i otoka, postizanje pune ekstenzije u zglobu, mobilizacija patele za smanjenje posthirurških ožiljaka i rano uspravljanje na obe noge, bez štaka ili štapa. Važna mera predostrožnosti u ovoj fazi je izbegavanje velikih opterećenja na koleno u poslednjih 30° ekstenzije da bi se smanjio stres na ACL, sekundarne strukture kolena ili ligamentni transplant (Hernández, 2010). U fazi oporavka, ciljevi su postizanje

punog obima pokreta, postizanje kontrole mišića kvadricepsa, rad na mišićima kuka, kao i ostalim mišićima jezgra, poboljšanje propriocepcije i ravnoteže, i konačno, integrisanje funkcionalnih aktivnosti u 3 ravni kretanja. Mere predostrožnosti uključuju izbegavanje rotacionih naprezanja kolena pre inicijalne inkorporacije grafta u kost, što se dešava otprilike u 4. nedelji za transplante kost-patelarna tetiva-kost i između 8.-12. nedelje za alotransplante tetiva zadnje lože buta, povratak sportu pre sazrevanja grafta i postizanja neuromišićne kontrole donjih ekstremiteta. Trčanje je obično dozvoljeno oko 3-4 meseca nakon operacije, a sportske aktivnosti počinju 4-6 meseci nakon rekonstrukcije. Vežbanje u vodi može biti sastavna komponenta ove faze rehabilitacije zbog blagotvornog dejstva hidrostatskog pritiska na zglobove, smanjenog opterećenja zglobova usled plovnosti i otpornosti na vodu, što omogućava prelazak na funkcionalne aktivnosti (Becker, 2009). U funkcionalnoj fazi rehabilitacije, ciljevi su jačanje kompletnog kinetičkog lanca, rad na snazi i povratak sportu. U ovom trenutku se uvodi program prevencije ponovnih povreda koji kombinuje snagu, fleksibilnost i neuromišićni trening sa tehnikama specifičnim za sport. Funkcionalno učvršćivanje (korišćenjem steznika) nakon rekonstrukcije ACL-a se ne primenjuje rutinski. Pacijentima koji izaberu neoperativno lečenje, koji sporo napreduju u programu rehabilitacije, osećaju se nestabilno po povratku specifičnoj sportskoj aktivnosti ili izraze želju za dodatnom zaštitom pri povratku na takmičenje treba ponuditi opciju funkcionalnog steznika. Ove ortoze pružaju subjektivan osećaj zaštite, ali ne pružaju značajnu rotacionu kontrolu kolena kada su izložene velikim silama i brzinama tokom sportskih aktivnosti (Chew, 2007).

Opseg pokreta

Nakon rekonstrukcije ACL-a, postizanje punog opsega pokreta u kolenu treba da se postigne što je pre moguće. Gubitak ekstenzije dovodi do abnormalne artrokinematike tibiofemoralnog i patelofemoralnog zgloba. Ovo zauzvrat dovodi do abnormalnog kontaktnog pritiska zglobne hrskavice i inhibicije kvadricepsa (Harner, 1992; Shelbourne, 2009; Benum 1982). Najvažniji prijavljeni razlog za niske ocene na testovima samoprocene pacijenata je odsustvo normalne ekstenzije i fleksije kolena (Shelbourne, 2009). Postizanje potpunog opružanja bi u idealnom slučaju trebalo da se postigne pre operacije. Strategije lečenja koje se koriste da bi se postigla potpuna ekstenzija uključuju produžena statičko-pasivna istezanja. Mobilizacije patelofemoralnog zgloba u superiornom pravcu se koriste za podsticanje pokreta ekstenzije kolena (Fulkerson, 1990). Spavanje sa zglobnom protezom zaključanom dok je koleno u ekstenziji koristi se za podsticanje ekstenzije i obeshrabrivanje stvaranja fleksione kontrakture tokom noći. Potpuna ekstenzija je jedan od nekoliko važnih kriterijuma koje treba ispuniti da bi pacijent bezbedno rešio štaka nakon operacije. Vežbe za olakšavanje fleksije počinju odmah nakon rekonstrukcije. Postizanje 120° fleksije treba da bude ispunjeno 4 nedelje nakon operacije, a potpuna simetrična fleksija se postiže za 12 nedelja. Strategije koje se koriste za dalji napredak pokreta fleksije uključuju klizanje pete po podlozi, aktivno-potpomognute vežbe i vožnja bicikl ergometra (Schwartz, 1991). Mobilizacije patelofemoralnog zgloba inferiorno podstiču povećanje fleksije kolena (Fulkerson, 1990).

Oslonac na obe noge i opterećenje koje trpi koleno

Nakon rekonstrukcije ACL-a sa graftom kost-patelarni ligament-kost prenošenje sopstvene težine je prvo delimično (50 %) korišćenjem štaka, a zatim se prenosi bez štaka do praga tolerancije. Samostalno kretanje u vodi (bazen ili podvodni tredmil) može se koristiti za postepeno

povećavanje opterećenja i razvoj normalnog obrasca hoda. Hodanje u dubokoj vodi do visine grudi dovodi do smanjenja težine za 60-75 %, dok hodanje u vodi do visine struka doprinosi smanjenju težine za 40 do 50 % (Bates, 1996; Harrison, 1992). U opštoj praksi post operativne proteze se ne koriste kod mnogih pacijenata. Koriste se samo u prve 2 nedelje kod pacijenata kojima je teško da povrate samopouzdanje ili su temperamentno konzervativni i anksiozni (Saka, 2014). Postoperativna proteza je inicijalno zaključana na 0° zbog samostalnog kretanja i zaštite operisanog zgloba. Proteza se isključuje iz upotrebe kada se demonstrira kontrola kvadricepsa sposobnošću pacijenta da ležeći na leđima podigne nogu opruženu u zglobu kolena, bez zaostajanja ili pritužbi na bol. Zatim se ukidaju štake, nakon uspešno izvedene demonstracije normalnog neantalgičnog hoda (Tyler, 1998).

Kontrola otoka i jačanje mišića.

Ponovno uspostavljanje kontrole kvadricepsa je rani cilj postoperativne rehabilitacije. Kontrolisanje postoperativnog izliva pomaže u obeshrabrivanju inhibicije kvadricepsa. Spencer i sar. su identifikovali da mehanoreceptori u zglobnoj kapsuli reaguju na promene u napetosti i zauzvrat inhibiraju motorne neurone koji snabdevaju mišićna vlakna kvadricepsa (Spencer, 1984). Terapijske intervencije koje se koriste uključuju upotrebu komercijalne aparature koja istovremeno pruža hlađenje i kompresiju i vežbe aktivacije kvadricepsa. Ako pacijent ima poteškoća da izazove kontrakciju, može se koristiti električni stimulator mišića u sadejstvu sa aktivnom kontrakcijom kvadrocepsa kako bi se proizvela bolja kontrakcija mišića. Brojne studije (Delitto, 1988; Wigerstad-Lossing, 1988; Snyder-Mackler, 1991; Snyder-Mackler, 1995; Hasegawa, 2011) su pokazale raniji povratak jačine kvadricepsa nakon rekonstrukcije uz upotrebu električne stimulacije, dok druge nisu (Sisk, 1987; Wright, 2008).

Kada se ispune kriterijumi normalne aktivacije mišića i normalnog neantalgičnog hoda, uvode se vežbe zatvorenog kinetičkog lanca (ZKL) unutar bezbolnog opsega pokreta, jer se pokazalo da ove aktivnosti smanjuju stres na ACL (Bynum, 1995; Wilk, 1996; Ohkoshi, 1991; Henning, 1985; Lutz, 1993; Yack, 1993). Jačanje kvadricepsa je jedan od glavnih postulata programa rehabilitacije nakon povrede i rekonstrukcijr. Pokazalo se da slabost kvadricepsa traje i do 2 godine nakon operacije i da je u korelaciji sa funkcijom kolena tokom aktivnosti kao što je hod (Risberg, 1999; Lewek, 2002). Ograničeni dokazi sada pokazuju da vežbe otvorenog kinetičkog lanca unutar opsega pokreta 90°–0° ipak neće ugroziti labavost grafta (Mikkelsen, 2000; Hooper, 2001; Morrissey, 2002). Sa demonstracijom opsega pokreta 0°–130°, vežbe OKL-a počinju izometrijskim kontrakcijama kvadricepsa pri različitim zglobnim uglovima u rasponu od 90° do 40°. Izometrijske vežbe progresuju u izotonične vežbe koristeći progresivno doziranje opterećenja. Nakon 3 meseca postoperativno, izotonične vežbe su dozvoljene u punom opsegu pokreta, a dalji progres postiže se uvođenjem izokinetičkih vežbi koje koriste umereno velike brzine. Tokom ove progresije, specijalista za rehabilitaciju treba pažljivo da prati patelofemoralni zglob, zbog eventualnih krepitacija i pritužbi na bol (Cavanaugh, 2017). Dve odvojene studije su izjavile da koordinirana koaktivacija mišića zadnje lože buta i kvadricepsa može da igra ulogu u smanjenju rizika od primarnih povreda smanjenjem naprezanja ligamenta (Griffin, 2000) i promovisanjem normalne mehanike doskoka (Ford, 2011). U transverzalnoj studiji iz 2012. godine, Begalle i sar. su izvestili da su najizbalansiraniji odnosi koaktivacije kvadricepsa i mišića zadnje lože buta identifikovani u vežbama unilateralnog mrtvog dizanja, bočnog poskoka, poprečnog poskoka i bočnog hoda sa

gumom, koje se mogu bezbedno koristiti u programima rehabilitacije nakon povrede (Begalle, 2012).

Tabela 1. Maksimalno naprezanje ACL-a prilikom izvođenja različitih vežbi otvorenog i zatvorenog kinetičkog lanca (Heijne, 2004; Beynnon, 1998).

Rehabilitacione vežbe	**Pik naprezanja pod određenim uglom**
Izometrijska ekstenzija kolena iz sedeće pozicije (30 Nm)	4.4 % na 15°
Izotonična ekstenzija kolena sedeći (45 Nm - 4.5 kg)	3.8 % na 10°
Lachman-ov test (150 N - 15 kg)	3.7 % na 30°
Čučanj sa ili bez opterećenja od 136 N - 13.6 kg	3.6 % - 4.0 % na 10°
Izotonična ekstenzija, bez dodatnog spoljašnjeg otpora	2.8 % na 10°
Jednonožni boks čučanj (testirano na 30°, 50° i 70° fleksije)	2.8 % na 30°
Step-up/-down (penjanje uz stepenice) (na 30°, 50° i 70° fleksije)	2.5 % - 2.7 % na 30°
Leg press sa spoljašnjim opterećenjem (40% telesne mase)	2.1 % na 20°
Iskorak unapred (testirano na 30°, 50° i 70° fleksije)	1.9 % na 30°
Stacionarni bicikl	1.7 %

Međutim, treba napomenuti da varijacije u tehnikama čučnja i iskoraka mogu uticati na naprezanje ACL-a (Beynnon, 1998; Escamilla, 2009; Escamilla, 2010; Farrokhi, 2008). Na primer, čučanj i iskorak sa nagibom trupa unapred regrutuju mišiće zadnje lože buta, što pomaže da se rasteretiti ACL smanjujući prednju translaciju tibije u većoj meri nego čučanj i iskorak sa verikalnim trupom (Ohkoshi, 1991; Escamilla, 2010; Farrokhi, 2008). Takođe, glutealna muskulatura ima veću aktivaciju, što može pomoći u medijalno-lateralnoj kontroli kolena. Dodatno, vežbe ZKL koriste se za obuku neuromišićnog kontrolnog sistema. Specifične vežbe za neuromišićnu kontrolu dizajnirane da dinamički kontrolišu valgus i varus momente u kolenu uključuju: front step-down, lateral step-down, kao i jednonožne vežbe balansa (Wilk, 2012).

Trening jačine sam po sebi ne smanjuje broj povreda ACL-a (Lehnhard, 1996), međutim kada se kombinuje sa pliometrijskim treningom postoji značajno smanjenje povreda, naročito kod sportistkinja (Hewett, 1999).

Neuromišićni trening i propriocepcija

Iako je utvrđeno da se propriocepcija poboljšava nakon rekonstrukcije ACL-a, ona ne dostiže nivoe pre povrede (Lephart, 1997). Nakon rekonstrukcije, aferentne informacije se menjaju, što dovodi do poremećaja nervnog puta koji spaja centar za ravnozežu i bazu oslonca (Corrigan, 1992). Ovaj nalaz je doveo do teorije da rekonstrukcija ACL-a ponovo uspostavlja statičku stabilnost, ali da na dinamičku stabilnost utiču drugi elementi kao što su propriocepcija kolena,

snaga mišića, obrasci regrutacije, kao i zamor (Ireland, 2002; Dugan, 2005; Wilk, 2003; Johansson, 1990). Iz ovih razloga, neuromišićni trening i vežbe propriocepcije su ključni u rehabilitaciji povrede ACL-a. Pokazalo se da su programi neuromišićnog treninga (NMT) superiorniji od samih programa treninga snage u globalnoj funkciji kolena (Risberg, 2007).

Progresija u rehabilitaciji do neuromišićnog treninga se dešava kada pacijent nema bol i otok, kada postigne pun opseg pokreta i dovoljnu jačinu mišića donjih ekstremiteta da učestvuje u dinamičnijim vežbama sa opterećenjem. Tokom ove faze, pacijent nastavlja da se fokusira na povećanje snage mišića donjih ekstremiteta i jezgra, ali sada može da koristi sredstva kao što su naprednije varijante vežbi ravnoteže, propriocepcije, kardiovaskularnog kondicioniranja i neuromišićnog treninga (Paterno, 2017).

Progresija do sportsko-specifičnog treninga

Pre progresije ka sportsko-specifičnoj fazi rehabilitacije, pacijent mora pokazati uspešan završetak faze neuromišićnog treninga, bez epizoda „popuštanja“ kolena. Pored toga, pacijent mora imati dovoljnu snagu kvadricepsa i mišića zadnje lože buta, što pokazuje simetrija izokinetičke snage od > 90 % u poređenju sa kontralateralnim ekstremitetom. Kada se ovi faktori postignu, pacijent je spreman da napreduje do završne faze (Paterno, 2017). Poslednji princip rehabilitacije ACL-a, uključuje obnavljanje funkcije kroz trening usmeren na specifične aspekte sporta u kojima se sportista takmiči. Vežbe kao što su poligoni sa kapicama/čunjevima, iskoraci sa sportskim užetom, pliometrijske vežbe i napredovanje u tehnici trčanja i agilnosti, mogu se modifikovati za specifične funkcionalne obrasce pokreta koji su povezani sa pacijentovim izabranim sportom.

Kriterijumi za povratak sportu nakon povrede i rekonstrukcije ACL-a

Vreme za povratak sportskim aktivnostima nakon povrede ACL-a, rekonstrukcije i rehabilitacije zasniva se na proceni pacijenata i funkcionalnom testiranju. Subjektivne skale ocenjivanja, testiranje labavosti kolena, izokinetičko testiranje, testiranje funkcionalnosti skoka, testiranje ravnoteže i kvalitativna procena pokreta se koriste za obezbeđivanje dokaza u procesu donošenja odluka. Prihvatljivi rezultati na ovim procenama su potrebni da bi se sportista bezbedno vratio sportu (Cavanaugh, 2017). Pored toga, kompletna klinička procena treba da obuhvati odnos izokinetičke snage mišića zadnje lože buta i kvadricepsa, kao i merenje labavosti. Funkcionalni testovi koji se najčešće koriste su poskok u dalj, troskok sa jednom nogom, tempirani poskoci na 6 m i „cik-cak“ skokovi na jednoj nozi u dalj. Rezultati se porede sa nepovređenom nogom i pokazatelji su snage i izdržljivosti. Važeće preporuke za tačne baterije testova za određivanje sportskog povratka ne postoje, ali bi trebalo da uključuju testove snage, testove skočnosti i video analizu za određivanje kvaliteta kretanja (van Melick, 2016; Panariello, 2016). Generalno, kriterijumi koji se koriste za povratak sportskim aktivnostima uključuju odsustvo bola ili izliva, postizanje punog obima pokreta, manju razliku od 3 mm između zdrave i povređene noge na testu KT-1000, negativan lateralni pivot shift test, simetričnost snage mišića zadnje lože buta i kvadricepsa približno 85% -100% nepovređene noge, a baterija za funkcionalno testiranje ≥ 85% u poređenju sa nepovređenom nogom (Tabela 2.).

Tabela 2. Kriterijumi za povratak sportu (Cascio, 2004).

1. Zadovoljavajući klinički pregled (odstustvo otoka i epizoda "popuštanja")
2. Postizanje simetričnog opsega pokreta u zglobu kolena
3. *KT-1000* razlika u labavosti između dva ekstremiteta < 3 mm/ *KT-2000* < 2.5 mm
4. Izokinetički parametri
   - Bilateralna komparacija m. quadriceps femoris-a (≥ 80 %)
   - Odnos obrtnog momenta m. quadriceps femoris-a i telesne mase (≥ 65 %)
   - Odnos m. quadriceps femoris-a i mišića zadnje lože buta (> 66 % kod muškaraca, >75 % kod žena)
   - Stepen ubrzanja u 0.2 s (> 80 % maksimalnog obrtnog momenta m. quardriceps femoris-a
5. Funkcionalni testovi skočnosti (≥ 85 % kontralateralne noge)
   - Skok u dalj jednom nogom
   - Troskok jednom nogom
   - Tempirani poskoci na 6 m
   - "Crossover" troskok na jednoj nozi

Nakon otpuštanja iz formalnog programa rehabilitacije, potrebno je izmeniti obim atletskog izlaganja. Nekoliko studija je pokazalo deficite mišićne snage, kinestetičkog čula i ravnoteže 6 meseci do 2 godine nakon rekonstrukcije (Paterno, 2014; Decker, 2004; Ernst, 2000; Mattacola, 2002). Povratak sportu 6 meseci nakon operacije ACL-a, stoga više nije očekivana norma (Cavanaugh, 2017).

Zaključak

ACL je neophodan za statičku stabilnost kolena. Obično se povređuje tokom sportskih aktivnosti beskontaktnim mehanizmom. Faktori rizika koji se mogu iliti ne mogu modifikovati predisponiraju sportiste (posebno žene) na povrede ACL-a. Rana dijagnoza i rehabilitacija igraju važnu ulogu u zbrinjavanju povreda ACL-a. Kriterijumi kao što su bol, epizode nestabilnosti, povrede sekundarnih struktura i nivo aktivnosti pre povrede treba uzeti u obzir kada se odlučuje o načinu lečenja. Operacija se obično preporučuje mladim pacijentima, elitnim sportistima i pojedincima sa aktivnim životnim stilom. Protokoli rehabilitacije koji uključuju vežbe otvorenog i zatvorenog kinetičkog lanca preporučuju se nakon povrede ili hirurške rekonstrukcije. Pored treninga snage, u planiranju trenažnih ciklusa treba ostaviti dovoljno mesta i za trening veština, koristeći se metodama neuromišićnog treninga, što pozitivno deluje na usvajanje kvalitetnih obrazaca kretanja koji čuvaju ACL. Nakon otpuštanja iz formalnog programa rehabilitacije, potrebno je izmeniti obim sportskog izlaganja. Deficiti mišićne sile, snage, propriocepcije i ravnoteže prisutni su 6 meseci do 2 godine nakon rekonstrukcije. Buduća istraživanja treba da se usmere na načine motornog učenja koji će imati najefikasniji učinak u prevenciji povreda ACL-a, sa naglaskom na faktore rizika koji se mogu promeniti. Ako smo u mogućnosti da sprečimo i samo jednu povredu ACL-a, vredi truda. Samo obrazovanjem ćemo videti redukciju ove strašne povrede, koja je za neke često kraj sezone ili karijere.

Literatura

Micheo, W., Hernández, L., & Seda, C. (2010). Evaluation, management, rehabilitation, and prevention of anterior cruciate ligament injury: current concepts. *PM & R: the journal of injury, function, and rehabilitation*, *2*(10), 935–944.

Hernández, L. M., Micheo, W. F., & Amy, E. (2006). Rehabilitation update for the anterior cruciate ligament injured patient: current concepts. *Boletin de la Asociacion Medica de Puerto Rico*, *98*(1), 62–72.

Saka T. (2014). Principles of postoperative anterior cruciate ligament rehabilitation. *World journal of orthopedics*, *5*(4), 450–459.

Cavanaugh, J. T., & Powers, M. (2017). ACL Rehabilitation Progression: Where Are We Now?. *Current reviews in musculoskeletal medicine*, *10*(3), 289–296.

Li, G., DeFrate, L. E., Sun, H., & Gill, T. J. (2004). In vivo elongation of the anterior cruciate ligament and posterior cruciate ligament during knee flexion. *The American journal of sports medicine*, *32*(6), 1415–1420.

Brown, J. R., & Trojian, T. H. (2004). Anterior and posterior cruciate ligament injuries. *Primary care*, *31*(4), 925–956.

Kennedy, J. C., Hawkins, R. J., Willis, R. B., & Danylchuck, K. D. (1976). Tension studies of human knee ligaments. Yield point, ultimate failure, and disruption of the cruciate and tibial collateral ligaments. *The Journal of bone and joint surgery. American volume*, *58*(3), 350–355.

Schultz, R. A., Miller, D. C., Kerr, C. S., & Micheli, L. (1984). Mechanoreceptors in human cruciate ligaments. A histological study. *The Journal of bone and joint surgery. American volume*, *66*(7), 1072–1076.

Reider, B., Arcand, M. A., Diehl, L. H., Mroczek, K., Abulencia, A., Stroud, C. C., Palm, M., Gilbertson, J., & Staszak, P. (2003). Proprioception of the knee before and after anterior cruciate ligament reconstruction. *Arthroscopy: the journal of arthroscopic & related surgery: official publication of the Arthroscopy Association of North America and the International Arthroscopy Association*, *19*(1), 2–12.

Grigg, P. (1994). Peripheral Neural Mechanisms in Proprioception, *Journal of Sport Rehabilitation*, *3*(1), 2-17.

Lephart, S. M., Pincivero, D. M., Giraldo, J. L., & Fu, F. H. (1997). The role of proprioception in the management and rehabilitation of athletic injuries. *The American journal of sports medicine*, *25*(1), 130–137.

Hewett, T. E., & Johnson, D. L. (2010). ACL prevention programs: fact or fiction?. *Orthopedics*, *33*(1), 36–39.

Zazulak, B. T., Hewett, T. E., Reeves, N. P., Goldberg, B., & Cholewicki, J. (2007). Deficits in neuromuscular control of the trunk predict knee injury risk: a prospective biomechanical-epidemiologic study. *The American journal of sports medicine*, *35*(7), 1123–1130.

Hewett, T. E., Torg, J. S., & Boden, B. P. (2009). Video analysis of trunk and knee motion during non-contact anterior cruciate ligament injury in female athletes: lateral trunk and knee abduction motion are combined components of the injury mechanism. *British journal of sports medicine*, *43*(6), 417–422.

Hewett T. E. (2009). Prevention of noncontact ACL injuries in women: use of the core of evidence to clip the wings of a "Black Swan". *Current sports medicine reports,* 8(5), 219–221.

Yoo, J. H., Lim, B. O., Ha, M., Lee, S. W., Oh, S. J., Lee, Y. S., & Kim, J. G. (2010). A meta-analysis of the effect of neuromuscular training on the prevention of the anterior cruciate ligament injury in female athletes. *Knee surgery, sports traumatology, arthroscopy: official journal of the ESSKA*, *18*(6), 824–830.

Hewett, T. E., Stroupe, A. L., Nance, T. A., & Noyes, F. R. (1996). Plyometric training in female athletes. Decreased impact forces and increased hamstring torques. *The American journal of sports medicine*, *24*(6), 765–773.

Huston, L. J., & Wojtys, E. M. (1996). Neuromuscular performance characteristics in elite female athletes. *The American journal of sports medicine*, *24*(4), 427–436.

Boden, B. P., Griffin, L. Y., & Garrett, W. E., Jr (2000). Etiology and Prevention of Noncontact ACL Injury. *The Physician and sportsmedicine*, *28*(4), 53–60.

Arendt, E. A., Agel, J., & Dick, R. (1999). Anterior cruciate ligament injury patterns among collegiate men and women. *Journal of athletic training*, *34*(2), 86–92.

Uhorchak, J. M., Scoville, C. R., Williams, G. N., Arciero, R. A., St Pierre, P., & Taylor, D. C. (2003). Risk factors associated with noncontact injury of the anterior cruciate ligament: a prospective four-year evaluation of 859 West Point cadets. *The American journal of sports medicine*, *31*(6), 831–842.

Chappell, J. D., Creighton, R. A., Giuliani, C., Yu, B., & Garrett, W. E. (2007). Kinematics and electromyography of landing preparation in vertical stop-jump: risks for noncontact anterior cruciate ligament injury. *The American journal of sports medicine*, *35*(2), 235–241.

Hewett, T. E., Di Stasi, S. L., & Myer, G. D. (2013). Current concepts for injury prevention in athletes after anterior cruciate ligament reconstruction. *The American journal of sports medicine*, *41*(1), 216–224.

Noyes, F. R., & Barber-Westin, S. D. (2014). Neuromuscular retraining intervention programs: do they reduce noncontact anterior cruciate ligament injury rates in adolescent female athletes?. *Arthroscopy : the journal of arthroscopic & related surgery : official publication of the Arthroscopy Association of North America and the International Arthroscopy Association*, *30*(2), 245–255.

Powers C. M. (2010). The influence of abnormal hip mechanics on knee injury: a biomechanical perspective. *The Journal of orthopaedic and sports physical therapy*, *40*(2), 42–51.

Boden, B. P., Dean, G. S., Feagin, J. A., Jr, & Garrett, W. E., Jr (2000). Mechanisms of anterior cruciate ligament injury. *Orthopedics*, *23*(6), 573–578.

Wilk K. E. (2015). Anterior Cruciate Ligament Injury Prevention and Rehabilitation: Let's Get It Right. *The Journal of orthopaedic and sports physical therapy*, *45*(10), 729–730.

Amy E, Micheo W. Anterior cruciate ligament tear. In: Frontera WR, J Silver, T Rizzo, eds. (2008). Essentials of Physical Medicine and Rehabilitation, 2nd ed. *Philadelphia, PA: Saunders,* 307-314.

Kegerreis S. (1983). The construction and implementation of functional progressions as a component of athletic rehabilitation. *The Journal of orthopaedic and sports physical therapy*, *5*(1), 14–19.

Wilk, K. E., Macrina, L. C., Cain, E. L., Dugas, J. R., & Andrews, J. R. (2012). Recent advances in the rehabilitation of anterior cruciate ligament injuries. *The Journal of orthopaedic and sports physical therapy*, *42*(3), 153–171.

Shelbourne, K. D., Wilckens, J. H., Mollabashy, A., & DeCarlo, M. (1991). Arthrofibrosis in acute anterior cruciate ligament reconstruction. The effect of timing of reconstruction and rehabilitation. *The American journal of sports medicine*, *19*(4), 332–336.

Meighan, A. A., Keating, J. F., & Will, E. (2003). Outcome after reconstruction of the anterior cruciate ligament in athletic patients. A comparison of early versus delayed surgery. *The Journal of bone and joint surgery. British volume*, *85*(4), 521–524.

Becker B. E. (2009). Aquatic therapy: scientific foundations and clinical rehabilitation applications. *PM & R: the journal of injury, function, and rehabilitation*, *1*(9), 859–872.

Chew, K. T., Lew, H. L., Date, E., & Fredericson, M. (2007). Current evidence and clinical applications of therapeutic knee braces. *American journal of physical medicine & rehabilitation*, *86*(8), 678–686.

Harner, C. D., Irrgang, J. J., Paul, J., Dearwater, S., & Fu, F. H. (1992). Loss of motion after anterior cruciate ligament reconstruction. *The American journal of sports medicine*, *20*(5), 499–506.

Shelbourne, K. D., & Gray, T. (2009). Minimum 10-year results after anterior cruciate ligament reconstruction: how the loss of normal knee motion compounds other factors related to the development of osteoarthritis after surgery. *The American journal of sports medicine*, *37*(3), 471–480.

Benum P. (1982). Operative mobilization of stiff knees after surgical treatment of knee injuries and posttraumatic conditions. *Acta orthopaedica Scandinavica*, *53*(4), 625–631.

Fulkerson JP, Hungerford D. (1990). Disorders of the patellofemoral joint. *2nd ed. Williams & Wilkens: Baltimore*.

Schwartz, R. E., Asnis, P. D., Cavanaugh, J. T., Asnis, S. E., Simmons, J. E., & Lasinski, P. J. (1991). Short crank cycle ergometry. *The Journal of orthopaedic and sports physical therapy*, *13*(2), 95–100.

Bates A, Hanson N. (1996). The principles and properties of water. In: *Aquatic exercise therapy. Philadelphia: WB Saunders*, 1–320.

Harrison RA, Hilman M, Bulstrode S. (1992). Loading of the lower limb when walking partially immersed: implications for clinical practice. *Physiotherapy*, 78(3), 164-166.

Tyler, T. F., McHugh, M. P., Gleim, G. W., & Nicholas, S. J. (1998). The effect of immediate weightbearing after anterior cruciate ligament reconstruction. *Clinical orthopaedics and related research*, (357), 141–148.

Spencer, J. D., Hayes, K. C., & Alexander, I. J. (1984). Knee joint effusion and quadriceps reflex inhibition in man. *Archives of physical medicine and rehabilitation*, *65*(4), 171–177.

Delitto, A., Rose, S. J., McKowen, J. M., Lehman, R. C., Thomas, J. A., & Shively, R. A. (1988). Electrical stimulation versus voluntary exercise in strengthening thigh musculature after anterior cruciate ligament surgery. *Physical therapy*, *68*(5), 660–663.

Wigerstad-Lossing, I., Grimby, G., Jonsson, T., Morelli, B., Peterson, L., & Renström, P. (1988). Effects of electrical muscle stimulation combined with voluntary contractions after knee ligament surgery. *Medicine and science in sports and exercise*, *20*(1), 93–98.

Snyder-Mackler, L., Ladin, Z., Schepsis, A. A., & Young, J. C. (1991). Electrical stimulation of the thigh muscles after reconstruction of the anterior cruciate ligament. Effects of electrically elicited contraction of the quadriceps femoris and

hamstring muscles on gait and on strength of the thigh muscles. *The Journal of bone and joint surgery. American volume*, *73*(7), 1025–1036.
Snyder-Mackler, L., Delitto, A., Bailey, S. L., & Stralka, S. W. (1995). Strength of the quadriceps femoris muscle and functional recovery after reconstruction of the anterior cruciate ligament. A prospective, randomized clinical trial of electrical stimulation. *The Journal of bone and joint surgery. American volume*, *77*(8), 1166–1173.
Hasegawa, S., Kobayashi, M., Arai, R., Tamaki, A., Nakamura, T., & Moritani, T. (2011). Effect of early implementation of electrical muscle stimulation to prevent muscle atrophy and weakness in patients after anterior cruciate ligament reconstruction. *Journal of electromyography and kinesiology : official journal of the International Society of Electrophysiological Kinesiology*, *21*(4), 622–630.
Sisk, T. D., Stralka, S. W., Deering, M. B., & Griffin, J. W. (1987). Effect of electrical stimulation on quadriceps strength after reconstructive surgery of the anterior cruciate ligament. *The American journal of sports medicine*, *15*(3), 215–220.
Wright, R. W., Preston, E., Fleming, B. C., Amendola, A., Andrish, J. T., Bergfeld, J. A., Dunn, W. R., Kaeding, C., Kuhn, J. E., Marx, R. G., McCarty, E. C., Parker, R. C., Spindler, K. P., Wolcott, M., Wolf, B. R., & Williams, G. N. (2008). A systematic review of anterior cruciate ligament reconstruction rehabilitation: part II: open versus closed kinetic chain exercises, neuromuscular electrical stimulation, accelerated rehabilitation, and miscellaneous topics. *The journal of knee surgery*, *21*(3), 225–234.
Bynum, E. B., Barrack, R. L., & Alexander, A. H. (1995). Open versus closed chain kinetic exercises after anterior cruciate ligament reconstruction. A prospective randomized study. *The American journal of sports medicine*, *23*(4), 401–406.
Wilk, K. E., Escamilla, R. F., Fleisig, G. S., Barrentine, S. W., Andrews, J. R., & Boyd, M. L. (1996). A comparison of tibiofemoral joint forces and electromyographic activity during open and closed kinetic chain exercises. *The American journal of sports medicine*, *24*(4), 518–527.
Ohkoshi, Y., Yasuda, K., Kaneda, K., Wada, T., & Yamanaka, M. (1991). Biomechanical analysis of rehabilitation in the standing position. *The American journal of sports medicine*, *19*(6), 605–611.
Henning, C. E., Lynch, M. A., & Glick, K. R., Jr (1985). An in vivo strain gage study of elongation of the anterior cruciate ligament. *The American journal of sports medicine*, *13*(1), 22–26.
Lutz, G. E., Palmitier, R. A., An, K. N., & Chao, E. Y. (1993). Comparison of tibiofemoral joint forces during open-kinetic-chain and closed-kinetic-chain exercises. *The Journal of bone and joint surgery. American volume*, *75*(5), 732–739.
Yack, H. J., Collins, C. E., & Whieldon, T. J. (1993). Comparison of closed and open kinetic chain exercise in the anterior cruciate ligament-deficient knee. *The American journal of sports medicine*, *21*(1), 49–54.
Risberg, M. A., Holm, I., Tjomsland, O., Ljunggren, E., & Ekeland, A. (1999). Prospective study of changes in impairments and disabilities after anterior cruciate ligament reconstruction. *The Journal of orthopaedic and sports physical therapy*, *29*(7), 400–412.
Lewek, M., Rudolph, K., Axe, M., & Snyder-Mackler, L. (2002). The effect of insufficient quadriceps strength on gait after anterior cruciate ligament reconstruction. *Clinical biomechanics (Bristol, Avon)*, *17*(1), 56–63.
Mikkelsen, C., Werner, S., & Eriksson, E. (2000). Closed kinetic chain alone compared to combined open and closed kinetic chain exercises for quadriceps strengthening after anterior cruciate ligament reconstruction with respect to return to sports: a prospective matched follow-up study. *Knee surgery, sports traumatology, arthroscopy: official journal of the ESSKA*, *8*(6), 337–342.
Hooper, D. M., Morrissey, M. C., Drechsler, W., Morrissey, D., & King, J. (2001). Open and closed kinetic chain exercises in the early period after anterior cruciate ligament reconstruction. Improvements in level walking, stair ascent, and stair descent. *The American journal of sports medicine*, *29*(2), 167–174.
Morrissey, M. C., Drechsler, W. I., Morrissey, D., Knight, P. R., Armstrong, P. W., & McAuliffe, T. B. (2002). Effects of distally fixated versus nondistally fixated leg extensor resistance training on knee pain in the early period after anterior cruciate ligament reconstruction. *Physical therapy*, *82*(1), 35–43.11. Griffin, L. Y., Agel, J., Albohm, M. J., Arendt, E. A., Dick, R. W., Garrett, W. E., Garrick, J. G., Hewett, T. E., Huston, L., Ireland, M. L., Johnson, R. J., Kibler, W. B., Lephart, S., Lewis, J. L., Lindenfeld, T. N., Mandelbaum, B. R., Marchak, P., Teitz, C. C., & Wojtys, E. M. (2000). Noncontact anterior cruciate ligament injuries: risk factors and prevention strategies. *The Journal of the American Academy of Orthopaedic Surgeons*, *8*(3), 141–150.
Fujiya, H., Kousa, P., Fleming, B. C., Churchill, D. L., & Beynnon, B. D. (2011). Effect of muscle loads and torque applied to the tibia on the strain behavior of the anterior cruciate ligament: an in vitro investigation. *Clinical biomechanics (Bristol, Avon)*, 26(10), 1005–1011.
Ford, K. R., Myer, G. D., Schmitt, L. C., Uhl, T. L., & Hewett, T. E. (2011). Preferential quadriceps activation in female athletes with incremental increases in landing intensity. *Journal of applied biomechanics*, *27*(3), 215–222.

Begalle, R. L., Distefano, L. J., Blackburn, T., & Padua, D. A. (2012). Quadriceps and hamstrings coactivation during common therapeutic exercises. *Journal of athletic training*, *47*(4), 396–405.
Heijne, A., Fleming, B. C., Renstrom, P. A., Peura, G. D., Beynnon, B. D., & Werner, S. (2004). Strain on the anterior cruciate ligament during closed kinetic chain exercises. *Medicine and science in sports and exercise*, *36*(6), 935–941.
Beynnon, B. D., & Fleming, B. C. (1998). Anterior cruciate ligament strain in-vivo: a review of previous work. *Journal of biomechanics*, *31*(6), 519–525.
Escamilla, R. F., Zheng, N., Imamura, R., Macleod, T. D., Edwards, W. B., Hreljac, A., Fleisig, G. S., Wilk, K. E., Moorman, C. T., 3rd, & Andrews, J. R. (2009). Cruciate ligament force during the wall squat and the one-leg squat. *Medicine and science in sports and exercise*, *41*(2), 408–417.
Escamilla, R. F., Zheng, N., Macleod, T. D., Imamura, R., Edwards, W. B., Hreljac, A., Fleisig, G. S., Wilk, K. E., Moorman, C. T., 3rd, Paulos, L., & Andrews, J. R. (2010). Cruciate ligament forces between short-step and long-step forward lunge. *Medicine and science in sports and exercise*, *42*(10), 1932–1942.
Farrokhi, S., Pollard, C. D., Souza, R. B., Chen, Y. J., Reischl, S., & Powers, C. M. (2008). Trunk position influences the kinematics, kinetics, and muscle activity of the lead lower extremity during the forward lunge exercise. *The Journal of orthopaedic and sports physical therapy*, *38*(7), 403–409.
Lehnhard, R.A., Lehnhard, H.R., Young, R., & Butterfield, S.A. (1996). Monitoring Injuries on a College Soccer Team: The Effect of Strength Training. *Journal of Strength and Conditioning Research, 10*, 115–119.
Hewett, T. E., Lindenfeld, T. N., Riccobene, J. V., & Noyes, F. R. (1999). The effect of neuromuscular training on the incidence of knee injury in female athletes. A prospective study. *The American journal of sports medicine*, *27*(6), 699–706.
Corrigan, J. P., Cashman, W. F., & Brady, M. P. (1992). Proprioception in the cruciate deficient knee. *The Journal of bone and joint surgery. British volume*, *74*(2), 247–250.
Ireland M. L. (2002). The female ACL: why is it more prone to injury?. *The Orthopedic clinics of North America*, *33*(4), 637–651.
Dugan S. A. (2005). Sports-related knee injuries in female athletes: what gives? *American journal of physical medicine & rehabilitation*, *84*(2), 122–130.
Wilk, K. E., Reinold, M. M., & Hooks, T. R. (2003). Recent advances in the rehabilitation of isolated and combined anterior cruciate ligament injuries. *The Orthopedic clinics of North America*, *34*(1), 107–137.
Johansson, H., Sjölander, P., & Sojka, P. (1990). Activity in receptor afferents from the anterior cruciate ligament evokes reflex effects on fusimotor neurones. *Neuroscience research*, *8*(1), 54–59.
Risberg, M. A., Holm, I., Myklebust, G., & Engebretsen, L. (2007). Neuromuscular training versus strength training during first 6 months after anterior cruciate ligament reconstruction: a randomized clinical trial. *Physical therapy*, *87*(6), 737–750.
Paterno M. V. (2017). Non-operative Care of the Patient with an ACL-Deficient Knee. *Current reviews in musculoskeletal medicine*, 10(3), 322–327.
van Melick, N., van Cingel, R. E., Brooijmans, F., Neeter, C., van Tienen, T., Hullegie, W., & Nijhuis-van der Sanden, M. W. (2016). Evidence-based clinical practice update: practice guidelines for anterior cruciate ligament rehabilitation based on a systematic review and multidisciplinary consensus. *British journal of sports medicine*, *50*(24), 1506–1515.
Panariello, R. A., Stump, T. J., & Maddalone, D. (2016). Postoperative rehabilitation and return to play after anterior cruciate ligament reconstruction. *Operative Techniques in Sports Medicine*, *24*(1), 35-44.
Cascio, B. M., Culp, L., & Cosgarea, A. J. (2004). Return to play after anterior cruciate ligament reconstruction. *Clinics in sports medicine*, *23*(3), 395–ix.
Paterno, M. V., Rauh, M. J., Schmitt, L. C., Ford, K. R., & Hewett, T. E. (2014). Incidence of Second ACL Injuries 2 Years After Primary ACL Reconstruction and Return to Sport. *The American journal of sports medicine*, *42*(7), 1567–1573.
Decker, M. J., Torry, M. R., Noonan, T. J., Sterett, W. I., & Steadman, J. R. (2004). Gait retraining after anterior cruciate ligament reconstruction. *Archives of physical medicine and rehabilitation*, *85*(5), 848–856.
Ernst, G. P., Saliba, E., Diduch, D. R., Hurwitz, S. R., & Ball, D. W. (2000). Lower extremity compensations following anterior cruciate ligament reconstruction. *Physical therapy*, *80*(3), 251–260.
Mattacola, C. G., Perrin, D. H., Gansneder, B. M., Gieck, J. H., Saliba, E. N., & McCue, F. C., 3rd (2002). Strength, Functional Outcome, and Postural Stability After Anterior Cruciate Ligament Reconstruction. *Journal of athletic training*, 37(3), 262–268.

MUSCULOSKELETAL TESTING IN THE FUNCTION OF INJURY PREVENTION OF CROATIAN FEMALE JUNIOR TENNIS PLAYER

Lucija Faj[1], Josip Cvenić[1]
[1] Faculty of Kinesiology, Osjek, Croatia

Introduction

Repetitive physical activity without proper rest or excessive amounts of high-intensity physical activity may increase the risk of injury, illness or improper functioning of the body. Overload of the body is a serious problem in young athletes for many reasons (eg, growing ligaments, bones, tendons and cartilage of the young athletes that cannot manage as much stress as mature, passive adult structures) (Matos and Winsley, 2007). Musculoskeletal testing is a common tool utilized in sports medicine to evaluate, treat and prevent injuries as well as to improve performance (Ellenbecker, 2009). Also, in order to determine whether a young athlete can tolerate a training program and reduce the risk of possible negative outcomes, a routine assessment of fatigue and recovery is very important (Halson, 2014). Quantifying the effect of peripheral fatigue-related changes in electrophysiological and dynamic muscle characteristics was investigated previously (Tosovic et al., 2016; Kallenberg et al., 2007). Diagnostic imaging methods such as ultrasound (US) and magnetic resonance (MRI) allow macroscopic changes in the structure of the injured muscle to be seen. In addition, tensiomyography (TMG) can measure the functional deficit of an injured muscle. It was first used in the 1990s for assessing the superficial muscles contractile properties. It can also be used to measure the radial muscle belly enlargements in a single muscle. In global, TMG is a potentially effective tool for detecting muscle fatigue after exercise and a tool to detect imbalances and asymmetries as potential risk factors for injury. (Park, 2020).

The aim of this study was to present a case of a 17-year old tennis player where musculoskeletal testing was used to assess a sport-specific musculoskeletal profile of the player at two points, with 6-month time distance. Also, the player complained of mild pain before the second testing so we present the contractile properties changes due to muscle fatigue signalizing the future training orientation of the player.

Methods

A right handed, 17-year-old female elite junior tennis player was tested by experienced kinesiologist several times during her development. Here, a musculoskeletal test results from 2018, are presented, at two points. At first measurement, the player was currently in training and/or competing, and was free from injuries that prohibited her full participation in her competition or training activities. The second test athlete took in the middle of the preparatory period, 6 months after the first presented test. At the time of second testing, the athlete complained of mild pain in her right shoulder and ankle. She attached an X-ray and an MRI of cervical spine and shoulders. X-ray and MRI of the cervical spine, and x-ray of the shoulder indicates tendinitis m.supraspinatus and subacromial clash syndrome of grade II. Then, the athlete was tested again using musculoskeletal tests in order to prevent further injuries and optimize the training process. Tests started with a manual examination, and a restriction of the myofascial system in the area is

observed lower leg of the back (area of m.gastrocnemius lateralis) more right side compared to on the left, a possible predisposition to the development of iliotibial tract syndrome if left untreated. There is also a restriction of the myofascial system in the area of the right foot, i.e., in the area of the metatarsal bone. Testing the right shoulder, Load and Shift test (Gerber and Ganz, 1984) is positive, which indicates instability shoulder (from anamnesis, earlier MRI indicates an injury to m.supraspinatus). It is recommended to work on activation and stabilization exercises for rotator cuff muscles.

All musculoskeletal tests were performed in the same location using the same methodology. Key components of the testing program were:

The measurement method known as TMG is used to identify the skeletal muscles' contractile properties, lateral and functional symmetry. During TMG, the muscle is stimulated with a single short electrical stimulus lasting 1 ms. Then, the measurements are performed under isometric conditions. The technique is based on the radial deformation of the isolated muscle belly and the time it takes for this action to occur during an isometric twitch contraction evoked by electrical stimulation (Simola et al., 2016). Five primary measures are obtained; one spatial measure expressed in millimeters (mm), and four temporal measures expressed in milliseconds (ms), which can be derived from the twitch displacement-time curve: muscle displacement (Dm), delay time (Td), contraction time (Tc), half-relaxation time (Tr), and sustain Time (Ts) (Figure 1).

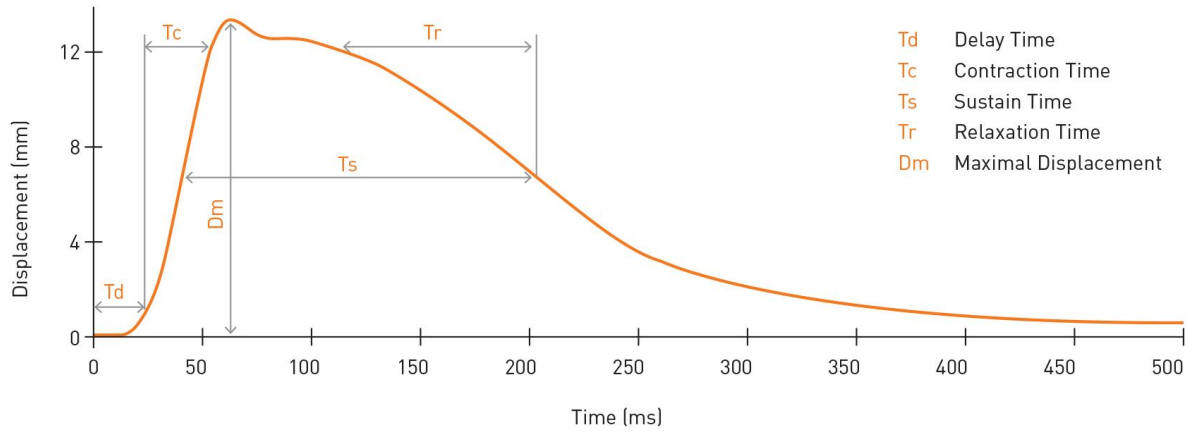


Figure 1. Parameter definitions in tensiomiyography.

The parameters presented in Figure 1. are the most evaluated primary TMG parameters, with the highest level of reliability (Tous-Fajardo et al., 2010; Krizaj et al., 2008). Dm provides the information of muscle fatigue, muscle stiffness and early atrophic processes (Pisot et al., 2016; Hunter et al., 2012; Ditroilo et al., 2011; Pisot et al., 2008). As can be read from the Figure 1., Td reflects the time from the onset of electrical stimulation until 10% of Dm. This is characterized as reaction or activation time (Alentorn-Geli et al., 2015). Tc is defined as the time lapse between 10 and 90% of the peak value of Dm (Figure 1). This measure is commonly linked to muscle fibre type composition (Simunic et al., 2011; Dahmane et al., 2001), and speed of force generation (Loturco et al., 2016). TMG measurements are done on both sides of the body. It allows to compare the parameters given on the Figure 1. This means that a symmetry can be evaluated by comparing the

superficial muscles contractile properties between the right and left side. This is called lateral symmetry. Also, it allows a measurement of functional symmetry since the muscles that surround a joint are also measured. To establish a measurement based on the TMG parameters given in the Figure 1, an algorithm has been developed and implemented in the TMG-BCM tensiomyography® software. Additionally, statistical analysis and the differences between antagonistic pairs, synergistic pairs and lateral pairs are calculated. The measured subject is in a predefined position. Joints are put in a natural physiognomic position – flexed for 5 – 30 degrees. Both electrodes are placed on the isolated muscle belly; the positive electrode (anode) is placed proximally and the negative electrode (cathode) distally. The surface electrodes are self-adhesive. The measuring tool – the displacement sensor is pressed to the skin above the measured muscle belly, radially to the surface. The positioning of the sensor is performed in a voluntary contracted or electrically stimulated muscle by palpation. Electrical stimulation consists of a single DC electrical stimulus of 1 ms duration. Its amplitude is of supramaximal value. The stimulator is powered by internal batteries. The stimuli are repeated three to five times with at least 5 s pauses between them. Muscle responses are stored and analyzed with an algorithm. The standard output of a TMG measurement is a table of results and a software compares measured subject's data and the database of average responses for each muscle or the database on a specific sport (in this case tennis).

Besides TMG, the muscle strength was evaluated using Load and Shift and manual dynamometry tests. The results obtained show the strength of individual muscle groups, bilateral muscle asymmetry (difference between left and right side) and functional asymmetry (difference between agonist and antagonist).

Then, the flexibility – hip flexion, extension, and abduction were measured using a universal digital goniometer. During the goniometric measurements, the player was positioned prone with test side knee extended (hip extension), supine (hip flexion) and supine with hips and knees in neutral position (hip abduction). The mobility tests were done by the same experienced kinesiologist at the same time during the day after a day of rest. The tests were done to check the possibility of passive movement of the joints in the expected directions and the range with respect to the characteristics of the joint. The range of motion is essential for determining the arthrokinetic and biomechanical characteristics of the joint.

Results and discussion

The results of the research indicate that on the initial measurement, the player achieved better average values in overall lateral symmetry considering both sides of 24 measured muscles (Sym3=77.1 % > Sym9=72.7 %) and functional symmetry considering 6 main joints (78.4>68.2). In both measurements highest overall symmetry data is recorded for muscle vastus medialis of 92% observed left and right side at first point, while at the second point the same muscles have a symmetry of 96%. The test results in the second measurement suggest to an overtrained state of the organism. In the second measurement, there is a noticeable decrease in the level of strength in certain segments, i.e. the muscles of the hip joint and ankle joint compared to the first test (Figures 2 and 3).

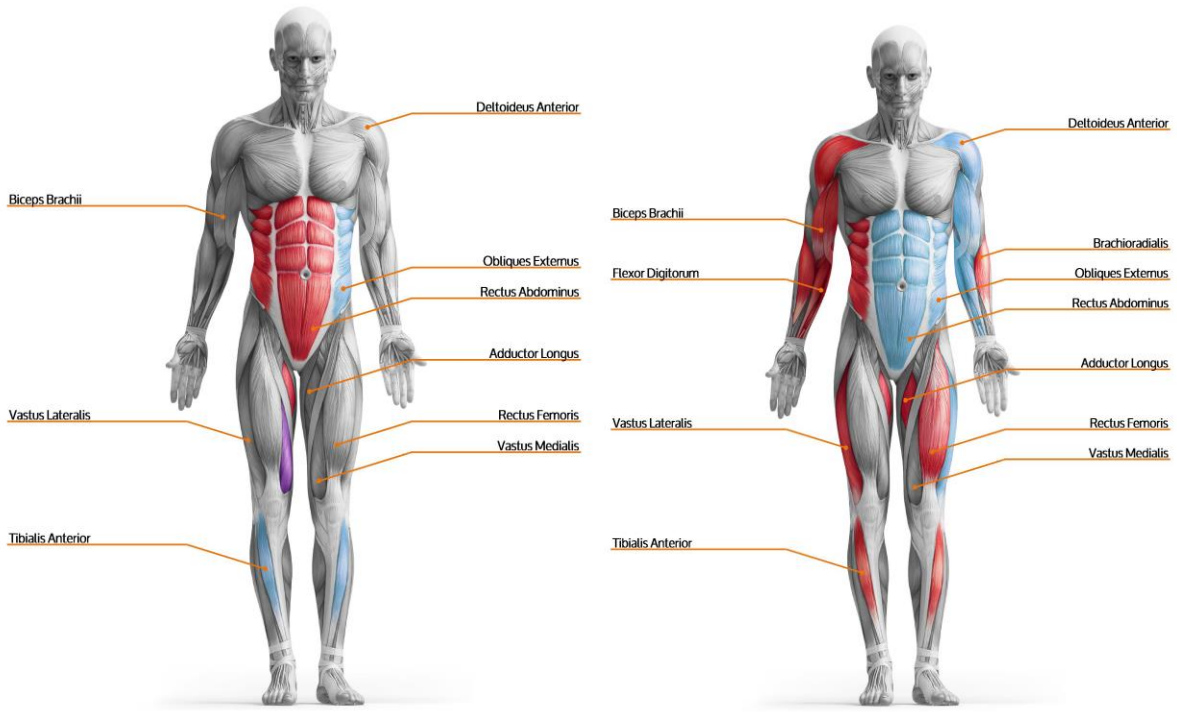


Figure 2. Anterior muscle legend with indication of the need for activation (red color), strength (purple color) or strectching excercises (blue color) of both TMG measurements. Results of the first measurements are presented on the left, and results of the second measurements on the right side.

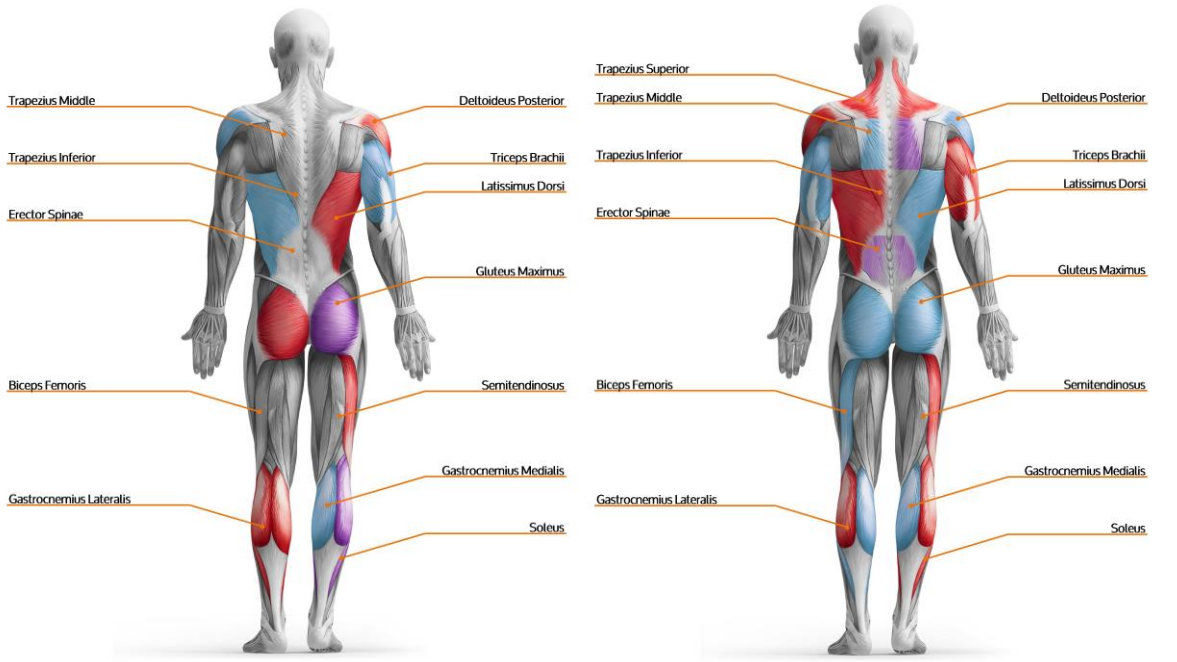


Figure 3. Posterior muscle legend with indication of the need for activation (red color), strength (purple color) or strectching excercises (blue color) of both TMG measurements. Results of the first measurements are presented on the left, and results of the second measurements on the right side.

In summary, the TMG determine muscle contractile properties changes due to muscle fatigue which helped player to decide next training load orientation. In addition, it detects muscle group imbalances and side-to-side asymmetries that can alert player to take radiological diagnostics in the near future. So, the TMG parameters can be useful to control and individualize the players training load, either during a specific period or through the entire season.

Also, the comparison of measuring variables in flexibility, better average values in initial measurement were shown (70.8 cm >65.0 cm). The flexibility test results obtained on flexion, extension and abduction of hip joint indicate a predominantly satisfactory state of training. In the second measurement only, extensions of hip were not on satisfied level (L leg 28 cm- R leg 25 cm). The mobility tests established the orderly mobility of the tested segments in the full range of motion in the hip joint and reduced mobility and pain when performing movements in the ankle joint.

Nevertheless, in the second measurement, player achieved better average dynamometry values (174.5<224.2). The hip joint was tested through flexion and extension, adduction and abduction. The knee joint was tested through flexion and extension. The results in the second measurement indicate that attention should be paid to the strength level of the hip flexors of the left and right leg, left and right hip abductors. Measurements of hip extension and flexion showed unsatisfactory strength values (expressed in Newtons) of the left and right leg compared to average tennis player results. In first measurement bilateral asymmetry was found due to weaker extensors and flexors of the left leg (Table 1) and it does not represent a problem cause the differences are small <10%. Nevertheless, the player is advised to reduce asymmetries evenly increasing the strength of all segments responsible for hip extension and flexion movements.

Table 1. Results of the dynamometry measurements of the hip extension and flexion. Differences are given as an absolute numbers (N) and percentage (%).

	Left	**Right**	**Diff (N;%)**	
Hip extension	163,7	180,7	17	9,41
Hip flexion	186,4	193,9	7,5	3,87
Functional diff (N;%)	-22,7 12,18	-13,2 6,81		

Conclusion

The information in this article provides a guide to the interpretation and application of the objective musculoskeletal testing programs in elite junior female tennis player. It has been done for both, injury prevention and performance enhancement. The results showed that TMG recognized the muscle contractile properties changes due to muscle fatigue signalizing the player the orientation of the training in the future. Based on the results presented, the player should continue with systematic strength training in order to raise the current values to a higher level and to avoid major asymmetries in strength but the training load should assure that overtrained state of the organism will be avoided.

References

Alentorn-Geli, E., Álvarez-Díaz, P., Ramon, S., Marin, M., Steinbacher, G., Boffa, J.J. (2015). Assessment of neuromuscular risk factors for anterior cruciate ligament injury through tensiomyography in male soccer players. *Knee Surgery, Sports Traumatology, Arthroscopy*. 23 (9), 2508–2513.

Dahmane, R., Valenčič, V., Knez, N., Eržen, I., 2001. Evaluation of the ability to make non-invasive estimation of muscle contractile properties on the basis of the muscle belly response. *Medical and Biological Engeneering and Computing* 39 (1), 51–55.

Ditroilo, M., Hunter, A.M., Haslam, S., de Vito, G. (2011). The effectiveness of two novel techniques in establishing the mechanical and contractile responses of biceps femoris. *Physiological Measurement* 32 (8), 1315–1326.

Ellenbecker, T.S, Pluim, B., Vivier, S., Sniteman, C. (2009). Common injuries in tennis players: exercises to address muscular imbalances and reduce injury risk. *Strength and Conditioning Journal*, 31(4), 50-58.

Halson, S. L. (2014). Monitoring training load to understand fatigue in athletes. *Sports Medicine.* 44, 139–147.

Hunter, A.M., Galloway, S.D.R., Smith, I.J., Tallent, J., Ditroilo, M., Fairweather, M.M. (2012). Assessment of eccentric exercise-induced muscle damage of the elbow flexors by tensiomyography. *Journal of Electromyography and Kinesiol*ogy 22 (3), 334–341.

Gerber, C., & Ganz, R. (1984). Clinical assessment of instability of the shoulder. With special reference to anterior and posterior drawer tests. The Journal of bone and joint surgery. British volume, 66(4), 551–556. https://doi.org/10.1302/0301-620X.66B4.6746691

Kallenberg, L.A., Schulte, E., Disselhorst-Klug, C., Hermens, H. J. (2007). Myoelectric manifestations of fatigue at low contraction levels in subjects with and without chronic pain. *Journal of electromyography and kinesiology: official journal of the International Society of Electrophysiological Kinesiology*, *17*(3), 264–274.

Krizaj, D., Simunic, B., & Zagar, T. (2008). Short-term repeatability of parameters extracted from radial displacement of muscle belly. *Journal of electromyography and kinesiology: official journal of the International Society of Electrophysiological Kinesiology*, *18*(4), 645–651.

Loturco, I., Pereira, L. A., Kobal, R., Kitamura, K., Ramírez-Campillo, R., Zanetti, V., Abad, C. C., Nakamura, F. Y. (2016). Muscle Contraction Velocity: A Suitable Approach to Analyze the Functional Adaptations in Elite Soccer Players. *Journal of sports science & medicine*, *15*(3), 483–491.

Matos, N., Winsley, R. J. (2007). Trainability of young athletes and overtraining. *Journal of sports science & medicine*, *6*(3), 353–367.

Park, S. (2020). Theory and usage of tensiomyography and the analysis method for the patient with low back pain. *Journal of exercise rehabilitation*, *16*(4), 325.

Pisot, R., Simunic, B., Dolenc, P. (2016). Physical inactivity effects on morphological and muskuloskeletal changes. *Acta Salus Vitae* 4 (1), 34–49.

Pisot, R., Narici, M.V., Simunic, B., de Boer, M., Seynnes, O., Jurdana, M. (2008). Whole muscle contractile parameters and thickness loss during 35-day bed rest. *European Journal of Applied Physiology* 104 (2), 409–414.

Simola, R., Raeder, C., Wiewelhove, T., Kellmann, M., Meyer, T., Pfeiffer, M. (2016). Muscle mechanical properties of strength and endurance athletes and changes after one week of intensive training. *Journal of Electromyography and Kinesiology* 30, 73–80.

Šimunič, B., Degens, H., Rittweger, J., Narici, M., Mekjavić, I. B., Pišot, R. (2011). Noninvasive estimation of myosin heavy chain composition in human skeletal muscle. *Medicine and science in sports and exercise*, *43*(9), 1619–1625.

Tosovic, D., Than, C., Brown, J. M. (2016). The effects of accumulated muscle fatigue on the mechanomyographic waveform: implications for injury prediction. *European journal of applied physiology*, *116*(8), 1485–1494.

Tous-Fajardo, J., Moras, G., Rodríguez-Jiménez, S., Usach, R., Doutres, D. M., Maffiuletti, N. A. (2010). Inter-rater reliability of muscle contractile property measurements using non-invasive tensiomyography. *Journal of electromyography and kinesiology: official journal of the International Society of Electrophysiological Kinesiology*, *20*(4), 761–766.

THE IMPACT OF "BABY SWIMMING" ON THE HEALTH AND DEVELOPMENT OF INFANTS AND BABIES

Aleksandra Piljak[1], Anastasija Kocić[1]
[1] University of Belgrade, Faculty of Sport and Physical Education, Belgrade, Serbia

Introduction

Swimming is one of the most important forms of human movement. The application of this movement appears in different forms, the most often in a recreational and competitive forms, but its importance is also reflected in the form of rehabilitation. Thus, swimming is used as a means of recovery from injuries (Smith et al., 2006) or to improve general physical condition (Cox et al., 2010; Gappmaier et al., 2006; Taaffe et al., 1995). According to the author's opinion, the influence of swimming would certainly be significant for use in young people, especially in children and babies.

Previous studies show that swimming causes significant progress in the neuropsychological development of children, the development of movement and emotions, as well as that it promotes the development of speech (A. I. Kliorin, N. Zh. Aleksandrovich, 1989; Jorgensen 2012). In recent years, researchers have used a number of methods, including swimming to treat and care for jaundiced infants (Zhou, 2015), while others have looked at the effect of swimming on children suffering from respiratory difficulties (Font-Ribera et al., 2011; Wang, 2009). "Besides athletics and gymnastics, swimming is another sport that belongs to the group of basic sports. Swimming is characterized by a number of physiological specificities that make it different from the usual activities outside the water environment'' (Ilić, 2021). Babies have a locomotor reflex of automatic swimming, so there lies the answer for babies who seem to know how to swim. While swimming, babies develop the muscles needed to hold their head up, move their arms and legs, and build their core in coordination with the rest of their body. The bathing procedure is not standardized; therefore, there is no consensus regarding water temperature or procedures to be performed during bathing (Nishino et al., 2021). Based on the available literature, the use of water in different forms and at different temperatures can have different effects on different body systems (Mooventhan et al., 2014). Swimming can improve cognitive functioning. When swimming, a baby moves their arms while kicking their legs, which means their brain registers the tactile sensation of the water plus its resistance.

When exercising in the pool, scientists have proven that the fine motor skills of the hands develop, which is connected to the nervous system and speech. Breathing exercises, such as puffing the cheeks and controlled breathing are additional speech therapy exercises and help improve pronunciation in the future (NDFAuthors, 2022). "Swimming for babies can have quite specific effects in the motor domain, as well as other potential positive benefits that should also be explored in other areas of importance for child development" (Sigmundsson & Hopkins, 2009). It is incredibly exciting to see that specific training for babies has impact on abilities later in life," says Prof. Sigmundsson. Infants' participation in aquatic activities has increased significantly over the last few decades. The proposed aquatic programs are not aimed at teaching babies (usually between 6-36 months) to swim or prevent drowning, instead therefore, they should aim to contribute to their sensory and motor development (Martins, et al., 2020).

The aim of this paper is to analyze previous research that has studied swimming infants and babies, show how staying in water affects their health, motor, social and cognitive development. The research was conducted with the aim of determining the impact of early activities of infants and babies in the water (swimming for babies) on the growth, development and health of children (strong influence of experience).

Methods

Inclusion criteria were studies conducted on babies that assessed the impact of infant and toddler swimming on their health, social and cognitive development.

Table 1. Criteria for inclusion and exclusion of works

Eligibility Criteria	Exclusion criteria
Swimming and being in water for newborns and babies that affects health, motor, social and cognitive development, speech development	Abstracts without presented complete papers
Studies involving components affected by swimming: motor skills, growth and early motor development, sleep patterns, communication withadults and other children, development of movement, emotions and speech, environmental factors	A sample of respondents that does not belong to newborns and babies up to 36 months
Infants and babies of both sexes	Research in which children after 36 months of age are included as a sample of respondents
Research covered until September 2022.	Research that includes children with disabilities, autism, children born prematurely, orsick children as a sample of respondents and Case study

Search Strategy

The search was conducted in electronic databases: PubMed, Web of Science, KoBSON, SCIndeks, Google Scholar. The last search was conducted in September 2022. Search terms: baby swimming, health, growth, infant swimming, swimming benefits, etc. Language was limited to Serbian, Croatian and English.

Data Collection Process and Quality Analysis

Titles and abstracts of papers that met the inclusion criteria were reviewed, and full-text articles that met the requirements were included in this review.

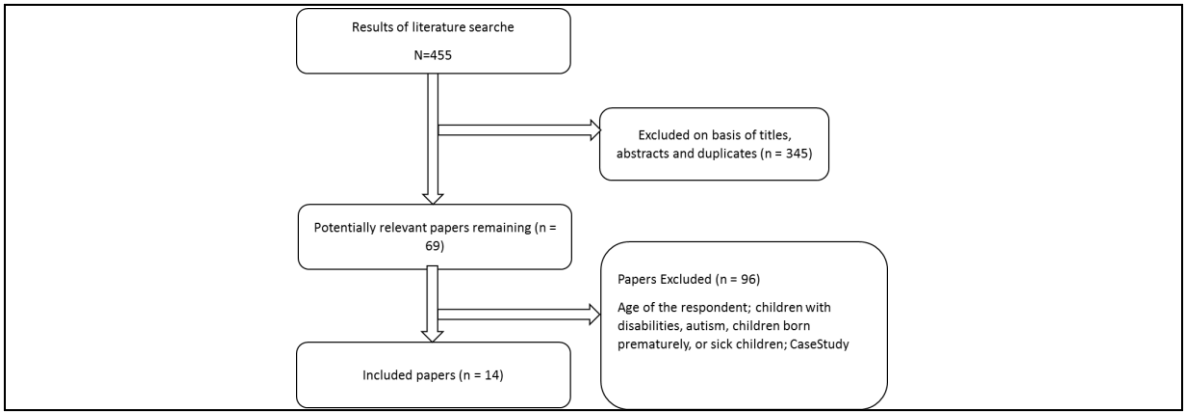


Figure 1. Flow diagram of the search process of the impact of "baby swimming" on the health and development of infants and babies

Results

The literature search identified 455 potentially relevant studies (Figure 1). After reviewing 345 studies were excluded (based on titles, abstracts and duplicates), and the remaining 110 studies were analyzed. 96 were excluded based on the criteria, resulting in 14 included papers that were analyzed.

Characteristics of the Included Studies

Table 2. shows that most of the studies were performed on the infant and toddler population. Regarding the age of the subjects, infants and babies up to 36 months were analyzed. The research results indicated that there is a connection between infant and baby swimming and motor development, speech development, social and cognitive development. Swimming in babies causes: a regular sleep, stimulates and balances hormones, improves the immune system, blood circulation and helps strengthen muscles, affects the optimal development of the brain and organs and optimizes the ability of the sensory organs. Swimming increases lung capacity, which improves blood flow to the brain. Water relaxes and relieves stress in babies. Babies move freely and actively in the water, and by overcoming the resistance of the water, they strengthen all muscle groups and develop their joints. While swimming, the fine motor skills of the hands are developed, which is connected with the child's nervous system, vision, attention and perception. The data also showed the health benefits of the physical activity of infants in the water, which range from cardiovascular adaptations to the development of motor and social interaction.

Table 2. Characteristics of the included studies

Author	Participants	Sports/activity	Age	Main Results
Borioni,F. (2022)	(N=27)	Swimming; swimming for babies	Babies from 13 months and babies from 22 months	Improvement of gross and fine motor skills
Dias, J. (2013)	(N=12)	Swimming	Babies aged 7 to 9 months	The experimental group showed an increase; swimming lessons have a more general and qualitative effect on motor development

Costa,MJ. (2016)	(N=14)	Swimming program	Babies (36±5.08 months) were tested before (M1) and 4 months after (M2)	Auditory frequency adaptations; greater ability to perform basic aquatic motor skills and less stressful behaviour
Leo, I. (2022)	(N=28)	Water activities	Infants 6-10 months	The younger infants in the experimental group have a higher level of motor development than the older ones in the control group
Martins, M. (2020)	(N=14) babies with previous experience in water	Swimming	Babies 13.7±7.5 months and with experience of 7.71±7.54 months	Swimming contributes to the development of the child and affects the development of motor and social interaction
Martins, M. (2006)	(N=66)	Swimming; water activities	Babies 3 months to 36 months	Social, cognitive and motor development; security development; awareness of body; positive changes in biological maturation
Oktapiani, A. (2020)	(N= 31)	Swimming: Baby Spa	Babies 3-6 months	Reduction of fatigue; improvement of blood circulation; regular sleep; strengthening of the immune system; stimulation of enzymes in the stomach; muscle strengthening; brain development and optimization of sensory organs
Pedroso, F. (2012)	(N= 31)	Swimming: diving reflex	Infants between 2 and 6 months to 12 months	Diving reflex observed in newborns and infants. At 6 months it decreases, but it persist in 90% of infants up to 12 months
Sigmundsson, H. (2021)	Iceland: (N=38), (N=19) children with and (N=19) children without baby swimming experience	Swimming	Babies 3 to 7/8 months	Swimming for babies is important for the motor development and the specificity of learning; stimulants are key to development; positive effect on concentration,

Sigmundsson, H. (2017)	(N=12)	Swimming for babies	Babies 3 to 5 months	The existence of motor learning in a standing position; the development of independent standing is under the influence of genetic and environmental factors
Sigmundsson, H. (2009/2010)	(N=38)	Swimming and swimming program for babies	Babies aged 2 to 7 months and as children aged 4-5 years (the research was carried out after 4 years:	Physical exercise and swimming programs for babies have positive effects on the development of motor skills; baby swimming provides vestibular stimulation; positive effects in motor domain
Sudiro,K. (2018)	(H= 70) baby; (H=35)- intervention group (H=35) control group	Swimming: Baby Spa	Babies aged 3-12 months	Baby swimming has a relaxing effect on babies; sleep better; development of motor movements; increased oxygen intake; lung development; stretching the muscles and straightening the body and joints after birth
Zelazo, P.R. (2006)	(N=30)	Swimming Daily training of five swimming behaviors	Babies aged 4 months (±20 days); babies aged 8 months (±20 days); babies aged 12 months (± 10 days); babies aged 16 months (±16 days)	Improving water skills and behaviours in babies in organised exercise
Wayan, N.N. (2018)	(N=20)	Swimming, i.e. bathing in water	Infants aged 3-6 months	Stimulation of motor movement; positive influence on the growth and development of infants aged 3-6 months

Discussion

The research was conducted with the aim of showing how being in water (swimming for babies) affects motor, social and cognitive development, speech development, as well as to determine the effects of early activities of infants and babies in water on growth, development and health (strong influence of experience).

Wayan (2018) suggests that caring for a baby is not enough just as a routine treatment, but must be with a lot of attention, activity and affection. Playing with water, the baby's muscles develop, body growth increases, and the body becomes flexible. The primary goal of baby swimming is to stimulate the activities of infants, while its function is to increase IQ, strengthen health and stimulate motor movements, reduce fear of water, improve social skills, independence, courage and strengthen self- confidence.

The age of 4-6 months is the best time for the baby to learn about the pool, because of the diving reflex that has not yet disappeared (the ability to inhale before touching the water) and

which prevents them from swallowing water while in the water. The diving reflex is fully observed in newborns and infants, while at 6 months of age it begins to decline (Pedroso et all, 2012; Panneton & Gan, 2020).

Martins, et al. (2020) collected and recorded data on infants' behavior during a routine swimming session through natural observation and using video recordings. The dimension of motor behavior included the child's interaction (with an adult, another child, water or an object) and motor skills, while the socio-affective dimension followed the child's gaze (on another child, on an adult, on water, on an object) and emotional expressions (laughs, cries, screams, is passive, uncomfortable). The researchers believe that the application of a child-oriented methodology leads to positive behavior during this type of session and contributes to the healthy development of the child, and regarding the cognitive aspect of the child's development, the importance of water games in creating opportunities for the development of language and elementary mathematical concepts is emphasized.

In their work, Sudiro (2018) and colleagues comes to the conclusion that swimming and Spa for babies are a stimulation that is beneficial for the health and development of the baby. Playing in the water, the baby's muscles develop very well, the baby grows optimally, the body length increases, and the body becomes flexible. Baby Spa for babies is a stimulation that is beneficial for the health and development of the baby. According to research, it has been shown that babies who undergo hydrotherapy can learn to walk and balance more quickly.

Research by Sigmundsson (2021) showed that the practice of baby swimming in Iceland can be important for the child's motor development and supports the view of the specificity of learning. Research has shown that baby swimming, which includes 2 hours of training per week with children aged 3 to 7-8 months, can have a positive effect on hand-eye coordination, balance. Researchers say that infant swimming can also have a positive effect on concentration, attention and focus. Children observe and their senses and nervous system are constantly under various stimuli during their stay in the pool. Getting different stimuli is extremely important for brain development at any age. The brain grows and becomes stronger with training and exercise just like muscles. After the first year, it is important for the child to regularly go to the pool, to play, and after that to swim. In relation to the development of skills, it is possible to talk about quantitative and qualitative changes. Quantitative changes imply the development of new skills (the focus is not on the quality of skills). Qualitative changes include skill improvement. The child's development of new skills (quantitative development) and the achieved level of each skill (qualitative development) are indicators of his physical and mental health (Wayan, 2018). Hand control and balance are factors that are better in children who participated in baby swimming than in a control group that did not participate in such training, so it can be said that early intervention works in practice. The swimming program for babies aims at activities that promote hand-eye coordination and provide vestibular stimulation and have positive effects on motor development. Borioni et al. (2022) reveals that contact with water from birth can be an important experience for a child's development. Baby swimming affects development in the motor and cognitive domains. Analyzes revealed that infants in the swimming group improved gross, fine, and gross motor skills and showed slightly better inhibition speed and movement accuracy.

Martins et al. (2006) provide a characterization of the development of children (6-36 months) who participate in water adaptation classes for babies in different areas (motor

development, language, cognitive area, etc.) and analyze the importance that parents attribute to each of the developmental areas and its connection with the practice of this water activities. In the early stages of children's development, biological maturation is the strongest determinant of changes observed in behavior in the aquatic environment. Studies on this activity are therefore extremely important in order to provide solid scientific knowledge that allows parents and experts in this field to use grounded methodological instructions.

Sigmundsson et al. (2017) suggest that 3- to 5-month-old infants are capable of showing signs of motor learning while standing. Considered the process of development of independent standing in relation to the complex interaction between genetic and environmental factors. Studies of specific standing tasks have been conducted as part of the infant swimming routine and are considered safe. The findings of Costa et al. (2016) suggest that infants experience significant auditory frequency adaptations while participating in a swimming program and indicate greater ability to perform basic aquatic motor skills and less stressful behavior during lessons.

Dias et al. (2013) conducted a study to investigate how infant swimming courses may affect early motor development in infants. The advantage of the influence of swimming on motor development is in infants who have practiced it regularly compared to those who have never attended baby swimming courses. Numerous studies suggest potential improvements in motor development as a result of infant swimming (especially grasping and balance), however methodological limitations prevent definitive conclusions (Dias et al., 2013; Sigmundsson and Hopkins, 2010).

This is also the case with other findings such as Leo et al. (2022) which support the effect of water activities on motor development. The results showed that children involved in water activities (swimming) during the first year of life tend to have better motor skills. This research is therefore the first step in understanding how early forms of motor activity can positively influence the acquisition of new skills in infants. Since the movements become slower in the water, the sensory perception of these movements is enhanced. Emotions arise when the mind interprets body sensations, which in turn arise in response to various stimuli, so motor development should not be considered distant from cognitive and language processes. In the first months after birth, the baby's reflexes are triggered by the quantity and quality of received stimuli. The water environment is a multi-sensory stimulator, and its encounter with neuroplasticity in the first months of a child's life may be responsible for the differences in the motor domain between the experimental and control groups. Buoyancy, water density and hydrostatic pressure act as sensory stimuli on babies. (Devereux 2005). By swimming in water in conditions of less gravity, babies gain control over their muscles (Yahya, 2011). The first year of life is quite a critical period for a child. (Schoentgen et al., 2020). Investigating the relationship between motor development and infant swimming could provide a starting point for those who wish to investigate the stages of cognitive development in infants. Observation of motor skills, language and cognitive development would provide insight into the potential effectiveness of staying in water (swimming) in children aged 0 to 36 months. The results of this study provide evidence of the potential impact of early water activities on children's motor development, showing that infants in the experimental group, although younger than children in the control group, achieved a higher level of motor development after participating in water activities.

Physical activities in water can provide health benefits (Center for disease control, 2022; U.S. Department of Health and Human Services, 2008), and exercises in water can be beneficial to all age categories.

Conclusion

In the comprehensive systematization of the research, which aimed to investigate the impact of swimming of infants and babies on motor, social, and cognitive development, it was established that early swimming has a great impact, and the studies provide evidence of the potential impact of early water activities on children's motor development. It is inevitable to conclude that swimming from an early age contributes to the physical health and improvement of children's cognitive functioning. Activity in the water exposes the child to unique sensorimotor stimuli and provides multi-sensory stimulation by combining three sensory systems: tactile, proprioceptive and vestibular. The benefits of an aquatic environment for babies can provide useful knowledge, as early childhood is the most cost- effective period for long-term interventions (Reynolds, et al., 2001), and due to neuroplasticity, the effectiveness is greater (Hannaford, 2005). Difficulties in assessing children aged 3 to 36 months and the lack of available literature on infant and toddler swimming present certain limitations to the study. The limited prevalence of swimming courses and the acknowledged difficulty in recruiting sufficient numbers of infant subjects are likely to blame for the sometimes arbitrary age selection in the literature. This leads to a number of inconsistent or inexplicable results. Future research could shed light on the relationship between motor, language and cognitive development during the first year of life, so that water activities can be applied to motor development and extended to the language domain.

References

Borioni, F., Biino, V., Tinagli, V. & Pesce, C. (2022) Effects of Baby Swimming on Motor and Cognitive Development: A Pilot Trial. *Percept Mot Skills*, 129(4):977-1000.

Centers for Disease Control. (2022). Health Benefits of Swimming.

Costa,MJ., Barbosa, TM.,Ramos,A.& Marinho, DA.(2016). Effects of a swimming program on infants' heart rate response. *JSports Med Phys Fitness*. 2016 Apr;56(4):352-8.

Dias, JA., Manoel, EJ., Dias, RB.& Okazaki,VH. (2013). Pilot study on infant swimming classes and early motor development.Percept Mot Skills, 117(3),950-5.

Ilić, V.(2021). Pravo u vodu: plivanje jača srce i pluća, ali ne ispravlja kičmu.

Jorgensen, R., & Grootenboer, P. (2011). Early years swimming as a site for early mathematical learning Proceedings of theAnnual Mathematics Education Research Conference. Alice Springs: MERGA.

Jorgensen, R. (2012). Under-fives swimming as a site for capital building: Supporting and enhancing transitions.

Leo, I., Leone, S., Dicataldo, R., Vivenzio, C., Cavallin, N., Taglioni, C. & Roch M.(2022). A Non-Randomized Pilot Study on the Benefits of Baby Swimming on Motor Development. *International Journal of Environmental Research and Public Heal*th, 19(15), 9262.

Randomized_Pilot_Study_on_the_Benefits_of_Baby_Swimming_on_Motor_Development;

Mooventhan, A., and L. Nivethitha (2014). Scientific evidence-based effects of hydrotherapy on various systems of the body. *North American Journal of Medical Sciences*, 6 (5).

Martins M, Moreira A, Silva A J et al.(2006). Caracterização do desenvolvimento de crianças (6-36 meses) participantes emaulas de adaptação ao meio aquático para bebés. Motricidade. 2, 91–98.

Martins, M., Costa,A., Costa,MJ., Marinho,DA. and Barbosa, TM: (2020).Interactional Response During Infants' aquatic Sessions. *Sports Med Int*, 4 (3).

NDFAuthors, Jevtić, A. (2022). Kako plivanje doprinosi razvoju bebe.

Oktapiani, A., Patimah, S. & Rohmatin, E. (2020). Effect Of Baby Spa On Sleep Quality of Baby 3-6 Months. *Midwifery andnursing research (MANR) journal*, 2(2), 49-52.

Pedroso, F., et all. (2012). The diving reflex in healthy infants in the first year of life, *Journal of child neurology*, 27(2):168-71.

Sigmundsson, H., Hopkins B.(2009). Baby swimming: Exploring the effects of early intervention on subsequent motor abilities.*Child Care Health Dev*. 36, 428–430.

Sigmundsson H, Lorås H W, Haga M. (2017). Exploring task-specific independent standing in 3-to 5-month-old infants. *Front Psycho*l, 8, 657.

Sigmundsson, H. (2021). Specificity of learning, skill development and baby swimming in Iceland. *J. Phys. Educ. Sport*. 21, 549–552.

Sudiro, K., & Mulyati, S. (2018). Baby Spa Effect on Growth. *Asian Journal of Applied Sciences*, 6(5).

U.S. Department of Health and Human Services. (2008). Physical Activity Guidelines for Americans: Be active, healthy, and happy! In Chapter 2: Physical Activity Has Many Health Benefits. 2009.

Zelazo,P.R.,&Weiss, M. J. (2006). Infant swimming behaviors: cognitive control and the infl uence of experience. *Journal of Cognition and Development*, 7(1), 1-25.

Zhou K. (2015). Analysis of treatment progress on neonatal jaundice. World Latest *Med. Inform*. 31,58-60

Yilmaz, I., Yanarda, M., Birkan, B. & Bumin, G. (2004) Effects of swimming training on physical fitness and water orientation in autism. *Pediatrics Internationa*l,46, 624–626.

Wayan, N. (2018). The impact of baby spa on the growth and development of infants aged 3-6 months at Puskesmas I Denpasar Selatan. *International Journal of Research in Medical Sciences*, 6(8), 2601-2605.

UTICAJ „PLIVANJA ZA BEBE'' NA ZDRAVLJE I RAZVOJ ODOJČADI I BEBA

Aleksandra Piljak [1], Anastasija Kocić [1]
[1] Univerzitet u Beogradu, Fakultet sporta i fizičkog vaspitanja, Beograd, Srbija

Uvod

Plivanje predstavlja jedan od najvažnijih oblika kretanja čoveka. Primena ovog kretanja pojavljuje se u različitim oblicima, najčešće u rekreativnom i takmičarskom, ali značaj se ogleda i u rehabilitacionom obliku. Tako se plivanje koristi kao sredstvo oporavka usled povreda (Smith et al., 2006) ili za poboljšanje opšteg telesnog stanja. (Cox et al., 2010; Gappmaier et al., 2006; Taaffe et al., 1995). Prema mišljenju autora, uticaj plivanja svakako bi bio značajan za primenu kod mladih, posebno kod dece i beba.

Dosadašnje studije pokazuju da plivanje uzrokuje značajan napredak u neuropsihičkom razvoju dece, razvoju pokreta i emocija kao i da pospešuje razvoj govora. (A. I. Kliorin, N. Zh. Aleksandrovich, 1989; Jorgensen, 2012). Poslednjih godina istraživači su koristili brojne metode, uključujući plivanje za lečenje i negu novorođenčadi sa žuticom (Zhou, 2015), dok su drugi razmatrali uticaj plivanja na decu koja pate od respiratornih poteškoća (Font-Ribera et al., 2011; Wang, 2009). ,,Pored atletike i gimnastike, plivanje je još jedan sport koji pripada grupi bazičnih sportova. Plivanje se odlikuje nizom fizioloških specifičnosti zbog kojih se razlikuje od uobičajenih aktivnosti van vodene sredine. '' (Ilić, 2021). Bebe poseduju lokomotorički refleks automatskog plivanja, pa tu leži odgovor za bebe koje naizgled znaju da plivaju. Prilikom plivanja bebe razvijaju mišiće potrebne da drže glavu gore, pomeraju ruke i noge i grade svoje jezgro u koordinaciji sa ostatkom tela. Postupak kupanja nije standardizovan; dakle, ne postoji konsenzus u vezi sa temperaturom vode ili procedurama koje treba obaviti tokom kupanja (Nishino et al., 2021). Na osnovu dostupne literature upotreba vode u različitim oblicima i na različitim temperaturama može imati različite efekte na različite sisteme tela (Mooventhan et al., 2014). Plivanje može poboljšati kognitivno funkcionisanje. Kada pliva, beba pomera ruke dok udara nogama, što znači da njihov mozak registruje taktilni osećaj vode plus njen otpor.

Prilikom vežbanja u bazenu, naučnici su dokazali da se razvija fina motorika ruku, što je povezano sa nervnim sistemom i govorom. Vežbe disanja, kao što su naduvavanje obraza i kontrolisano disanje su dodatne vežbe logopedske terapije i pomažu u poboljšanju izgovora u budućnosti (NDFAuthors, 2022).

,,Plivanje za bebe može imati prilično specifične efekte u domenu motorike, kao i druge potencijalne pozitivne koristi koje takođe treba istražiti u drugim oblastima od značaja za razvoj deteta''. (Sigmundsson & Hopkins, 2009) "Neverovatno je uzbudljivo videti da specifični trening beba ima uticaj na kasnije sposobnosti u životu", kaže prof. Sigmundsson. Učeše odojčadi u vodenim aktivnostima značajno se povećalo u poslednjih nekoliko decenija. Predloženi vodeni programi imaju za cilj da doprinesu njihovom senzornom i motoričkom razvoju.(Martins, et al., 2020)

Cilj ovog rada bio je da se analizom dosadašnjih rezultata istraživanja, koja su proučavala plivanje novorođenčadi i beba, prikaže na koji način boravak u vodi utiče na njihovo zdravlje, na motorički, socijalni i kognitivni razvoj. Istraživanje je sprovedeno sa ciljem utvrđivanja uticaja ranih aktivnosti odojčadi i beba u vodi (plivanje za bebe) na rast, razvoj i zdravlje dece (snažan uticaj iskustva).

Metode

Kriterijumi za uključivanje su bile studije sprovedene na bebama gde je procenjivan uticaj plivanja novorođenčadi i beba na njihovo zdravlje, na motorički, socijalni i kognitivni razvoj.

Tabela 1. Kriterijumi za uključivanje i isključivanje radova

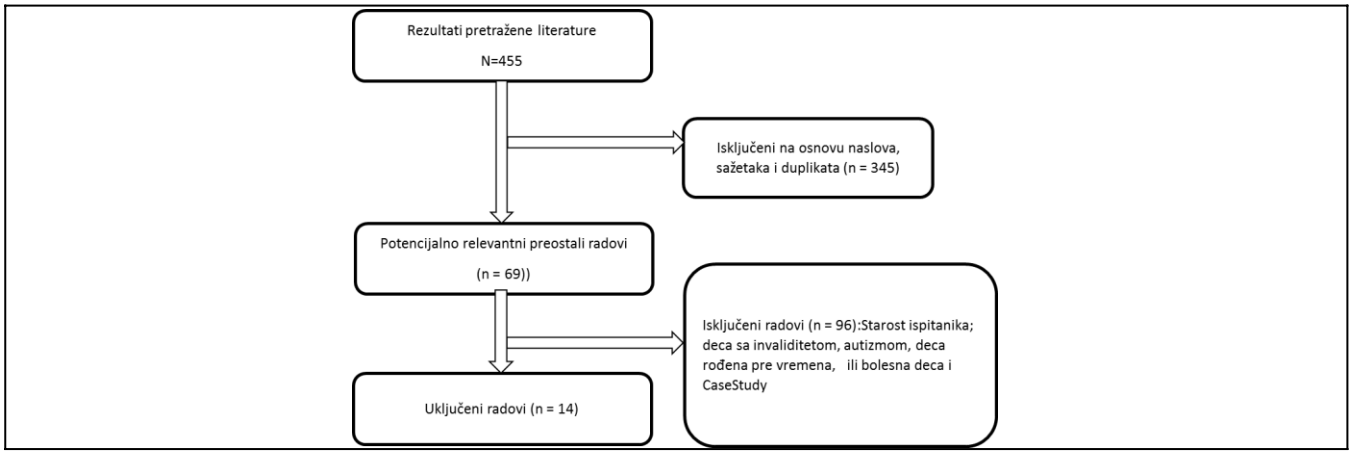
Kriterijumi za uključivanje	Kriterijumi za isključivanje
1. Plivanje i boravak u vodi novorođenčadi i beba koje utiče na zdravlje, na motorički, socijalni i kognitivni razvoj, razvoj govora	1. Abstrakti bez prikazanih kompletnih radova
2.Studije koje uključuju komponente na koje utiče plivanje: motoričke sposobnosti, rast i rani motorički razvoj, obrazac spavanja, komunikaciju sa odraslima i drugom decom, razvoj pokreta, emocija i govora, faktore sredine	2. Uzorak ispitanika koji ne spada u novorođenčad i bebe do 36 meseci
3. Novorođenčad i bebe oba pola	3. Istraživanja u kojima su obuhvaćena deca posle 36 meseci starosti kao uzorak ispitanika.
4. Istraživanja obuhvaćena do septembra2022. godine	4. Istraživanja u kojima su obuhvaćena deca sa invaliditetom, autizmom, deca rođena pre vremena, ili bolesna deca kao uzorak ispitanika i Case study

Strategija pretraživanja

Pretraživanje literature je sprovedeno u sledećim elektronskim bazama podataka: PubMed, Web of Science, KoBSON, SCIndeks, Google Scholar. Poslednje pretraživanje je obavljeno u septembru 2022. Strategije pretraživanja su koristile sledeće sistematske termine za pretraživanje: motoričke sposobnosti, razvoj, plivanje za odojčad, plivanje za bebe, učenje, ravnoteža, novorođenčad ili bebe, plivanje za odojčad, socijalna interakcija, govor, zdravlje, rast, ponašanje odojčadi, development, infant swimming; baby swimming, learning, swimming benefits, motor ability, Baby spa, growth, infant behavior. Jezik je bio ograničen na srpski, hrvatski i engleski jezik.

Proces prikupljanja podataka i analiza kvaliteta

Pregledani su naslovi i apstrakti radova koji su ispunili kriterijume za uključivanje, a članci sa punim tekstom, koji su ispunili uslove (uzrast, pol, sport, rezultati) su uključeni u ovaj pregled.



Slika 1. Dijagram toka procesa pretraživanja plivanja novorođenčadi i beba

Rezultati

Pretraživanjem literature identifikovana su 455 potencijalno relevantna rada (Slika 1). Nakon pregleda 345 studija je isključeno (na osnovu naslova, sažetaka i duplikata), a analizirano je preostalih 110 studija. Na kraju, 96 studija je isključeno zbog starosti ispitanika, deca sa invaliditetom, autizmom, deca rođena pre vremena i drugih karakteristika. Ovo je rezultiralo sa 14 uključenih radova koji su analizirani u ovom pregledu.

Karakteristike uključenih studija

Tabela 2. pokazuje da je većina studija izvedena na populaciji novorođenčadi i beba. Što se tiče starosti ispitanika analizirana su novorođenčad i bebe do 36 meseci. Rezultati istraživanja su ukazali da postoji povezanost plivanja novorođenčadi i beba i motoričkog razvoja, razvoja govora, socijalnog i kognitivnog razvoja. Plivanje kod beba izaziva: redovan san, stimuliše i uravnotežava hormone, poboljšavaja imuni sistem, cirkulaciju krvi i pomaže u jačanju mišića, utiče na optimalan razvoj mozga i organa i optimizuje sposobnost čulnih organa. Plivanje povećava kapacitet pluća, što poboljšava dotok krvi u mozak. Voda opušta i ublažava stres kod beba. Bebe se slobodno i aktivno kreću u vodi, a savladavajući otpor vode jačaju sve mišićne grupe i razvijaju zglobove. Prilikom plivanja razvija se fina motorika ruku, što je povezano sa nervnim sistemom, vidom, pažnjom i percepcijom deteta. Podaci su pokazali i zdravstvene koristi od fizičke aktivnosti odojčadi u vodi koje se kreću od kardiovaskularnih adaptacija do razvoja motoričke i socijalne interakcije.

Tabela 2. Karakteristike obuhvaćenih studija

Author	Participants	Sports/activity	Age	Main Results
Borioni,F. (2022)	(N=27)	Swimming; swimming for babies	Babies from 13 months and babies from 22 months	Improvement of gross and fine motor skills
Dias, J. (2013)	(N=12)	Swimming	Babies aged 7 to 9 months	The experimental group showed an increase; swimming lessons have a more general and qualitative effect on motor development
Costa,MJ. (2016)	(N=14)	Swimming program	Babies (36±5.08 months) were tested before (M1) and 4 months after (M2)	Auditory frequency adaptations; greater ability to perform basic aquatic motor skills and less stressful behaviour
Leo, I. (2022)	(N=28)	Water activities	Infants 6-10 months	The younger infants in the experimental group habe a higher level of motor development than the older ones in the control group
Martins, M. (2020)	(N=14) babies with previous experience in water	Swimming	Babies 13.7±7.5 months and with experience of 7.71±7.54 months	Swimming contributes to the development of the child and affects the development of motor and social interaction
Martins, M. (2006)	(N=66)	Swimming; water activities	Babies 3 months to 36 months	Social, cognitive and motor development; security development; awareness of body; positive changes in biological maturation
Oktapiani, A. (2020)	(N= 31)	Swimming: Baby Spa	Babies 3-6 months	Reduction of fatigue; improvement of blood circulation; regular sleep; strengthening of the immune system; stimulation of enzymes in the stomach; muscle strengthening; brain development and optimization of sensory organs
Pedroso, F. (2012)	(N= 31)	Swimming: diving reflex	Infants between 2 and 6 months to 12 months	Diving reflex observed in newborns and infants. At 6 months it decreases, but it persist in 90% of infants up to 12 months

Sigmundsson, H. (2021)	Iceland: (N=38), (N=19) children with and (N=19) children without baby swimming experience	Swimming	Babies 3 to 7/8 months	Swimming for babies is important for the motor development and the specificity of learning; stimulants are key to development; positive effect on concentration,
Sigmundsson, H. (2017)	(N=12)	Swimming for babies	Babies 3 to 5 months	The existence of motor learning in a standing position; the development of independent standing is under the influence of genetic and environmental factors
Sigmundsson, H. (2009/2010)	(N=38)	Swimming and swimming program for babies	Babies aged 2 to 7 months and as children aged 4-5 years (the research was carried out after 4 years:	Physical exercise and swimming programs for babies have positive effects on the development of motor skills; baby swimming provides vestibular stimulation; positive effects in motor domain
Sudiro,K. (2018)	(H= 70) baby; (H=35)- intervention group (H=35) control group	Swimming: Baby Spa	Babies aged 3-12 months	Baby swimming has a relaxing effect on babies; sleep better; development of motor movements; increased oxygen intake; lung development; stretching the muscles and straightening the body and joints after birth
Zelazo, P.R. (2006)	(N=30)	Swimming Daily training of five swimming behaviors	Babies aged 4 months (±20 days); babies aged 8 months (±20 days); babies aged 12 months (± 10 days); babies aged 16 months (±16 days)	Improving water skills and behaviours in babies in organised exercise
Wayan, N.N. (2018)	(N=20)	Swimming, i.e. bathing in water	Infants aged 3-6 months	Stimulation of motor movement; positive influence on the growth and development of infants aged 3-6 months

Diskusija

Istraživanje je sprovedeno sa ciljem da se prikaže na koji način boravak u vodi (plivanje za bebe) utiče na motorički, socijalni i kognitivni razvoj, razvoj govora, kao i da se utvrde uticaji ranih aktivnosti odojčadi i beba u vodi na rast, razvoj i zdravlje (snažan uticaj iskustva).

Wayan (2018) sugeriše da briga o bebi nije dovoljna samo kao rutinski tretman, već mora biti sa puno pažnje, aktivnosti i naklonosti. Igrajući se sa vodom, mišići bebe se razvijaju, rast tela se

povećava, a telo postaje gipko. Primarni cilj bebinog plivanja je da stimuliše aktivnosti odojčadi, dok je njegova funkcija povećanje koeficijenta inteligencije, jačanje zdravlja i stimulisanje motoričkih pokreta, redukcija straha od vode, razvoj društvenih veština, nezavisnosti, hrabrosti i samopouzdanja.

Uzrast od 4-6 meseci je najbolje vreme da beba sazna za bazen, zbog refleksa ronjenja koji još nije nestao (sposobnost da udahne pre nego što dodirne vodu) i koji ih sprečava da gutaju vodu dok su u vodi. Refleks ronjenja je u potpunosti uočen kod novorodjenčadi i odojčadi, dok sa 6 meseci starosti počinje da opada (Pedroso et al., 2012; Panneton & Gan, 2020).

Martins et al. (2020) su prikupili i registrovali podatke o ponašanju beba tokom rutinske sesije plivanja kroz prirodno posmatranje i koristeći video snimke. Dimenzija motoričkog ponašanja je obuhvatala interakciju deteta (sa odraslom osobom, drugim detetom, vodom ili predmetom) i motoričke sposobnosti, dok je socioafektivna dimenzija pratila detetov pogled (na drugo dete, na odraslu osobu, na vodu, na predmet) i emocionalne izraze (smeje se, plače, vrišti, pasivno je, neprijatno mu je). Istraživači smatraju da primena metodologije usmerene na dete dovodi do pozitivnog ponašanja tokom ove vrste sesije i doprinosi zdravom razvoju deteta, a što se tiče kognitivnog aspekta razvoja deteta ističe se značaj vodenih igara u stvaranju mogućnosti za razvoj jezika i elementarnih matematičkih pojmova.

Sudiro (2018) i saradnici u svom radu dolaze do zaključka da su plivanje i Spa za bebe stimulacija koja je korisna za zdravlje i razvoj bebe. Igrajući se u vodi, bebini mišići se veoma dobro razvijaju, bebe optimalno rastu, povećava se rast dužine tela, a telo postaje fleksibilno. Baby Spa za bebe je stimulacija koja je korisna za zdravlje i razvoj bebe. Prema istraživanju pokazalo se da bebe koje su podvrgnute hidroterapiji mogu brže naučiti da hodaju i da drže ravnotežu.

Istraživanja Sigmundssona (2021) su pokazala da praksa plivanja beba na Islandu može biti važna za motorički razvoj deteta i podržava pogled na specifičnost učenja. Istraživanja su pokazala da plivanje za bebe, koje uključuje 2 sata treninga nedeljno sa decom uzrasta od 3 do 7-8 meseci, može imati pozitivan efekat na koordinaciju očiju i ruku, ravnotežu. Istraživači kažu da plivanje dojenčadi takođe može pozitivno uticati na koncentraciju, pažnju i fokus. Dečja čula i nervni sistem su pod stalnim raznim nadražajima tokom boravka u bazenu. Dobijanje različitih stimulusa je izuzetno važno za razvoj mozga u bilo kom uzrastu. Mozak raste i postaje jači uz trening i vežbu slično mišićima. Posle prve godine, važno je da dete redovno ide na bazen, da se igra, a nakon toga i da pliva. U odnosu na razvoj veština, moguće je govoriti o kvantitativnim i kvalitativnim promenama. Kvantitativne promene podrazumevaju razvijanje novih veština (fokus nije na kvalitetu veštine). Kvalitativne promene uključuju poboljšanje veštine. Detetov razvoj novih veština (kvantitativni razvoj) i dostignuti nivo svake veštine (kvalitativni razvoj) su pokazatelji njegovog fizičkog i mentalnog zdravlja (Wayan, 2018).

Kontrola ruku i ravnoteža su faktori koji su bolji kod dece koja su učestvovala u plivanju za bebe nego u kontrolnoj grupi koja nije učestvovala u takvoj obuci, pa se može reći da rana intervencija funkcioniše u praksi. Program plivanja za bebe ima za cilj aktivnosti koje promovišu koordinaciju oko- ruka i obezbeđivanje vestibularne stimulacije i ima pozitivne efekte na motorički razvoj. Borioni et al. (2022) otkriva da kontakt sa vodom od rođenja, može biti važno iskustvo za razvoj deteta. Plivanje beba utiče na razvoj u motoričkom i kognitivnom domenu. Analize su otkrile da su novorođenčad u grupi koja je plivala poboljšala grube, fine i ukupne motoričke veštine i pokazala neznatno bolju brzinu inhibicije i tačnost pomeranja.

Martins et al. (2006) daju karakterizaciju razvoja dece (6-36 meseci) koja učestvuju u nastavi vodene adaptacije za bebe u različitim područjima (motorički razvoj, jezik, kognitivno područje i dr.) i analiziraju važnost koju roditelji pripisuju svakom od razvojnih područja i njegovu povezanost s praksom ove vodene aktivnosti. U ranim fazama razvoja dece biološko sazrevanje je najjača determinanta promena uočenih u ponašanju u vodenoj sredini. Praksa plivanja za bebe je sve više prisutna, pa roditelji sve više traže vodeni prostor gde se ova aktivnost odvija. Studije o ovoj aktivnosti su s toga izuzetno važne kako bi se pružila solidna naučna saznanja koja omogućavaju roditeljima i stručnjacima u ovoj oblasti da koriste utemeljena metodološka uputstva.

Sigmundsson et al. (2017) sugerišu da su bebe od 3 do 5 meseci sposobne da pokažu znakove motoričkog učenja u stojećem položaju. Razmatrali su proces razvoja samostalnog stajanja u odnosu na složenu interakciju između genetskih i faktora sredine. Istraživanja zadataka samostalnog stajanja, sprovedena su kao deo rutine plivanja za bebe i smatrana su sigurnim.

Nalazi Costa et al. (2016) sugerišu da bebe doživljavaju značajne adaptacije frekvencije sluha dok učestvuju u programu plivanja i ukazuju na veću sposobnost izvođenja osnovnih vodenih motoričkih veština i manje stresno ponašanje tokom časova.

Dias et al. (2013) su sproveli studiju kako bi istražili kako kursevi plivanja za bebe mogu uticati na rani motorički razvoj kod odojčadi. Prednost uticaja plivanja na motorički razvoj je kod odojčadi koja su ga redovno praktikovala u poređenju sa onima koji nikada nisu pohađali kurseve plivanja za bebe. Brojne studije sugerišu potencijalna poboljšanja u motoričkom razvoju kao rezultat plivanja beba (posebno hvatanja i ravnoteže), međutim metodološka ograničenja onemogućavaju konačne zaključke (Dias et al., 2013; Sigmundsson i Hopkins, 2010).

To je slučaj i sa drugim nalazima poput Leo et al. (2022) koji podupiru učinak aktivnosti u vodi na motorički razvoj. Rezultati su pokazali da deca uključena u aktivnosti u vodi (plivanju) tokom prve godine života imaju tendenciju da imaju bolje motoričke sposobnosti. Ovo istraživanje je stoga prvi korak u razumevanju kako rani oblici motoričke aktivnosti mogu pozitivno uticati na sticanje novih veština kod odojčadi. Pošto pokreti postaju sporiji u vodi, čulna percepcija ovih pokreta je pojačana.

Emocije nastaju kada um interpretira telesne senzacije, koje pak nastaju kao odgovor na različite stimuluse, pa motorički razvoj ne treba smatrati udaljenim od kognitivnih i jezičkih procesa. U prvim mesecima nakon rođenja, bebini refleksi su izazvani količinom i kvalitetom primljenih stimulusa. Vodena sredina je multi senzorni stimulator, a njen susret sa neuroplastičnosti u prvim mesecima života deteta, može biti odgovorna za razlike u motoričkom domenu između eksperimentalne i kontrolne grupe. Uzgon, gustina vode i hidrostatički pritisak deluju kao senzorni stimulansi na vestibularni i taktilni sistem beba (Devereux 2005). Plivanjem u uslovima manje gravitacije, bebe stiču kontrolu nad svojim mišićima (Yahya, 2011). Prva godina života je prilično kritičan period za dete. (Schoentgen et all, 2020). Istraživanje veze između motoričkog razvoja i plivanja beba mogao bi pružiti polaznu tačku za one koji žele da istraže faze kognitivnog razvoja kod novorođenčadi. Posmatranje motoričkih veština, jezika i kognitivnog razvoja pružilo bi uvid u potencijalnu efikasnost boravka u vodi(plivanja) kod dece uzrasta od 0 do 36 meseci. Rezultati ove studije pružaju dokaze o potencijalnom uticaju ranih vodenih aktivnosti na motorički razvoj dece, pokazujući da su odojčad u eksperimentalnoj grupi, iako mlađa od dece u kontrolnoj grupi, postigla veći nivo motoričkog razvoja nakon učešća u aktivnostima u vodi.

Fizicke aktivnosti u vodi mogu pruziti zdravstvene benefite (Center for disease control,2022; U.S. Department of Health and Human Services, 2008), a vežbe u vodi mogu biti od koristi svim uzrasnim kategorijama

Zaključak

U obuhvaćenoj sistematizaciji istraživanja koja je za cilj imala da istraži uticaj plivanja odojčadi i beba na motorički, socijalni, kognitivni razvoj, ustanoviljeno je da rano plivanje ima veliki uticaj, a studije pružaju dokaze o potencijalnom uticaju ranih aktivnosti u vodi na motorički razvoj dece. Neminovno se nameće zaključak da plivanje od najranijeg uzrasta doprinosi fizičkom zdravlju i poboljšanju kognitivnog funkcionisanja dece. Aktivnost u vodi izlaže dete jedinstvenim senzomotornim stimulansima i obezbeđuje multi-senzornu stimulaciju kombinujući tri senzorna sistema: taktilni, proprioceptivni i vestibularni. Prednosti vodenog okruženja za bebe mogu pružiti korisna znanja, jer je rano detinjstvo najpogodniji period za dugoročne intervencije (Reynolds,et al., 2001), a zbog neuroplastičnosti veća je i efikasnost (Hannaford, 2005). Poteškoće u proceni dece u uzrastu od 3 do 36 meseci i nedostatak dostupne literature o plivanju dojenčadi i beba predstavljaju određena ograničenja pri ispitivanju. Ograničena rasprostranjenost kurseva plivanja i priznate poteškoće u prikupljanju dovoljnog broja ispitanika novorođenčadi verovatno su krivci za ponekad proizvoljan izbor uzrasta u literaturi. Ovo dovodi do niza neskladnih ili neobjašnjivih rezultata. Buduća istraživanja bi mogla da rasvetle vezu između motoričkog, jezičkog i kognitivnog razvoja tokom prve godine života, kako bi se aktivnosti u vodi primenile na razvoj motorike i proširile na jezički domen

Literatura

Borioni, F., Biino, V., Tinagli, V. & Pesce, C. (2022) Effects of Baby Swimming on Motor and Cognitive Development: A Pilot Trial. *Percept Mot Skills*, 129(4):977-1000.

Centers for Disease Control. (2022). Health Benefits of Swimming.

Costa,MJ., Barbosa, TM.,Ramos,A.& Marinho, DA.(2016). Effects of a swimming program on infants' heart rate response. *JSports Med Phys Fitness*. 2016 Apr;56(4):352-8.

Dias, JA., Manoel, EJ., Dias, RB.& Okazaki,VH. (2013). Pilot study on infant swimming classes and early motor development.Percept Mot Skills, 117(3),950-5.

Ilić, V.(2021). Pravo u vodu: plivanje jača srce i pluća, ali ne ispravlja kičmu.

Jorgensen, R., & Grootenboer, P. (2011). Early years swimming as a site for early mathematical learning Proceedings of theAnnual Mathematics Education Research Conference. Alice Springs: MERGA.

Jorgensen, R. (2012). Under-fives swimming as a site for capital building: Supporting and enhancing transitions.

Leo, I., Leone, S., Dicataldo, R., Vivenzio, C., Cavallin, N., Taglioni, C. & Roch M.(2022). A Non-Randomized Pilot Study on the Benefits of Baby Swimming on Motor Development. *International Journal of Environmental Research and Public Heal*th, 19(15), 9262.

Randomized_Pilot_Study_on_the_Benefits_of_Baby_Swimming_on_Motor_Development;

Mooventhan, A., and L. Nivethitha (2014). Scientific evidence-based effects of hydrotherapy on various systems of the body. *North American Journal of Medical Sciences*, 6 (5).

Martins M, Moreira A, Silva A J et al.(2006). Caracterização do desenvolvimento de crianças (6-36 meses) participantes emaulas de adaptação ao meio aquático para bebés. Motricidade. 2, 91–98.

Martins, M., Costa,A., Costa,MJ., Marinho,DA. and Barbosa, TM: (2020).Interactional Response During Infants' aquatic Sessions. *Sports Med Int*, 4 (3).

NDFAuthors, Jevtić, A. (2022). Kako plivanje doprinosi razvoju bebe.

Oktapiani, A., Patimah, S. & Rohmatin, E. (2020). Effect Of Baby Spa On Sleep Quality of Baby 3-6 Months. *Midwifery andnursing research (MANR) journal*, 2(2), 49-52.

Pedroso, F., et all. (2012). The diving reflex in healthy infants in the first year of life, *Journal of child neurology*, 27(2):168-71.

Sigmundsson, H., Hopkins B.(2009). Baby swimming: Exploring the effects of early intervention on subsequent motor abilities.*Child Care Health Dev*. 36, 428–430.

Sigmundsson H, Lorås H W, Haga M. (2017). Exploring task-specific independent standing in 3-to 5-month-old infants. *Front Psycho*l, 8, 657.

Sigmundsson, H. (2021). Specificity of learning, skill development and baby swimming in Iceland. *J. Phys. Educ. Sport*. 21, 549–552.

Sudiro, K., & Mulyati, S. (2018). Baby Spa Effect on Growth. *Asian Journal of Applied Sciences*, 6(5).

U.S. Department of Health and Human Services. (2008). Physical Activity Guidelines for Americans: Be active, healthy, and happy! In Chapter 2: Physical Activity Has Many Health Benefits. 2009.

Zelazo,P.R.,&Weiss, M. J. (2006). Infant swimming behaviors: cognitive control and the infl uence of experience. *Journal of Cognition and Development*, 7(1), 1-25.

Zhou K. (2015). Analysis of treatment progress on neonatal jaundice. World Latest *Med. Inform*. 31,58-60

Yilmaz, I., Yanarda, M., Birkan, B. & Bumin, G. (2004) Effects of swimming training on physical fitness and water orientation in autism. *Pediatrics Internationa*l,46, 624–626.

Wayan, N. (2018). The impact of baby spa on the growth and development of infants aged 3-6 months at Puskesmas I Denpasar Selatan. *International Journal of Research in Medical Sciences*, 6(8), 2601-2605.

ASYMMETRY OF CONTRACTILE CHARACTERISTICS OF KNEE EXTENSORS AND FLEXORS IN ELITE BADMINTON PLAYERS

Ana Todorović[1], Kristina Malečkar[1], Daša Mihailović[1], Marko Kapeleti[1], Miloš Ubović[1], Marija Glibetić[2], Vuk Stevanović[2], Vladimir Mrdaković[1]

[1] University of Belgrade, Faculty of Sport and Physical Education, Belgrade, Serbia

[2] University of Belgrade, Institute for Medical Research, Belgrade, Serbia

Introduction

Badminton is a sports game that is characterized by the maximum speed and agility of competitors at the elite level. Timely placement of the athlete's body in the most effective position for a technically correct and tactically designed shot is crucial for achieving an advantage over the opposing player and winning points, matches, and even medals at competitions. The athlete's movement technique in badminton is a unilateral movement where each strike is performed by moving the dominant side of the body (legs and arms) in the direction of the ball strike (figure 1). Many years of repetitions of this unilateral movement puts the player at risk of muscle imbalance and asymmetry at the one joint level or between the extremities.

Muscles are in bilateral symmetry if the capacity of one side is not below 90% of the capacity of the other side (Kannus, 1994; Baltzopoulos & Brodie, 1989). Bilateral muscle asymmetry around the knee joint has been cited as the etiology of many injuries, particularly hamstring strains (Burkett, 1970). Muscles are in functional symmetry if the capacity of the weaker muscle group is above 65% of the capacity of the stronger muscle group (Garcia-Garcia et al., 2019). Any deviation indicates the occurrence of muscle asymmetry and the potential risk of injury.

There are numerous methods for determining muscle asymmetries. One of the reliable and valid methods is tensiomyography (Hanney et al., 2022). Tensiomyography is a non-invasive method of assessing the contractile characteristics of muscles, which enables the assessment of bilateral symmetry, i.e. the ratio of the muscle contractile characteristics of the left and right leg, and functional symmetry, i.e. the ratio of contractile characteristics of the knee flexors and extensors (Macgregor et al., 2018).

The purpose of this research is to determine the existence of muscle asymmetries resulting from long-term adaptation to sports activity, while the subject of this research is muscle asymmetry of the knee extensors and flexors in elite badminton players. It is assumed that elite badminton players have functional and bilateral muscle asymmetry around the knee joint. This research aims to examine the bilateral and functional symmetry of the contractile characteristics of the knee extensors and flexors in elite badminton players, with the assumption that asymmetry can occur as a consequence of specific movement techniques.

Figure 1. The Serbian national team player Viktor Petrović while striking the ball with the dominant side of the body in a lunge position.

Methods

The research was carried out using the experimental method of the transversal type. Empirical-bibliographic methods of compiling the theoretical framework and statistical methods for processing the obtained data were used. The test was carried out using the method of tensiomyography for assessing muscle contractile characteristics.

The sample of subjects

The sample of subjects consisted of 15 competitors of the national badminton team of Serbia, male, age 19.5±3.3 years, with training experience longer than 8 years (with at least 4 training sessions per week) and without injuries. All subjects were tested voluntarily, with a previously signed consent participation form, which contained a detailed description of the research purpose and protocol. The basic anthropometric and morphological characteristics of the subjects are presented in the Results section (table 1).

Experimental protocol

Data collection was carried out over two days in the methodical-research laboratory of the Faculty of Sport and Physical Education (University of Belgrade), with one visit for each subject. After the explanation of the testing protocol and signing of the participation consent, the subjects' body height was measured using an anthropometer, after which body mass and body composition were measured using the bioelectrical impedance *InBody770* device (*InBody*, South Korea). After that, tensiomyographic testing was performed. The subjects were instructed not to consume food and liquids at least 1 hour before the test, as well as not to engage in any intense physical activity 24-48 hours before the test. All measurements were made in the morning hours.

The sample of variables

Tensiomyographic testing and analysis were performed using a *TMG S2* tensiomyograph and software (*TMG-BMC Ltd.*, Slovenia). To measure muscle contractile characteristics, an incremental protocol was used – increasing the current strength by 10mA until a plateau appears in 2 successive increases, that is until the muscle reaches a plateau in radial deformation. The initial current value was set between 20mA and 30mA. The pause between 2 consecutive stimuli was at least 10 seconds. The subject was placed in the testing position according to recommendations

from the equipment manufacturer (figure 2): (1) a supine position with 30° of knee flexion to measure characteristics of knee extensors and (2) a prone position with 30° of knee flexion to measure the characteristics of knee flexors. The subject was instructed to be relaxed and not move during the test.

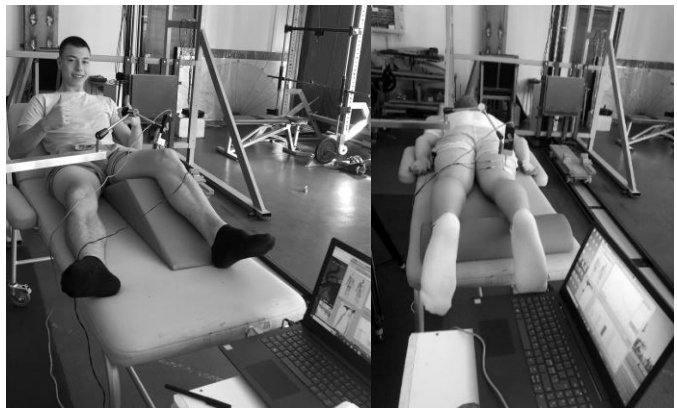


Figure 2. Subject's position during TMG testing of knee extensors and flexors.

The following muscles of both legs were tested in the given order, first on the dominant side and then on the non-dominant side:

1) *m. vastus lateralis* (VL)
2) *m. vastus medialis* (VM)
3) *m. rectus femoris* (RF)
4) *m. biceps femoris* (BF)

The following variables were sampled (figure 4):

1) *Maximal displacement* – Dm
2) *Delay time* – Td
3) *Contraction time* – Tc
4) *Sustain time* – Ts
5) *Half-relaxation time* – Tr

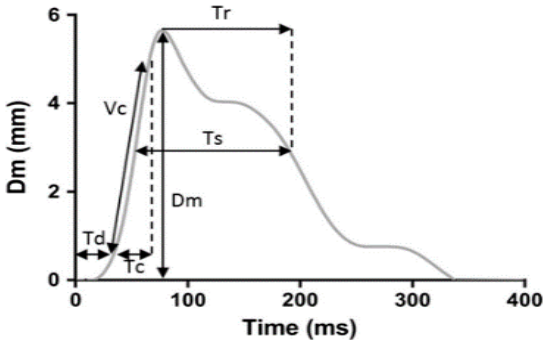


Figure 4. Variables from the curve of muscle radial deformation as a function of time (downloaded from Simunic et al. 2022).

Two types of muscle symmetries were calculated through the automated calculation of *TMG S2* software (figure 5):

1) Bilateral symmetry (Bs)
2) Functional symmetry (Fs)

$$LS = 0.1 \cdot \frac{\min\ (TDr\ TDl)}{max\ (TDr\ TDl)} + 0.6 \cdot \frac{\min\ (TCr\ TCl)}{max\ (TCr\ TCl)} + 0.1 \cdot \frac{\min\ (TSr\ TSl)}{max\ (TSr\ TSl)} + 0.2 \cdot \frac{\min\ (DMr\ DMl)}{max\ (DMr\ DMl)}$$

FS = 0.1*min(average(Tdr1, Tdr2), average(Tdr3, Tdr4))/max(average(Tdr1, Tdr2), average(Tdr3, Tdr4)) + 0.8*min(average(Tcr1, Tcr2), average(Tcr3, Tcr4))/max(average(Tcr1, Tcr2), average(Tcr3, Tcr4)) + 0.1*min(average(Tsr1, Tsr2), average(Tsr3, Tsr4))/max(average(Tsr1, Tsr2), average(Tsr3, Tsr4))

Figure 5. Automated formulas of TMG S2 software for calculating Bs and Fs (downloaded from Simunic et al., 2022). Marks with lowercase Latin letters "l" and "r" indicate the left and right side of the body, while numbers 1-4 in the Fs calculation indicate the serial number of the examined muscle.

Statistical data analysis

For anthropometric and morphological variables mean and standard deviations are shown in table 1 and for the TMG variables in graph 1. A two-tailed independent t-test with equal variances was used to assess Bs at the level of each muscle and all individual variables. Of the statistical parameters, p-value, t-value, and Df were noted. The level of statistical significance was set at $p<0.05$. Bs and Fs at the knee joint level were sampled through the automated calculation of the *TMG S2* software. The data was processed in the *Microsoft Office Professional Plus 2019 Excel* application program. The results are presented tabularly or graphically (tables 1-4, graph 1).

Results

Table 1 shows the results of basic anthropometric and morphological characteristics of subjects (N = 15).

Table 1. Basic anthropometric and morphological characteristics of subjects. BH – body height; BM – body mass; BMI – body mass index; MM – muscle mass; FM – fat mass.

	Age [years]	**BH [cm]**	**BM [kg]**	**BMI [kg/m²]**	**MM [kg]**	**FM [kg]**
Mean ± SD	19.6±3.3	182.8±4.6	75.8±10.6	22.7±2.8	38.8±5.9	7.7±3.0

The results of the independent T-test with equal variances indicate that there is a statistically significant bilateral difference in Dm between VL, VM, and RF on the left and right sides of the body ($p<0.05$), while for BF there is a tendency towards statistically significant difference ($p=0.07$) (table 2, graph 1). Dm values are in all cases higher on the non-dominant side than on the dominant side, except for RF. For all temporal variables (Td, Tc, Ts, and Tr) no statistically significant difference was shown in all tested muscles (table 2). Descriptive statistical results for all temporal variables and muscles are presented in table 3.

*Table 2. Statistical results of independent T-test with equal variances for all variables and muscles. * - Statistically significant difference. # - Tendency towards a statistically significant difference.*

		Dm	Td	Tc	Ts	Tr
VL	p	0.03*	0.19	0.08	0.93	0.82
	t	-2.25	-1.35	-1.83	-0.09	-0.23
	Df	26	26	26	26	26
VM	p	0.01*	0.13	0.10	0.86	0.32
	t	-3.02	-1.58	-1.69	0.18	1.02
	Df	26	26	26	26	26
RF	p	0.03*	0.59	0.26	0.32	0.21
	t	-2.28	-0.54	-1.15	-1.02	-1.28
	Df	26	26	26	26	26
BF	p	0.07#	0.15	0.65	0.95	0.20
	t	-1.92	-1.48	-0.46	0.06	1.31
	Df	26	26	26	26	26

Graph 1. Radial muscle deformation for the non-dominant (left column) and dominant (right column) side (mean value ± standard deviation). * - Statistically significant difference. # - Tendency towards a statistically significant difference.

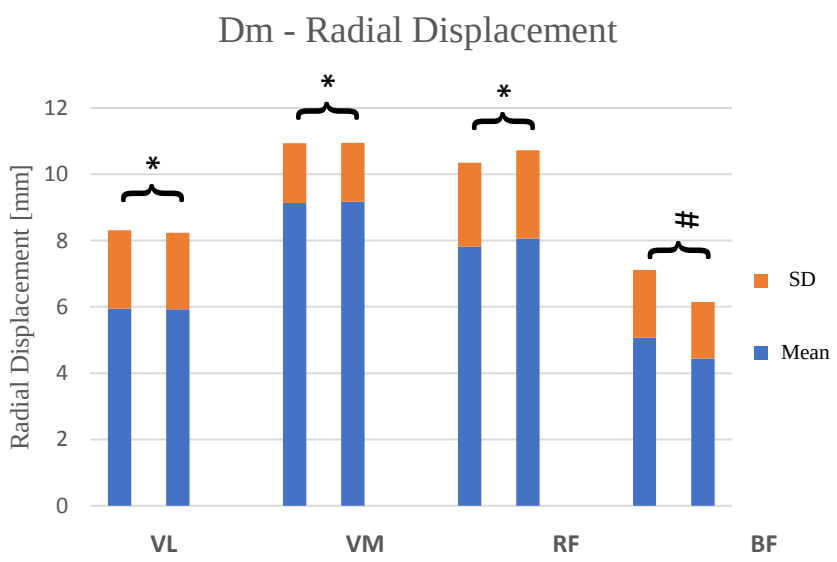


Table 3. Descriptive statistical results (mean ± standard deviation) for all temporal variables and muscles. D – dominant side; ND – non-dominant side.

	Td_D	Td_ND	Tc_D	Tc_ND	Ts_D	Ts_ND	Tr_D	Tr_ND
VL	25.7±3.2	25.9±4.0	25.4±4.6	24.3±4.3	83.4±50.7	83.6±57.5	45.6±37.8	44.1±40.6
VM	25.3±2.3	25.8±2.4	26.3±3.9	26.0±3.6	151.8±54.3	157.0±42.7	66.6±44.1	85.9±45.2
RF	25.1±2.3	26.5±3.8	33.4±6.8	32.3±7.5	113.8±40.2	97.5±53.7	66.3±39.8	50.3±34.5
BF	25.6±3.4	25.5±4.0	31.3±12.0	31.2±12.7	185.0±72.8	188.8±72.8	52.0±17.5	81.3±75.8

Below are presented the results of Bs (table 4) and Fs (table 5) obtained by automated software calculation.

Table 4. Results of bilateral symmetry for all muscles.

	Bs
VL	88.1 ± 7.4
VM	90.4 ± 4.9
RF	88 ± 8.2
BF	78.6 ± 11.3

Table 5. Results of functional symmetry at the knee joint for D (dominant side) and ND (non-dominant side).

	Fs
D	75.7 ± 8.3
ND	74.8 ± 7.1

Tables 4 and 5 show that the value of bilateral asymmetry for the knee extensors is between 9.6% and 12%, while for BF is 21.4%, all in favor of the dominant side. The Fs values are 75.7% (dominant leg) and 74.8% (non-dominant leg) in favor of the knee extensors. From these results it can be concluded that bilateral asymmetry is present in all tested muscles (together with a tendency towards VM asymmetry of 9.6%), while functional asymmetry is not present.

Discussion

This research aims to examine the bilateral and functional symmetry of the contractile characteristics of the knee extensors and flexors in elite badminton players, with the assumption that asymmetry can occur as a consequence of specific movement techniques. The theoretical importance of this research is reflected in its contribution to the problem of examining muscle imbalances in top athletes, while the practical importance is reflected in the possibility that the results of this research can gain insight into the potential state of muscle asymmetry in badminton players and thus make recommendations related to training process aimed at eliminating muscle asymmetry as a potential risk factor of injury.

From the results of this research, it is observed that the only variable that shows significant differences between the dominant and non-dominant side is Dm (table 2, graph 1), while for all temporal variables (Td, Tc, Ts, and Tr) no such difference was observed (table 2). Values for Dm ie. radial muscle deformation are smaller for VL, VM, and BF on the dominant side compared to the non-dominant side, except for RF. Thus, it can be seen that single-joint muscles on the dominant side have a higher degree of stiffness (less deformation) due to the asymmetric overload of the stepping leg. Interestingly, this phenomenon was not observed in the two-joint knee extensor RF. In contrast to the aforementioned, RF shows a greater degree of stiffness on the non-dominant side, which can be explained by the striking technique. In other words, stepping forward overloads the two-joint knee extensor (RF) on the non-dominant (rear) leg, having in mind that the striking technique is performed with an increased lunge.

With regards to the results obtained by statistical analysis (table 2) and considering that the software calculation, that combines all TMG variables, showed that there is bilateral asymmetry above recommended 10% (Kannus, 1994; Baltzopoulos & Brodie, 1989) (table 4), it is assumed that the asymmetry comes predominantly from the variable Dm. In accordance with the previous research (Macgregor et al., 2018), the highest symmetry is shown by VM and the lowest by BF. The obtained Fs results show that the knee flexor capacity is about 75% of the knee extensor capacity (table 5), which is in the zone of normal asymmetry (>65%) recommended by some authors (García-García et al., 2019). With these results, bilateral muscle asymmetry is generally found as a consequence of long-term specific movement technique to which the musculature has adapted, which partially confirmed the initial research assumption.

The general recommendation arising from these results refers to the adequate strengthening of the knee extensor muscles on the non-dominant side, all to reduce the potential risk of injury since higher Dm indicates lower muscle tone. The great advantage of this research is reflected in testing the sample of subjects that belong to top athletes, with many years of training experience and without injuries – 15 competitors of the national badminton team of Serbia. Future research on a sample of subjects in this sport should be done also with biomechanical and motoric methods that determine muscle asymmetries, given that the TMG method tests muscles in a relaxed state, while badminton is characterized by dynamism. In that manner, a more comprehensive picture of bilateral asymmetries in badminton players would be made.

Conclusion

The results of this research clearly show the influence of specific badminton movements on the occurrence of excessive bilateral asymmetry of contractile characteristics of the knee extensors and flexors in elite Serbian badminton players. Bilateral asymmetry can lead to an increased risk of injury. The general recommendation arising from these results refers to the adequate strengthening of the knee extensor muscles on the non-dominant side. Future research on a sample of subjects in this sport should be done also with biomechanical and motoric methods that determine muscle asymmetries, given that the TMG method tests muscles in a relaxed state, while badminton is characterized by dynamism. In that manner, a more comprehensive picture of bilateral asymmetries in badminton players would be made.

References

Baltzopoulos, V., & Brodie, D. A. (1989). Isokinetic dynamometry. *Sports medicine*, *8*(2), 101-116.

Burkett, L. N. (1970). Causative factors in hamstring strains. *Medicine and science in sports*, *2*(1), 39-42.

García-García, O., Cuba-Dorado, A., Álvarez-Yates, T., Carballo-López, J., & Iglesias-Caamaño, M. (2019). Clinical utility of tensiomyography for muscle function analysis in athletes. *Open Access Journal of Sports Medicine*, *10*, 49.

Hanney, W. J., Kolber, M. J., Salamh, P. A., Moise, S., Hampton, D., & Wilson, A. T. (2022). The Reliability of Tensiomyography for Assessment of Muscle Function in the Healthy Population: A Systematic Review. *Strength and Conditioning Journal*, *44*(6), 18-35.

Kannus, P. (1994). Isokinetic evaluation of muscular performance. *International journal of sports medicine*, *15*(S 1), S11-S18.

Macgregor, L. J., Hunter, A. M., Orizio, C., Fairweather, M. M., & Ditroilo, M. (2018). Assessment of skeletal muscle contractile properties by radial displacement: the case for tensiomyography. *Sports Medicine*, *48*(7), 1607-1620.

Simunic, Bostjan & Rozman, Sergej & Pišot, Rado. (2022). Detecting the velocity of the muscle contraction.

ASIMETRIJA KONTRAKTILNIH KARAKTERISTIKA MIŠIĆA OPRUŽAČA I PREGIBAČA ZGLOBA KOLENA KOD ELITNIH BADMINTONACA

Ana Todorović[1], Kristina Malečkar[1], Daša Mihailović[1], Marko Kapeleti[1], Miloš Ubović[1], Marija Glibetić[2], Vuk Stevanović[2], Vladimir Mrdaković[1]

[1] Univerzitet u Beogradu, Fakultet sporta i fizičkog vaspitanja, Beograd, Srbija

[2] Univerzitet u Beogradu, Institut za medicinska istraživanja, Beograd, Srbija

Uvod

Badminton je sportska igra koju na elitnom nivou karakterišu ispoljavanje maksimalne brzine i agilnosti takmičara. Pravovremeno postavljanje tela sportiste u najefikasniju poziciju za tehnički tačan i taktički osmišljen udarac krucijalno je za postizanje prednosti nad protivničkim igračem i osvajanje poena, meča, pa i odličja na takmičenjima. Tehnika kretanja sportiste u badmintonu zasniva se na unilateralnoj kretnji gde se svaki napad izvodi kretanjem dominantne strane tela (noge i ruke) u pravcu odigravanja loptice reketom (slika 1). Višegodišnje ponavljanje ovakve unilateralne kretnje dovodi sportistu u rizik od pojave mišićnog disbalansa, asimetrija na nivou jednog zgloba ili između ekstremiteta.

Mišići su u bilateralnoj simetriji ukoliko kapacitet jedne strane nije ispod 90% druge strane (Kannus, 1994; Baltzopoulos & Brodie, 1989). Bilateralna mišićna asimetrija oko zgloba kolena navodi se kao etiologija mnogih povreda, posebno istegnuća mišićne tetive (Burkett, 1970). Mišići su u funkcionalnoj simetriji ukoliko je kapacitet slabije mišićne grupe iznad 65% od jače mišićne grupe (Garcia-Garcia et al., 2019). Svako odstupanje ukazuje na pojavu mišićne asimetrije i potencijalni rizik od povrede.

Postoji veliki broj metoda za utvrđivanje mišićnih asimetrija. Jedna od pouzdanih i validnih metoda je tenziomiografija (Hanney et al., 2022). Tenziomiografija je neinvazivna metoda procene kontraktilnih karakteristika mišića koja omogućava procenu bilateralne simetrije, tj. odnos mišića leve i desne noge, i funkcionalne simetrije, tj. odnos mišića pregibača i opružača zgloba kolena (Macgregor et al., 2018).

Svrha ovog istraživanja jeste utvrđivanje postojanja mišićnih asimetrija nastalih usled dugoročne adaptacije na sportsku aktivnost, dok je predmet ovog istraživanja mišićna asimetrija opružača i pregiba zgloba kolena kod elitnih badmintonaca. Pretpostavka je da je kod elitnih badmintonaca zastupljena funkcionalna i bilateralna asimetrija mišića oko zgloba kolena. Cilj ovog istraživanja je da se kod elitnih badmintonaca ispita bilateralna i funkcionalna simetrija kontraktilnih karakteristika opružača i pregibača zgloba kolena, sa pretpostavkom da asimetrija može nastati kao posledica specifične tehnike kretanja.

Slika 1. Reprezentativac Srbije, Viktor Petrović, prilikom odigravanja udarca u karakterističnoj poziciji iskoraka i izvođenja udaraca dominantnom stranom tela.

Metode

Istraživanje je realizovano eksperimentalnom metodom transverzalnog tipa. Korišćen je empirijsko-bibliografski metod sastavljanja teorijskog okvira rada i statistički metod za obradu dobijenih podataka. Ispitivanje se sprovodilo metodom tenziomiografije za procenu kontraktilnih karakteristika mišića.

Uzorak ispitanika

Uzorak ispitanika činilo je 15 takmičara nacionalnog badminton tima Srbije, muškog pola, uzrasta 19.5±3.3 godina, trenažnog staža dužeg od 8 godina (sa najmanje 4 treninga nedeljno) i bez povreda. Svi ispitanici su testirani svojevoljno, uz prethodno potisan list saglasnosti za učestvovanje u istraživanju, koji je sadržao detaljan opis svrhe i protokola istraživanja. Osnovne antropometrijske i morfološke karakteristike ispitanika su prikazane u delu Rezultati (tabela 1).

Tok i postupci istraživanja

Prikupljanje podataka izvršeno je u dva dana, sa po jednim dolaskom za svakog ispitanika u metodičko-istraživačkoj laboratoriji Fakulteta sporta i fizičkog vaspitanja, Univerziteta u Beogradu. Nakon objašnjenja protokola samog testiranja i potpisivanja saglasnosti za učestvovanje u studiji, ispitanicima je izmerena telesna visina korišćenjem antropometraa nakon toga je urađeno merenje telesne mase i telesnog sastava korišćenjem *InBody770* aparata (*InBody*, Južna Koreja) koji koristi metodu bioelektrične impedance. Nakon toga pristupano je tenziomiografskom testiranju. Ispitanicima je data instrukcija da minimum 1 sat pre dolaska na testiranje ne konzumiraju hranu i tečnost, kao i da nemaju intenzivne fizičke napore 24-48 sati pred testiranje. Sva merenja su urađena u prepodnevnim časovima.

Uzorak varijabli i način njihovog merenja

Tenziomiografsko testiranje i analiza su urađene korišćenjem *TMG S2* tenziomiografa i softvera (*TMG-BMC Ltd.*, Slovenija). Za merenje kontraktilnih karakteristika mišića korišćen je inkrementni protokol – povećanje jačine struje za 10mA sve do pojave platoa u 2 uzastopna povećanja, odnosno dok mišić ne dostigne plato u radijalnoj deformaciji. Početna vrednost jačine struje je bila podešena između 20mA i 30mA. Pauza između 2 uzastopna stimulusa je bila najmanje

10 sekundi. Ispitanik je bio postavljen u testirajući položaj prema preporukama proizvođača opreme: (1) ležeći položaj na leđima sa 30° fleksije u zglobu kolena (slika 2) za merenje karakteristika mišića opružača u zglobu kolena i (2) ležeći položaj na stomaku sa 30° fleksije u zglobu kolena (slika 3) za merenje karakteristika mišića pregibača u zglobu kolena. Ispitaniku je data instrukcija da bude u opuštenom stanju i da se tokom testiranja ne pomera.

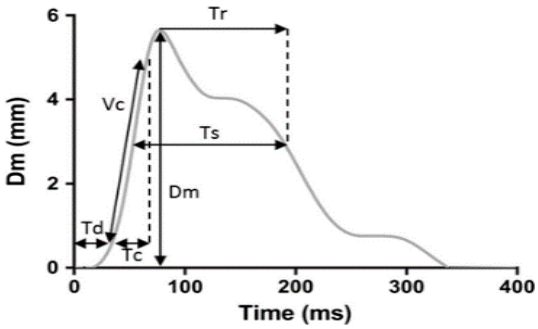
Slika 2. Položaj ispitanika tokom TMG testiranja mišića opružača i pregibača u zglobu kolena.

Testirani su sledeći mišići obe noge datim redosledom, prvo kod dominantne, a potom kod nedominantne strane:

5) *m. vastus lateralis* (VL)
6) *m. vastus medialis* (VM)
7) *m. rectus femoris* (RF)
8) *m. biceps femoris* (BF)

Uzorkovane su sledeće varijable (slika 4):

6) Radijalna deformacija mišića (*maximal displacement* – Dm)
7) Vreme kašnjenja (*delay time* – Td)
8) Vreme kontrakcije (*contraction time* – Tc)
9) Vreme održavanja (*sustain time* – Ts)
10) Poluvreme relaksacije (*half-relaxation time* – Tr)



Slika 4. Varijable iz krive radijale deformacije mišića u funkciji vremena (preuzeto iz Simunic et al. 2022).

Izračunate su dve vrste mišićnih simetrija putem automatizovanog proračuna *TMG S2* softvera (slika 5):

3) Bilateralna simetrija (Bs)
4) Funkcionalna simetrija (Fs)

$$LS = 0.1 \cdot \frac{\min\ (TDr\ TDl)}{max\ (TDr\ TDl)} + 0.6 \cdot \frac{\min\ (TCr\ TCl)}{max\ (TCr\ TCl)} + 0.1 \cdot \frac{\min\ (TSr\ TSl)}{max\ (TSr\ TSl)} + 0.2 \cdot \frac{\min\ (DMr\ DMl)}{max\ (DMr\ DMl)}$$

```
FS = 0.1*min(average(Tdr1, Tdr2), average(Tdr3, Tdr4))/max(average(Tdr1, Tdr2),
average(Tdr3, Tdr4)) + 0.8*min(average(Tcr1, Tcr2), average(Tcr3, Tcr4))/max(average(Tcr1,
Tcr2), average(Tcr3, Tcr4)) + 0.1*min(average(Tsr1, Tsr2), average(Tsr3,
Tsr4))/max(average(Tsr1, Tsr2), average(Tsr3, Tsr4))
```

Slika 5. Automatizovane formule TMG S2 softvera za izračunavanje Bs i Fs (preuzeto iz Simunic et al., 2022). Oznake malim latiničnim slovima „l“ i „r“ označavaju levu i desnu stranu tela, dok brojevi 1-4 u Fs kalkulaciji označavju redni broj ispitanog mišića.

Statistička obrada podataka

Za antropometrijske i morfološke varijable prikazane su srednje vrednosti i standardne devijacije u tabeli 1, dok su za TMG varijable u grafikonu 1. Za procenu Bs na nivou svakog mišića i svih pojedinačnih varijabli korišćen je dvosmerni nezavisni t-test sa jednakim varijansama. Od statističkih parametara beležene su p-vrednost, t-vrednost i Df. Nivo statističke značajnosti je podešen na $p<0.05$. Putem automatizovanog proračuna *TMG S2* softvera praćene su Bs i Fs na nivou zgloba kolena. Podaci su obrađeni u *Microsoft Office Professional Plus 2019 Excel* aplikacionom programu. Rezultati su prikazani tabelarno ili grafički (tabele 1-4, grafikon 1).

Rezultati

U tabeli 1 su prikazani rezultati osnovnih antropometrijskih i morfoloških karakteristika ispitanika (N = 15).

Tabela 1. Osnovne antropometrijske i morfološke karakteristike ispitanika. TV – telesna visina; TM – telesna masa; BMI – indeks telesne mase; MiM – mišićna masa; MaM – masna masa.

	Uzrast [godine]	**TV [cm]**	**TM [kg]**	**BMI [kg/m²]**	**MiM [kg]**	**MaM [kg]**
Prosek ± SD	19.6±3.3	182.8±4.6	75.8±10.6	22.7±2.8	38.8±5.9	7.7±3.0

Rezultati nezavisnog T-testa sa jednakim varijansama ukazuju da postoji statistički značajna bilateralna razlika u Dm između VL, VM i RF sa leve i desne strane tela ($p<0.05$), dok je za BF pokazana tendencija ka statistički značajnoj razlici ($p=0.07$) (tabela 2, grafikon 1). Vrednosti Dm su u svim slučajevima veće kod nedominantne u odnosu na dominantnu stranu, osim kod RF. Za sve vremenske varijable (Td, Tc, Ts i Tr) nije pokazana statistički značajna razlika za sve testirane mišiće (tabela 2). Deskriptivni statistički rezultati za sve vremenske varijable i mišiće su prikazani u tabeli 3.

*Tabela 2. Statistički rezultati nezavisnog T-testa sa jednakim varijansama za sve varijable i mišiće. * - Statistički značajna razlika. # - Tendencija ka statistički značajnoj razlici.*

		Dm	Td	Tc	Ts	Tr
VL	p	0.03*	0.19	0.08	0.93	0.82
	t	-2.25	-1.35	-1.83	-0.09	-0.23
	Df	26	26	26	26	26
VM	p	0.01*	0.13	0.10	0.86	0.32
	t	-3.02	-1.58	-1.69	0.18	1.02
	Df	26	26	26	26	26
RF	p	0.03*	0.59	0.26	0.32	0.21
	t	-2.28	-0.54	-1.15	-1.02	-1.28
	Df	26	26	26	26	26
BF	p	0.07#	0.15	0.65	0.95	0.20
	t	-1.92	-1.48	-0.46	0.06	1.31
	Df	26	26	26	26	26

*Grafikon 1. Radijalna deformacija mišića kod nedominantne (levi stubić) i dominantne (desni stubić) strane (srednja vrednost ± standardna devijacija). * - Statistički značajna razlika. # - Tendencija ka statistički značajnoj razlici.*

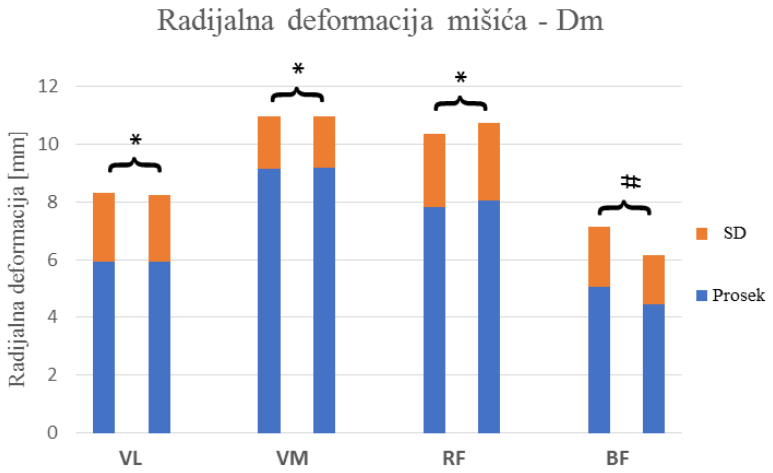


Tabela 3. Deskriptivni statistički rezultati (srednja vrednost ± standardna devijacija) za sve vremenske varijable i mišiće. D – dominantna strana; ND – nedominantna strana.

	Td_D	Td_ND	Tc_D	Tc_ND	Ts_D	Ts_ND	Tr_D	Tr_ND
VL	25.7±3.2	25.9±4.0	25.4±4.6	24.3±4.3	83.4±50.7	83.6±57.5	45.6±37.8	44.1±40.6
VM	25.3±2.3	25.8±2.4	26.3±3.9	26.0±3.6	151.8±54.3	157.0±42.7	66.6±44.1	85.9±45.2
RF	25.1±2.3	26.5±3.8	33.4±6.8	32.3±7.5	113.8±40.2	97.5±53.7	66.3±39.8	50.3±34.5
BF	25.6±3.4	25.5±4.0	31.3±12.0	31.2±12.7	185.0±72.8	188.8±72.8	52.0±17.5	81.3±75.8

U nastavku su prikazani rezultati Bs (tabela 4) i Fs (tabela 5) dobijeni automatizovanim softverskim proračunom.

Tabela 4. Rezultati bilateralne simetrije na nivou svih mišića.

	Bs
VL	88.1 ± 7.4
VM	90.4 ± 4.9
RF	88 ± 8.2
BF	78.6 ± 11.3

Tabela 5. Rezultati funkcionalne simetrije na nivou zgloba kolena kod D (dominantne strane) i ND (nedominantne strane).

	Fs
D	75.7 ± 8.3
ND	74.8 ± 7.1

Iz tabela 4 i 5 se uočava da je vrednost bilateralne asimetrije za mišiće opružače u zglobu kolena između 9.6% i 12%, dok je za BF 21.4%, sve u korist dominantne strane. Vrednosti Fs su 75.7% (dominantna) i 74.8% (nedominantna noga) u korist opružača u zglobu kolena. Iz ovih rezultata se može zaključiti da je prisutna bilateralna asimetrija kod svih testiranih mišića (zajedno sa tendencijom ka asimetriji od 9.6% kod VM), dok funkcionalna asimetrija nije prisutna.

Diskusija

Cilj ovog istraživanja je da se kod elitnih badmintonaca ispita bilateralna i funkcionalna simetrija kontraktilnih karakteristika opružača i pregibača zgloba kolena, sa pretpostavkom da kod badmintonaca može nastati asimetrija kao posledica specifične tehnike kretanja. Teorijska značajnost ovog istraživanja se ogleda u doprinosu problematici ispitivanja mišićnih asimetrija kod vrhunskih sportista, dok se praktična značajnost ogleda u mogućnosti da se rezultatima ovog istraživanja stekne uvid u potencijalno stanje mišićne asimetrije kod badmintonaca i da se na taj način izvedu preporuke koje se odnose na trenažni proces usmeren ka eliminaciji mišićne asimetrije kao potencijalnog faktora rizika od nastanka povrede.

Iz rezultata istraživanja se uočava da jedina varijabla koja pokazuje značajne razlike između dominantne i nedominantne strane jeste Dm (tabela 2, grafikon 1), dok za sve vremenske varijable (Td, Tc, Ts i Tr) takva razlika nije uočena (tabela 2). Vrednosti Dm tj. radijalne deformacije mišića su kod VL, VM i BF manje kod dominantne u odnosu na nedominantnu stranu, osim kod RF. Time se može uočiti da jednozglobni mišići sa dominantne strane imaju veći stepen krutosti (manju deformaciju) usled asimetričnog preopterećenja iskoračne noge. Interesantno je da ta pojava nije uočena kod dvozglobnog mišića opružača u zglobu kolena (RF). Nasuprot prethodnom, RF pokazuje veći stepen krutosti kod nedominantne strane, što se može objasniti tehnikom izvođenja udarca. Naime, iskorakom se preopterećuje dvozglobni opružač u zglobu kolena (RF) nedominantne (zadnje) noge, imajući u vidu da se tehnika udarca izvodi povećanim iskorakom.

U odnosu na rezultate dobijene statističkom analizom (tabela 2) i s obzirom da je softverskim proračunom koji kombinuje sve varijable tenziomiografa pokazano da postoji bilateralna asimetrija iznad preporučenih 10% (Kannus, 1994; Baltzopoulos & Brodie, 1989) (tabela 4), pretpostavlja se da asimetrija dominantno potiče iz varijable Dm. U skladu sa prethodnim istraživanjima (Macgregor et al., 2018) najveći stepen simetrije pokazuje VM, a najmanji BF. Dobijenim rezultatima Fs uočava se da je kapacitet pregibača u zglobu kolena na oko 75% kapaciteta opružača u zglobu kolena (tabela 5), što je u zoni normalne asimetrije (>65%) koja je preporučena od nekih autora (García-García et al., 2019). Ovim rezultatima je generalno ustanovljena bilateralna mišićna asimetrija kao posledica dugoročne specifične tehnike kretanja na čije se uslove rada muskulatura adaptirala, čime je delimično potvrđena početna istraživačka pretpostavka.

Opšta preporuka koja proizilazi iz ovih rezultata se odnosi na adekvatno jačanje mišića opružača u zglobu kolena kod nedominantne strane, sve u cilju umanjenja potencijalnog rizika od povrede, s obzirom da veći Dm ukazuje na manji mišićni tonus. Velika prednost ovog istraživanja se ogleda u testiranju uzorka ispitanika koji pripada uzorku vrhunskih sportista, sa višegodišnjim trenažnim iskustvom i bez prisutnih povreda – 15 takmičara nacionalnog badminton tima Srbije. Buduća istraživanja na uzorku ispitanika u ovom sportu bi trebalo biti urađena i sa biomehaničkim i motoričkim metodama koje utvrđuju asimetrije mišića, s obzirom da TMG metoda testira mišiće u relaksiranom stanju, dok je za igru u badmintonu karakteristična dinamičnost, a sve u cilju generalizovanja dobijenih rezultata i zaključaka.

Zaključak

Rezultati ovog istraživanja jasno pokazuju uticaj specifične tehnike kretanja u badmintonu na pojavu prekomerne bilateralne asimterije kontraktilnih karakteristika mišića opružača i pregibača u zglobu kolena kod elitnih srpskih badmintonaca. Bilateralna asimetrija može dovesti do povećanog rizika od povrede. Opšta preporuka koja proizilazi iz ovih rezultata se odnosi na adekvatno jačanje opružača u zglobu kolena kod nedominantne strane. Buduća istraživanja na uzorku ispitanika u ovom sportu bi trebalo biti urađena i sa biomehaničkim i motoričkim metodama koje utvrđuju asimetrije mišića, s obzirom da TMG metoda testira mišiće u relaksiranom stanju, dok je za igru u badmintonu karakteristična dinamičnost. Na taj način, stvorila bi se sveobuhvatnija slika o bilaterlanim asimetrijama kod badmintonaca.

Literatura

Baltzopoulos, V., & Brodie, D. A. (1989). Isokinetic dynamometry. *Sports medicine*, *8*(2), 101-116.

Burkett, L. N. (1970). Causative factors in hamstring strains. *Medicine and science in sports*, *2*(1), 39-42.

García-García, O., Cuba-Dorado, A., Álvarez-Yates, T., Carballo-López, J., & Iglesias-Caamaño, M. (2019). Clinical utility of tensiomyography for muscle function analysis in athletes. *Open Access Journal of Sports Medicine*, *10*, 49.

Hanney, W. J., Kolber, M. J., Salamh, P. A., Moise, S., Hampton, D., & Wilson, A. T. (2022). The Reliability of Tensiomyography for Assessment of Muscle Function in the Healthy Population: A Systematic Review. *Strength and Conditioning Journal*, *44*(6), 18-35.

Kannus, P. (1994). Isokinetic evaluation of muscular performance. *International journal of sports medicine*, *15*(S 1), S11-S18.

Macgregor, L. J., Hunter, A. M., Orizio, C., Fairweather, M. M., & Ditroilo, M. (2018). Assessment of skeletal muscle contractile properties by radial displacement: the case for tensiomyography. *Sports Medicine*, *48*(7), 1607-1620.

Simunic, Bostjan & Rozman, Sergej & Pišot, Rado. (2022). Detecting the velocity of the muscle contraction.

SOCIAL SCIENCES AND HUMANITIES IN PHYSICAL EDUCATION AND SPORT

DRUŠTVENO–HUMANISTIČKE NAUKE U FIZIČKOM VASPITANjU I SPORTU

Introductory lecture

MAIN TENDENCIES IN THE SOCIOLOGY OF SPORT

Sandra Radenović[1]
[1] University of Belgrade, Faculty of Sport and Physical Education, Belgrade, Serbia

Introduction

Sociology of sport is a special sociological discipline that focuses on the complex relationship between sport and society. Practically, the sociology of sport is most often focused on the research of the sports event, the characteristics of the elements of the sports event (athletes, mediators and the audience) and mutual interactions between the mentioned three elements of each sports event (Milovanović, 2017).

According to Koković (Koković, 2007), the sociology of sport deals with issues of context and social conditioning of sport. The development of the sociology of sport as a theoretical and empirical discipline is not only a simple consequence of the development of contemporary sociology, more precisely, of its spread to newer and newer phenomena, but this sociological discipline indicates a close interdependence between the development of sport and the development of certain areas of social life, certain phenomena in culture and civilization (Koković, 2007). Günter Riese's paper entitled "Sociology of Sport" (1921) is considered as one of the first attempts to discuss the essence of sport from a sociological aspect. In this paper, the author believes that sport is a reaction to the entire system that turns man into a machine. Heinrich Steinitzer's book "Sport and Culture" (1910) is considered to be the first publication on the topic of social problems of sport, in which the author discusses the relationship between sport and culture and criticizes the professional sport of that time. This publication met with a wide echo in the public and the sports world at the beginning of the 20th century (Koković, 2007; Radenović, 2021).

Contemporary researches in the sociology of sport observe sport as a form of culture, sport in everyday life, commercialization of sport, sport as a spectacle. Sociology of sport studies the impact of society on sport, but also, vice versa, impact of sport on society, therefore, issues of context and social conditioning of sport. It is considered that the scope of the sociology of sport primarily includes the following questions: sport as a factor and product of society and social development, the role of sport in the entire social life, the social position of participants in sport, the attitude of the wider social community towards sport, social relations within sport, etc. Sociology of sport indicates the place and importance of sport in modern society, its social nature and cultural value and conditioning. As Koković notes, the application of sociological knowledge in the management of sport as a social institution, as well as in the study of its possibilities in the realization of individual and social needs, is increasingly visible (Koković, 2007). Another field of practical study by sociologists concerns the social microstructure of sports, in fact, the formal and informal structure of sports collectives such as clubs, sports groups – very important in team sports, spontaneous amateur groups, dominant groups, etc. It is considered that the proper and efficient functioning of sport as an institution and the realization of the goals set by this institution depend to a significant extent on the study of these microstructures. An excellent example of such a

study is the influence of a formal or informal structure on the course and effects of sports training, as well as on the achievement of top results. Regarding the "sociotechnical" function of the sociology of sport, we have in mind the researches of life preoccupations, patterns of behavior, interests, value systems and personalities, primarily of athletes ('actors' of a sporting event), but also of 'mediators' of a sporting event (coaches, journalists, sponsors...) and audience (the psychology of the sports audience is considered). Koković points out that this side of the observed phenomena is on the border between the sociology of sport and the psychology of sport, in fact, it is the subject of interest for sociologists of sport who start from individual behavior observed in a social context and who study the socially conditioned components of the psychology of participants in sports (Koković, 2007). Let us also state that sociologists of sport generally believe that sociology of sport study sport in order to learn as much as possible about society (Kuljić, Koković, 2012). We will insist on the mutual relationship between sport and society as the backbone of research in the contemporary sociology of sport as a special sociological discipline (Radenović, 2021).
Tendencies in the development of the sociology of sport that can be observed both in the world and in the domestic intellectual and academic space relate to: 1. fragmentation of the sociology of sport and 2. approaching the sociology of sport to related disciplines.

Methods

The method of theoretical analysis was used in the paper.

Results

Regarding the fragmentation trend of the sociology of sport, we may observe subdisciplines derived from the sociology of sport, such as: sociology of football and sociology of Cristiano Ronaldo (Milovanović, Radenović, 2020).

Sociology of football is considered as a young special sociology created by the development and differentiation of the sociology of sport as a special sociological discipline. Sociology of football can be defined as a young sociological discipline, or rather, a 'subdiscipline', which has as its subject of study the complex relationship between society and football as the most popular sport throughout the history of sports, and more broadly, throughout the history of physical culture (Radenović, Milovanović, 2019). One of the goals of the sociology of football is to think critically about numerous aspects of the mutual relationship between society and football in the contemporary world and throughout the history of sports. Through the analysis of sociological terms within the sociology of football, it is possible to acquire relevant knowledge and orientation in the critical reflection of football as undoubtedly the most popular sport and one of the most significant social phenomena (Radenović, Milovanović, 2019).

As a young sociological discipline, the sociology of football offers the knowledge acquisition about a complex and very important area of permeation of society and football as the most popular sport in the modern world (Radenović, Milovanović, 2019). There are numerous dimensions of the interpenetration of society and football. Let us recall the example of the so-called "soccer war" between El Salvador and Honduras in South America in 1969. Because of the qualifying match for the World Cup in June 1969, El Salvador broke off diplomatic relations with neighboring Honduras. Firstly, the fans of both countries disrupted the first two, out of a total of three football matches, in big riots, so the final was played in front of 1,700 policemen. After the severance of diplomatic

relations, the ''soccer war'' continued to be fought with tanks and planes: the Salvadoran army entered Honduras and bombed the capital, killing more than 300 people and 10,000 Honduran immigrants fled back to El Salvador (Kuljić, Koković, 2012; Radenović, 2021). This is an extreme example of sport as a function of regional disintegration, and actually one of the examples of the interpenetration of society and football.

Let us recall the World Football Championship that took place in Qatar in 2022 and numerous examples of the permeation of global society and football. Thus, in Brussels, there were riots in the streets after the victory of the Moroccan national team over the Belgian national team, when Moroccan fans celebrated by carrying Moroccan flags, throwing pyrotechnics, overturning cars and setting fire to parked scooters (Tanjug, 2022). It is also interesting that the flags of the so-called state of Kosovo, as well as the flag of the terrorist organization "KLA", were seen at one of the stadiums as a political provocation during the match between the Swiss national team and the Serbian national team (Ljubisavljević, 2022). These examples once again show the multidimensionality of the complex relationship between society and football, and through the reflection of a mega sports event such as the Fifa World Cup in football.

Finally, regarding the sociology of Cristiano Ronaldo, let us recall that this 'subdiscipline' is studied as a teaching subject within the Canadian University of British Columbia under the title Sociology of Cristiano Ronaldo: Football, Identity and Representation (Milovanović, Radenović, 2020). More precisely, we can say that it is a 'subsubdiscipline' created by further fragmentation of the sociology of football. Although we are talking about the football player with top playing potential, who is well known out of the field for his enormous earnings and lifestyle worthy of Hollywood "stars", but also for his serious humanitarian work, the question arises whether a teaching subject called the sociology of Cristiano Ronaldo is really necessary at colleges and will that teaching subject continue to "live" when the media and sports industry in the future "produce" an even more admirable football star? (Milovanović, Radenović, 2020).

Approaching the sociology of sport to related disciplines refers primarily to common areas that are also studied within special sociological disciplines such as sociology of medicine and sociology of the body, sociology of morality, as well as within ethics and bioethics of sport.

Let us mention some of the less researched topics that are beginning to intrigue sociologists of sport, both at the global and national level: the presence of technological doping in professional sports; sociological aspects of e-sports; the impact and consequences of the COVID-19 pandemic on sports and the organization of sports events; environmental footprint of a sports event; gender inequalities in sports; transgender athletes; cyborgized athletes; appearance and importance of ethics committees in sports, etc. Thus, for example, the phenomenon of cyborgized athletes is researched not only within the sociology of sport, but also within the sociology of medicine, the sociology of the body, and certainly also within the bioethics of sport. The meeting points of the mentioned disciplines are health and disease, more precisely, the relationship between health and disease, then, physicality as the physical appearance of each individual, in this case - an athlete, and in the context of bioethics as the ethics of life, which should provide orientational knowledge about a certain phenomenon: whether is a certain phenomenon ethical?; does it produce ethical dilemmas and why?; can it suggests a solution to some ethical dilemma? etc. Therefore, numerous topics such as the use of doping, consideration of physicality from the perspectives of sociology of sport, sociology of the body and bioethics of sport, consideration of various cultural and social factors that

affect health, the concept of health and disease, are the backbone of the trend of bringing sociology of sport closer to related disciplines.

Discussion

The sociology of football undoubtedly emerged as a sociological discipline, or rather a 'subdiscipline' derived from the sociology of sport. The subject of that discipline is currently "outlined" as a complex relationship between society and football, as the most popular sport in the modern history of sports and physical culture in general. At the same time, this sociological subdiscipline tries to critically reflect on various aspects of the mutual relationship between society and football. Relying on the understanding and critical operationalization of key concepts from the field of the sociology of sport, the sociology of football seeks to develop critical knowledge about how in contemporary societies one type of sport has "fought" to become "the most important secondary activity of man". In the researches, that discipline also tries to develop specific theoretical approaches, but also to critically point out the consequences in social life that football and activities related to it leave on numerous structural and developmental problems of modern, global society (Milovanović, Radenović, 2020).

Regarding the sociology of Cristiano Ronaldo, the popularity of Cristiano Ronaldo as an extremely influential modern football player is unquestionable, but the tendency to fragment the basic and the most general science about society, through the "erosion" of disciplines into numerous subdisciplines, or more precisely, 'subsubdisciplines' whose critical and informative scope is not clear enough – is questionable. The sociology of sport is particularly sensitive in that area: as a young discipline, unevenly developed in different intellectual and academic environments, it is already experiencing "erosion", through the separation of subdisciplines (the sociology of football is among them), from which potential 'subsubdisciplines' are further separated (such as the sociology of Cristiano Ronaldo). If the trend of uncritical fragmentation of the sociology of sport continues, in the future there will be inevitably a need to reexamine the entire theoretical-methodological basis of that sociological discipline, whose importance for contemporary sociology is unquestionable, precisely because the influence that modern sports have on almost all societies of the world is enormous (Milovanović, Radenović, 2020).

Finally, when we talk about the sociology of sport and its approaching to related disciplines, this trend is inevitable, primarily because of the complexity of the 'new', less researched topics we mentioned, and because of the importance of simultaneously considering these new topics from the perspective of numerous related humanistic disciplines. For example, numerous topics such as the use of (technological) doping, consideration of physicality from the perspectives of sociology of sport and sociology of the body, consideration of various cultural and social factors that affect health, understanding of health and illness, etc. they are the backbone of numerous researches, both within the sociology of the body, the sociology of medicine, the bioethics of sport, and within the sociology of sport. We can notice that a peculiar principle of pluriperspectivism, i.e., consideration of the listed topics from the perspectives of different, but also related disciplines, contributes to the comprehensive understanding of these less researched phenomena.

Conclusion

We can conclude that the sociology of sport, as a young special sociological discipline, very quickly began to be 'shredded', 'crumbled' into ’subdisciplines’ such as the sociology of football, and into ’subsubdisciplines’ such as the sociology of Cristiano Ronaldo. The emergence of those disciplines is based on pragmatic reasons and is conditioned by the rapid development of certain sports, specifically football. Let us state that this trend goes further towards the study of individual phenomena and popular figures in the sphere of sports, which can lead that discipline to an unfathomable "dismemberment", even regarding only football, as undoubtedly the most popular sport nowdays, including its actors, and especially the highest paid, most successful and most influential football players (Milovanović, Radenović, 2020).

On the other hand, regarding the sociology of sport and its approaching to related disciplines, we believe that this trend is inevitable and above all useful primarily due to the complexity of 'new', less researched topics that are the focus of research, in the same time, of the sociology of sport and the sociology of the body, of the sociology of medicine, sociology of morality, and ethics and bioethics of sport. In this sense, the peculiar principle of pluriperspectivism contributes to a comprehensive understanding of these less researched phenomena.

Literature

Koković, D. (2007). „Sociologija sporta“ u: *Sociološki rečnik* (ur. Mimica, A., Bogdanović, M.), Beograd: Zavod za udžbenike, pg. 567-568.

Kuljić, R., Koković, D. (2012). *Sociologija i sociologija sporta*, Novi Sad: Fakultet sporta i fizičkog vaspitanja Univerzitet u Novom Sadu.

Ljubisavljević, M. (2022). FOTO Velika sramota: Šta će zastava OVK na utakmici Srbije i Švajcarske, available at:

Milovanović, I. (2017). *Uvod u sociologiju i sociologiju sporta*. Novi Sad: Fakultet sporta i fizičkog vaspitanja.

Milovanović, I., Radenović, S. (2018). Sociologija sporta – mogućnosti daljeg razvoja discipline U: Knjižica sažetaka međunarodne naučne konferencije Sociologija u XXI veku: izazovi i perspektive (povodom 80 godina od formiranja Društva za sociologiju i društvene nauke), 10.11.2018., (Departman za sociologiju, Filozofski fakultet Univerziteta u Nišu, Srpsko sociološko društvo), pg. 54-56.

Milovanović, I., Radenović, S. (2020). Savremene tendencije u sociologiji sporta: od konstituisanja do „razmrvljene” discipline. *Sociologija*, Vol LXII (2): 237-254.

Radenović, S., Milovanović, I. (2019). Sociologija fudbala kao posebna sociološka disciplina i nastavni predmet U: Zbornik sažetaka, Međunarodna naučna konferencija ‘Efekti primene fizičke aktivnosti na antropološki status dece, omladine i odraslih’, Fakultet sporta i fizičkog vaspitanja, Univerzitet u Beogradu, Beograd: 2019, pg. 28-29.

Radenović, S. (2021). *Sociologija sa sociologijom sporta*. Treće dopunjeno i izmenjeno izdanje. Beograd: Fakultet sporta i fizičkog vaspitanja Univerziteta u Beogradu.

Tanjug (2022). Haos na ulicama Brisela: Zbog poraza Belgije od Maroka izbili sukobi, upotrebljeni suzavac i vodeni topovi (VIDEO).

Uvodno predavanje

GLAVNE TENDENCIJE U SOCIOLOGIJI SPORTA

Sandra Radenović[1]
[1] Univerzitet u Beogradu – Fakultet sporta i fizičkog vaspitanja, Beograd, Republika Srbija

Uvod

Sociologija sporta jeste posebna sociološka disciplina koja u fokusu istraživanja ima kompleksan odnos između sporta i društva. Praktično, sociologija sporta se najčešće usmerava na istraživanje sportskog događaja, karakteristika elemenata sportskog događaja (sportisti, posrednici i publika) i međusobnih interakcija između pomenuta tri elementa svakog sportskog događaja (Milovanović, 2017).

Kako smatra Koković (Koković, 2007), sociologija sporta se bavi pitanjima konteksta i društvene uslovljenosti sporta. Razvoj sociologije sporta kao teorijske i empirijske discipline, nije samo prosta posledica razvoja savremene sociologije, tačnije, njenog rasprostiranja na sve novije i novije pojave, već ova sociološka disciplina ukazuje na usku međuzavisnost između razvoja sporta i razvoja određenih oblasti društvenog života, određenih pojava u kulturi i civilizaciji (Koković, 2007). Rad Gintera Rizea (*Günter Riese*) pod nazivom „Sociologija sporta" (1921. god.) smatra se jednim od prvih pokušaja razmatranja suštine sporta sa sociološkog aspekta. U ovom radu autor smatra da je sport reakcija na celokupan sistem koji čoveka preobraća u mašinu. Prvom publikacijom na temu društvenih problema sporta smatra se knjiga Hajnriha Štajnicera (*Heinrich Steinitzer*) „Sport i kultura" (1910. god.) u kojoj autor raspravlja o odnosu sporta prema kulturi i iznosi kritiku vrhunskog sporta tog vremena. Ova publikacija je naišla na širok odjek u javnosti i sportskom svetu početkom XX veka (Koković, 2007; Radenović, 2021).

Savremena istraživanja u sociologiji sporta posmatraju sport kao oblik kulture, sport u svakodnevnom životu, komercijalizaciju sporta, sport kao spektakl. Sociologija sporta proučava uticaj društva na sport, ali i povratni uticaj sporta na društvo, dakle, pitanja konteksta i društvene uslovljenosti sporta. Smatra se da delokrug sociologije sporta obuhvata prevashodno sledeća pitanja: sport kao činilac i proizvod društva i društvenog razvoja, uloga sporta u celokupnom društvenom životu, društveni položaj učesnika u sportu, odnos šire društvene zajednice prema sportu, društveni odnosi unutar sporta itd. Sociologija sporta ukazuje na mesto i značaj sporta u savremenom društvu, na njegovu društvenu prirodu i kulturnu vrednost i uslovljenost. Kako napominje Koković, sve je vidljivija primena socioloških saznanja pri upravljanju sportom kao društvenom institucijom, kao i u proučavanju njegovih mogućnosti u realizaciji individualnih i društvenih potreba (Koković, 2007). Još jedna oblast praktičnog proučavanja sociologa tiče se društvene mikrostrukture sporta, odnosno formalne i neformalne strukture sportskih kolektiva kao što su klubovi, sportske grupe – veoma važne u timskim sportovima, stihijske amaterske grupe, dominantne grupe itd. Smatra se da od proučavanja ovih mikrostruktura u značajnoj meri zavisi i pravilno i efikasno funkcionisanje sporta kao institucije i realizacija ciljeva koje ova institucija postavlja. Odličan primer takvog proučavanja jeste uticaj formalne ili neformalne strukture na tok i efekte sportskog treninga, kao i na ostvarivanje vrhunskog rezultata. Kada se govori o

“sociotehničkoj” funkciji sociologije sporta, imaju se na umu istraživanja životnih preokupacija, obrazaca ponašanja, interesovanja, sistema vrednosti i ličnosti prevashodno sportista (aktera sportskog događaja), ali i posrednika sportskog događaja (treneri, novinari, sponzori…) i publike (ima se u vidu psihologija sportske publike). Koković ukazuje da se ova strana posmatranih pojava nalazi na granici između sociologije sporta i psihologije sporta, odnosno, ona je predmet interesovanja sociologa sporta koji polaze od individualnog ponašanja posmatranog u društvenom kontekstu i koji proučavaju društveno uslovljene komponente psihologije učesnika u sportu (Koković, 2007). Navedimo i to da sociolozi sporta mahom smatraju da sociologija sporta istražuje sport da bi što više saznala o društvu (Kuljić, Koković, 2012). Mi ćemo insistirati na uzajamnom odnosu sporta i društva kao okosnici istraživanja u savremenoj sociologiji sporta kao posebnoj sociološkoj disciplini (Radenović, 2021).

Tendencije u razvoju sociologije sporta koje se mogu uočiti kako u svetskom, tako i u domaćem intelektualnom i akademskom prostoru odnose se na: 1. fragmentaciju sociologije sporta i na 2. približavanje sociologije sporta srodnim disciplinama.

Metod

U radu je korišćen metod teorijske analize.

Rezultati

Kada je reč o trendu fragmentacije sociologije sporta, mogu se uočiti subdiscipline proistekle iz sociologije sporta poput: sociologije fudbala i sociologije Kristijana Ronalda (Milovanović, Radenović, 2020).

Sociologija fudbala se smatra mladom posebnom sociologijom nastalom razvojem i diferenciranjem sociologije sporta kao posebne sociološke discipline. Sociologija fudbala se može definisati kao mlada sociološka disciplina, tačnije, subdisciplina, koja za predmet izučavanja ima kompleksan odnos društva i fudbala kao najpopularnijeg sporta kroz istoriju sporta, a i šire, kroz istoriju fizičke kulture (Radenović, Milovanović, 2019). Jedan od ciljeva sociologije fudbala jeste kritičko razmišljanje o brojnim aspektima međusobnog odnosa društva i fudbala u savremenom svetu i kroz istoriju sporta. Kroz analizu sociioloških pojmova u okviru sociologije fudbala, omogućava se sticanje relevantnih saznanja i orijentacija u kritičkom promišljanju fudbala kao nesumnjivo najpopularnijeg sporta i jednog od značajnijih društvenih fenomena (Radenović, Milovanović, 2019).

Kao mlada sociološka disciplina, sociologija fudbala nudi sticanje znanja o kompleksnoj i veoma značajnoj oblasti prožimanja društva i fudbala kao najpopularnijeg sporta u savremenom svetu (Radenović, Milovanović, 2019). Brojne su dimenzije prožimanja društva i fudbala. Podsetimo na tzv. primer „fudbalskog rata“ između Salvadora i Hondurasa u Južnoj Americi 1969. godine. Zbog kvalifikacione utakmice za svetsko prvenstvo u junu 1969. godine Salvador je prekinuo diplomatske odnose sa susednim Hondurasom. Najpre su navijači obeju zemalja omeli u velikim neredima prve dve, od ukupno tri utakmice, tako da je finale odigrano pred 1700 policajaca. Posle prekida diplomatskih odnosa, fudbalski rat je nastavljen da se vodi tenkovima i avionima: vojska Salvadora je ušla u Honduras i bombardovala glavni grad, poginulo je više od 300 ljudi, a 10.000 doseljenika iz Hondurasa je pobeglo natrag u Salvador (Kuljić, Koković, 2012; Radenović, 2021).

Ovo je ekstreman primer sporta u funkciji regionalne dezintegracije, a zapravo jedan od primera prožimanja društva i fudbala.

Podsetimo na Svetsko fudbalsko prvenstvo koje se odigralo u Kataru 2022. godine i brojnih primera prožimanja globalnog društva i fudbala. Tako je u Briselu došlo do nereda na ulicama posle pobede reprezentacije Maroka nad reprezentacijom Belgije kada su navijači Maroka slavili noseći marokanske zastave, bacali pirotehniku, prevrtali automobile i palili parkirane skutere (Tanjug, 2022). Zanimljivo je i da su se zastave tzv. države Kosovo, kao i zastava terorističke organizacije „OVK", našle na jednom od stadiona kao politička provokacija za vreme utakmice između reprezentacije Švajcarske i reprezentacije Srbije (Ljubisavljević, 2022). Ovi primeri još jednom pokazuju višedimenzionalnost kompleksnog odnosa društva i fudbala, a kroz refleksiju jednog mega sportskog događaja kakvo je Svetsko prvenstvo u fudbalu.

Najzad, kada je reč o sociologiji Kristijana Ronalda, podsetimo da se ova subdisciplina kao nastavni predmet izučava u okviru nastave kanadskog univerziteta University of British Columbia pod nazivom Sociology of Cristiano Ronaldo: Football, Identity and Representation (Milovanović, Radenović, 2020). Preciznije, možemo reći da je reč o 'subsubdisciplini' nastaloj daljom fragmentacijom sociologije fudbala. Iako je reč o fudbaleru vrhunskih igračkih potencijala, koji je van terena poznat po enormnoj zaradi i stilu života dostojnom holivudskih „zvezda", ali i ozbiljnom humanitarnom radu, nameće se pitanje da li je nastavni predmet pod nazivom sociologija Kristijana Ronalda zaista neophodan na fakultetima, kao i da li će taj predmet nastaviti da „živi" kada medijska i sportska industrija u budućnosti „proizvedu" fudbalsku zvezdu još vredniju divljenja? (Milovanović, Radenović, 2020).

Približavanje sociologije sporta srodnim disciplinama odnosi se prevashodno na zajedničke oblasti koje se izučavaju i u okviru posebnih sociioloških disciplina poput sociologije medicine i sociologije tela, sociologije morala, kao i u okviru etike i bioetike sporta.

Pomenimo neke od manje istraženih tema koje počinju da intrigiraju sociologe sporta, kako na globalnom, tako i na nacionalnom nivou: prisustvo tehnološkog dopinga u profesionalnom sportu; sociološki aspekti e-sporta; uticaj i posledice pandemije COVID-19 na sport i organizaciju sportskih događaja; ekološki otisak sportskog događaja; rodne nejednakosti u sportu; transrodni sportisti; kiborgizovani sportisti; pojava i značaj etičkih komiteta u sportu itd. Tako se, recimo, fenomen kiborgizovanih sportista istražuje ne samo u okviru sociologije sporta, već i u okviru sociologije medicine, sociologije tela, a svakako i u okviru bioetike sporta. Tačke susreta pomenutih disciplina jesu zdravlje i bolest, tačnije, odnos zdravlja i bolesti, zatim, telesnost kao fizička pojavnost svakog pojednica, u ovom slučaju – sportiste, a u kontekstu bioetike kao etike života koja bi trebalo da daje orijentacijsko znanje o određenom fenomenu: da li je ili ne određena pojava etična, moralna?; da li proizvodi etičke nedoumice i zašto?; da li može da predloži rešenje neke etičke nedoumice? itd. Dakle, brojne teme poput korišćenja dopinga, razmatranja telesnosti iz perspektiva sociologije sporta, sociologije tela i bioetike sporta, razmatranja različitih kulturnih i društvenih faktora koji utiču na zdravlje, poimanje zdravlja i bolesti, jesu okosnica trenda približavanja sociologije sporta srodnim disciplinama.

Diskusija

Sociologija fudbala se nesumnjivo pojavila kao sociološka disciplina, tačnije subdisciplina proistekla iz sociologije sporta. Predmet te discipline se za sada „ocrtava“ kao kompleksan odnos društva i fudbala, kao najpopularnijeg sporta u modernoj istoriji sporta i fizičke kulture uopšte. Pri tome, ta sociološka subdisciplina nastoji da kritički promišlja raznorodne aspekte međusobnog odnosa društva i fudbala. Oslanjajući se na razumevanje i kritičku operacionalizaciju ključnih pojmova iz domena sociologija sporta, sociologija fudbala nastoji da razvije kritička saznanja o tome kako se u modernim društvima jedna vrsta sporta „izborila“ da postane „najvažnija sporedna aktivnost čoveka“. U istraživačkom traganju, i ta disciplina pokušava da razvije specifične teorijske pristupe, ali i da kritički ukaže na posledice u društvenom životu koje fudbal i aktivnosti u vezi sa njim ostavljaju na brojne strukturalne i razvojne probleme modernog, globalnog društva (Milovanović, Radenović, 2020).

Kada je reč o sociologiji Kristijana Ronalda, neupitna je popularnost Krsitijana Ronalda kao izuzetno uticajnog savremenog fudbalera, ali jeste upitna tendencija usitnjavanja osnovne i najopštije nauke o društvu, kroz „eroziju“ disciplina u brojne subdiscipline, tačnije, ‘subsubdiscipline’ čiji je kritičko-saznajni opseg nedovoljno jasan. Sociologija sporta je u toj oblasti posebno osetljiva: kao mlada disciplina, neravnomerno razvijena u različitim intelektualnim i akademskim okruženjima, ona već doživljava „eroziju“, kroz izdvajanje subdiscipina (sociologija fudbala je među njima), iz kojih se dalje izdvajaju potencijalne ‘subsubdiscipline’ (kao što je sociologija Kristijana Ronalda). Ukoliko se nastavi trend nekritičke fragmentacije sociologije sporta, u budućnosti će neminovno doći do potrebe za preispitivanjem čitave teorijsko-metodološke osnove te sociološke discipline, čiji je značaj za savremenu sociologiju neupitan, samim tim što je uticaj koji savremeni sport ima na gotovo sva društva sveta ogroman (Milovanović, Radenović, 2020).

Najzad, kada govorimo o sociologiji sporta i približavanju srodnim disciplinama, ovaj trend je neizbežan prevashodno zbog kompleksnosti ’novih’, manje istraženih tema koje smo pomenuli, te zbog značaja istovremenog promišljanja ovih novih tema iz ugla brojnih srodnih humanističkih disciplina. Recimo, brojne teme poput korišćenja (tehnološkog) dopinga, razmatranja telesnosti iz perspektiva sociologije sporta i sociologije tela, razmatranja različitih kulturnih i društvenih faktora koji utiču na zdravlje, poimanje zdravlja i bolesti itd. okosnica su brojnih istraživanja, kako u okviru sociologije tela, sociologije medicine, bieotike sporta, tako i u okviru sociologije sporta. Možemo primetiti da svojevrstan princip pluriperspektivizma, odnosno, razmatranje pobrojanih tema iz perspektiva različitih, ali i srodnih disciplina, doprinosi celovitom shvatanju ovih manje istraženih fenomena.

Zaključak

Možemo zaključiti da se sociologija sporta kao mlada posebna sociološka disciplina veoma brzo počela da ’usitnjava’, ’mrvi’ na subdiscipline poput sociologije fudbala, te na subsubdiscipline poput sociologije Kristijana Ronalda. Nastanak tih disciplina zasnovan je na pragmatičkim razlozima i uslovljen je naglim razvojem pojedinih sportova, tačnije fudbala. Konstatujmo da taj trend ide dalje ka izučavanju pojedinačnih pojava i popularnih ličnosti u sferi sporta, što tu disciplinu može odvesti u nesagledivo „rasparčavanje“, čak i kada se radi samo o fudbalu, kao

nesumnjivo najpopularnijem sportu danas, uključujući i njegove aktere, a posebno najplaćenije, najuspešnije i najuticajnije fudbalere (Milovanović, Radenović, 2020).

Sa duge strane, kada je reč o sociologiji sporta i približavanju srodnim disciplinama, smatramo da je ovaj trend neizbežan i nadasve koristan prevashodno zbog kompleksnosti 'novih', manje istraženih tema koje su u fokusu istraživanja kako sociologije sporta, tako i sociologije tela, sociologije medicine, sociologije morala, te etike i bioetike sporta. U tom smislu, svojevrstan princip pluriperspektivizma doprinosi celovitom shvatanju ovih manje istraženih fenomena.

Literatura

Koković, D. (2007). „Sociologija sporta" u: *Sociološki rečnik* (ur. Mimica, A., Bogdanović, M.), Beograd: Zavod za udžbenike.

Kuljić, R., Koković, D. (2012). *Sociologija i sociologija sporta*, Novi Sad: Fakultet sporta i fizičkog vaspitanja Univerzitet u Novom Sadu.

Ljubisavljević, M. (2022). FOTO Velika sramota: Šta će zastava OVK na utakmici Srbije i Švajcarske

Milovanović, I. (2017). *Uvod u sociologiju i sociologiju sporta*. Novi Sad: Fakultet sporta i fizičkog vaspitanja.

Milovanović, I., Radenović, S. (2018). Sociologija sporta – mogućnosti daljeg razvoja discipline U: Knjižica sažetaka međunarodne naučne konferencije Sociologija u XXI veku: izazovi i perspektive (povodom 80 godina od formiranja Društva za sociologiju i društvene nauke), 10.11.2018., (Departman za sociologiju, Filozofski fakultet Univerziteta u Nišu, Srpsko sociološko društvo), str.:54-56.

Milovanović, I., Radenović, S. (2020). Savremene tendencije u sociologiji sporta: od konstituisanja do „razmrvljene" discipline. *Sociologija*, Vol LXII (2): 237-254.

Radenović, S., Milovanović, I. (2019). Sociologija fudbala kao posebna sociološka disciplina i nastavni predmet U: Zbornik sažetaka, Međunarodna naučna konferencija 'Efekti primene fizičke aktivnosti na antropološki status dece, omladine i odraslih', Fakultet sporta i fizičkog vaspitanja, Univerzitet u Beogradu, Beograd: 2019, str.: 28-29.

Radenović, S. (2021). *Sociologija sa sociologijom sporta*. Treće dopunjeno i izmenjeno izdanje. Beograd: Fakultet sporta i fizičkog vaspitanja Univerziteta u Beogradu.

Tanjug (2022). Haos na ulicama Brisela: Zbog poraza Belgije od Maroka izbili sukobi, upotrebljeni suzavac i vodeni topovi (VIDEO)

Football: From Global Phenomenon to Literary Text

Ana Penjak[1], Petar Gizdić[1]
Faculty of Kinesiology, University of Split, Croatia[1]

Introduction

Sport, a word derived from Old French word *desporter*, meaning 'to amuse, please, or play' (Elias and Dunning, 1986), has challenged and aspired many scholars through years and throughout different fields (from kinesiology and medicine to sociology and philosophy) to try to coin a single definition that would incorporate unified meaning. Shawn E. Klein explains that defining sport is not as easy as it might seem. Namely, the author states that when defining sport, we must pay attention to whether we address it as a term or as a concept. In other words, the author clarifies that when we address sport as a term then we are addressing it as a linguistic marker that, as such, is a subject to change; while if we address sport as a concept then we are addressing it as 'the range of activities in the world that we unite into one idea: sport' (Klein, 2017, p. xii). Simply said, 'Sport is everywhere, and for many, it is everything. Whether one is a participant, a casual spectator, a die-hard fan, or even a critic, sport plays a significant role in the lives of most people throughout the world. It is the topic of daily conversation and frequently the lead story on news. Sport unites (and sometimes divides) cities and nations-even families. It transcends ethnic, national, gender, age, religious, and belief boundaries. It is probably as old as the human civilization itself. In these ways it is no exaggeration to say that the study of sport is the study of humanity' (Klein, 2017, p. xi). Or as Perasović and Bertoluci explain, 'Sport is one of basic social institutions, inseparable from the structure of society and family, economy, media, politics, education, religion, etc., i.e. it is an integral part of the everyday life of people around the world' (2007, p. 106). Following these lines of thought, McPherson, Curtis and Loy (1989) state that they see the role of sport as a concept layered on three levels – sport as a fun activity, sport as a sporting activity and sport as a combat (in a sense of competition). Škerbić and Radenović offer their definition of sport in a context of a contemporary sport. The authors explain that contemporary sport is not simply about play and players, coaches and others involved around the play but that it is 'everything else that is external to the game and inseparable from sport, such as sports institutions and bodies, economic parameters, media and media echoes' (Škerbić, Radenović, 2018, p. 163). Bordin, Robene, and Heas (2007) and Madigan and Delaney (2009), on the other hand, approach sport as a social phenomenon saying that it incorporates and mirrors all of the social relations. Zagorac and Škerbić offer their understanding of sport within the context of philosophy where they bring an interesting discussion on the connection between sports and game, as well as their examination of the issue of the purpose of sport (sport as a competition, sport as leisure, sport as a way of acquiring finances, sport as a method of education, sport as means of therapy etc.) (2018). Furtheremore, Nedić and Škerbić go even further in their work where they work on the analysis of the term sport and its usage within Croatian legal acts regarding sports, as well as several international legal acts. Namely, authors state that, according to the European sports charter of the Council of Europe, sport is defined as a representation of all forms of physical activity that, through an organized or non-organized sports participation, aim to express or improve

physical fitness and mental well-being of their participants, i.e. to create, at the same time, social relationships and/or results in competitions on all levels (Nedić, Škerbić, 2020).

Culture, on the other hand, just like sport, consists of norms, values and believes. Culture, as the way of life, customs of particular group of people at a particular time, is a word that, in its early beginnings, was used primarily in a farming context (in a sense of cultivating the land). In rather short period of time, its meaning adopted broader meaning, i.e. it became a synonym for 'being civilized' (to be cultivated meant to have polite manners (when referring to an individual)), i.e. to make progress (spiritual and material). Saying this, Eagleton and Williams believe that culture represents one of three most difficult words in English to define since it represents one of the most complex concepts to explain (Eagleton, 2002; Williams, 1983). But the process of globalization, industrialization and the development of mass media (television, radio, daily press, Internet, etc.) have changed the way we perceive and consume culture today, i.e. they have brought culture and cultural content closer to masses as well as to all the other participants in various social contexts: from politics and economics to entertainment and sports (Tomić, Koludrović i Mihaljević, 1999). Rapid growth of all forms of sport, its prevalence around the societies in the world and the rapid development of mass media, on the other hand, have contributed to the fact that sport has become the phenomenon of the masses, be it on the level of spectators, active participants or just as mere sports enthusiast. Or simply said, sport has become 'an expression of that socio-cultural system in which it occurs' (Lüschen, 1967, p. 129).

Whichever approach or definition we agree upon, whether when talking about sport or culture, one thing is for sure: nowadays sport is being viewed not only as a structured sporting activity, a phenomenon of the masses, whether as spectators or active participants (Vrcan, 1990; Vrcan, 1971) but also as a cultural phenomenon. In other words, the sudden increase in all forms of sports activities, on the one hand, and mass media production of sporting contents (from television transmissions of sports matches to various marketing campaigns for different products (from crisps to underwear) featuring different sportsmen), on the other hand, led to the conclusion that sports – with a special emphasis, in this particular case, on football –
has become part of various other social spheres, culture being one of then, and as such has expanded its meaning and role. Although its obvious characteristics and content distinguish sport from literature (as a form of cultural expression), this paper will seek to present its entanglement through the examples of novels, with particular emphasis on the most translated novel worldwide – Nick Hornby's novel *Fever Pitch* (1992), all of the which ground their plot on football topics.

Therefore, this study is based on two hypotheses: 1) the presence of football in literature (novels) as a non-sports context contributes, changes and breaks the boundaries of thinking about sport simply as a phenomenon that combines entertainment and profit; 2) through mass media, sport can serve as a basis for numerous discussions in other contexts, such as literature and culture.

Methods

The methods used in this study are: 1) explicative method of analysis is used in analysing the space and role of sport (football) in society and mass-media and in analysing the way in which football has found its place in literature; 2) inductive method is used for making general conclusions and overalls on the roles, reasons and outcomes of reading novels with football as its topic within contemporary non-sports context.

Results

The process of democratization and education has brought culture and its contents closer to broader masses and, thus, made it, to certain extent, trivial (Solar, 2005). Social mobility, cultural diversity, the spread of literacy and the growing number of books in supermarkets and kiosks led to the expansion of the readership (Bowlby, 2005). Even more, the readers' habits have also slightly changed. Namely, nowadays we witness on numerous cheap book editions and their availably and exposure on places (for instance, kiosk or supermarkets) that before would have been reserved only for, for instance, newspapers, milk or bread. This has led not only to the accessibility of the books to broader masses but also to fulfilling of their so-called false needs and consumption. Namely, the expectations of today's readers have also changed. Today's reader expects from a novel to offer him an illusion of freedom, i.e. something new, extraordinary and unexpected that would be comprehensible to him without great intellectual effort or pre-knowledge of the topic (Eco, 2002). It is this 'openness' of the novel (its easiness and lightness of its topics, its accessibility to purchase it- be it its price or its place of selling) that tends to bridge literature and other socio-cultural contents (sports topics being of them) today.

Sport and its presence in mass media have made its content approachable and available to every individual or a household. Even more, we witness on how football, through years, has gained not only global popularity, but has grown from a global and mass phenomenon into a real profitable business (Bartoluci, 2003; Bodin, 2007). The European Commission Report (DGX, 1998 according to Bodin (2007) states that sport, football being the most popular one, and sports industry, in general, makes up to 1% of the total social product, i.e. up to 3% of the total social product at the level of the world economy. When all this is taken into consideration, the fact that sports topics, football in particular, have found its place outside of the sporting context, i.e. have become topic for many of the literary forms (novels, poems, short stories etc.) and discussions worldwide comes as no surprise. More precisely, football started being a topic for literary texts at the beginning of the 20th century (Duda, 2002) and, from then onwards, numerous literary works that have been using football as its topic.

Discussion

In order to make the aforementioned clear, we take novel *Fever pitch* (1992), written by Nick Hornby, as an example of how the lightness and openness of the novel's topic – football – has achieved not only massive appeal (it has been translated into 26 languages, sold millions of copies around the world and it has even been made into a film (*All About a Boy*, 2022)), but has actually raised awareness of some very important social issues of the time (class segregation, race issues etc.).

Namely, the novel *Fever pitch* is composed of a series of short essays that are divided into three chapters – each chapter marks a certain time period in the writer's life (1968-1975, 1976-1986, 1986-1992) – all of the which are imbued with and around his obsession with Arsenal football club. 'I fell in love with football as I was to fall in love with women', writes Hornby at the beginning of the novel, 'suddenly, inexplicably, uncritically, giving no thought to the pain or disruption it would bring with it', writes Hornby at the beginning of the novel (*Fever Pitch*, 1998, p.

7). Such a start of the novel leaves the reading thinking that the rest of the novel will be as fun and inviting as its beginning. Yes, this is true, but *Fever Pitch* is not only a novel about a beloved club, fun and interesting facts; it is a memoire, a confession about the culture of fans, about a period of (not) growing up, about the memory of other times; in other words, the novel is about the construction of an individual identity through social identification. Namely, Hornby's passion for football dates back to his early childhood years, more precisely in 1968 when, hoping to get closer to his father (his parents had just divorced), he went to his first match at Arsenal's stadium in London, Highbury. That event will mark the beginning of Hornby's love and infatuation with Arsenal and, little by little, it will become not only his way of life but a matter of life and death. Or as its main protagonist will say, it only marked the beginning of the record of his feelings for the Club but, at the same time, of the record of the social reality he was living in (settling into middle-class jobs, hooliganism that surrounded football matches, low social opinion of the game itself, gender and race segregation on football stadium – the crowd was composed of only white male). Thus, considering only the simplicity of the hero and the plot of the whole novel, not to mention the language, it becomes clear to the reader that her/she is facing rather simple and easy-to-relate issues.

Another thing should also be mentioned at this point. Namely, today's reader, when he/she accesses a certain title and content, expects of it to provide him/her with the possibility of direct identification. That is, the reader perceives the world of the novel as a kind of utopia, resulting simply from the conflict of his or her own desires and realistic possibilities. So, who, bearing in mind the novel *Fever Pitch*, from the male part of the population, at least for a moment, did not see himself in the role of a soccer player scoring a legendary goal on the field! Moreover, Duda believes that in order to understand such strong feelings and, consequently, further behaviour, it is important to understand the fan's feelings. That is, as Duda states, paraphrasing Raymond Williams, feelings caused by space and time – in this case, the stadium and matches – are a part of the lived experience of an individual and that, as such, represent not only individual value, but a greater shared social value (Duda, 2002). Nevertheless, when understanding such an 'easy read', one should know that it (the world of the novel) does not try to describe the immediate reality, does not try to imitate something that exists as an eternal aspiration in everyday life, but that it only aspires to create 'its own world', the world of fiction, which might enable the reader to mirror his everyday life with the everyday life of that particular fictional character.

Apart from Nick Hornby's novel *Fever Pitch* (2001), there are other examples of novels each of which also use football as its topic. For instance, Hungarian writer Peter Esterhazy's novel *Travel to the Depth of the Penalty Area* (2006) was published on the occasion of the 2006 World Cup in Germany. The novel written by John King, *The Football Factory* (2003) is another example of such novels in which the author addresses two social issues – class positions, rudeness of the fan subculture – but through the lens of football hooliganism gathered around Chelsea fans and their rivals.

The connection between football and class position, i.e. the rudeness of the fan subculture, has also used as the topic in Tim Parks' novel, *A Season with Verona* (2002). In the novel we read, in precise details, on the entire single season of author's beloved football club Hellas Verona and everything that occurred in that playing season.

Some of the novels have been used as a subtext for theatre plays. For instance, in 1990, Borivoj Radaković published his novel *Sjaj Epohe*, that, four years later has served as a dramatic text for the play *Welcome to Blue Hell*, which referred to the fans of the football club Dinamo, that are addressed as Bad Blue boys. There are also examples of novels in which football is not the backbone of the plot but an everyday presence that defines its characters, for instance: Bekim Sejranović's novel *Nigde, niotkuda* (2008), Ivana Kovačić's novel *Parabajka* (2013) or even one very old dated novel *Velo misto* (1981) by Miljenko Smoje. There are examples of poetry collection – Krešimir Bagić's poetry collection *Jezik za svaku udaljenost* (2001); a collection of short stories – eleven local authors in a collection entitled *Slobodni udarac: Nogometne priče* (2006), and even examples of children's novels– Slavko Kolar and his *Nogomenta utakmica* (1969) or Ivan Kušan and his novel *Ljubav ili smrt* (1988) all of the which celebrate football as its topic.

Bearing in mind all of the aforementioned, the novel *Fever Pitch* represents only one example of how literature does not represent an elevated cultural content allotted only to the elite group of people but how, by adopting topics such as football, its content becomes more approachable and understandable to wider population. In doing so, writer manages to break boundaries of thinking about sport, in this particular case, as only a combination of entertainment of profit but rather as a platform for many of the salient social debates that otherwise might not been addressed as much (from the role of fans for society to the role of sports in the process of youth identification).

Therefore, *Fever Pitch* should not be understood as an example of a novel with only a sports theme, but rather as a novel that skilfully, through sports, provides innovative comprehension of many of the social issues from a fresh perspective, i.e. it bears witness to the fact that 'sport is part of the culture of society, a human creation that changes in parallel with society in the whole' (Perasović, Bertoluci, 2007, p. 106).

Conclusion

Based on different multidisciplinary scholarly discussions on the topic, the results in this study confirm the transformation process of football as a global game and sport into the phenomenon of popular culture and mass media. Throughout the analyses of Nick Horby's novel *Fever Pitch* (1992), as one of the examples of the most read novels written on and around football, the results also confirmed the presence of football as a topic outside the sporting context. Therefore, the study points out how football has become a valuable subject and topic of many studies throughout different contexts as well as in various fields of interest: from literary texts, films and theatre plays to newspaper columns, TV shows and other.

Taken as a whole, the paper confirms the first hypothesis about the presence of football as an issue in a non-sports context (for instance, literature) thanks to mass media distribution. The paper also confirms the second hypothesis regarding the connection of football as a sporting activity with social areas unrelated to sports.

In conclusion, we may say that football represents a valuable issue for and of numerous contemporary socio-cultural dialogues and, as such, it should be addressed and researched by other future multidisciplinary studies.

References

Bodin, D. Robene, L., Heas, S. (2007). Sport i nasilje u Europi. Zagreb: Knjiga trgovina.
Bartoluci, M. (2003). Ekonomika i menadžment sporta. Zagreb: Informator.
Bowlby, R. (2005). Čitatelj/ica u supermarketu. *Quorum: časopis za književnost*, 2, 160-184.
Duda, D. (2002). Kulturalni studiji: ishodišta i problemi. Zagreb: AGM.
Eagleton, T. (2002). Ideja kulture. Zagreb: Naklada Jesenski i Turk.
Eco, U. (2002). Umberto Eco i nogomet. Zagreb: Naklada Jesenski i Turk.
Elias, N and Dunning, E. (1986). Quest for Excitement: Sport and Leisure in the Civilizing Process. Oxford: Basil Blackwell.
Hornby, N. (1998). Fever Pitch. Riverhead Books.
Klein, S. E. (2017). Defining Sport: Conceptions and Borderlines. Lanham: Lexington Books.
Lüschen, G. (1967). The interdependence of sport and culture. *International Review of Sport Sociology*, 2(1), 127-141.
Madigan, T. and Delaney, T. (2009). The Sociology of Sports: An Introduction. North Carolina: McFarland & Company.
McPherson, B. D., Curtis, J. E., Loy, J. W. (1989). Defining sport. The Social Significance of Sport: An Introduction to the Sociology. IL: Human Kinetics.
Nedić, T., Škerbić, M. M. (2020). Definiranje sporta u hrvatskim i međunarodnim pravnim aktima - na razmeđi prava i filozofije. Studia ethnologica Croatica, 32, 1, 155-181.
Perasović, B., Bartoluci, S. (2007). Sociologija sporta u hrvatskom kontekstu. *Sociologija i prostor*, 45, 1 (175), 105-119.
Solar, M. (2005). Laka i teška književnost. Zagreb: Matica hrvatska.
Škerbić, M. M., Radenović, S. (2018). Bioetika sporta: prisutnost bioetičkih tema na području filozofije i etike sporta u Hrvatskoj i Srbiji. *Jahr*, 9, 2, 159-184.
Tomić-Koludrović, I., Leburić, A., Mihaljević, A. (1999). Teorija popularne kulture: od hegemonije do semiotike. *Radovi (Sveučilište u Splitu. Filozofski fakultet Zadar. Razdio filozofije, psihologije, sociologije i pedagogije)*, 38 (15), 221-236.
Vrcan, S. (1990). Sport i nasilje danas u nas i druge studije iz sociologije sporta. Zagreb: Naprijed.
Vrcan, S. (1971). Sociolog pred fenomenom nogometa. *Sociologija: časopis za sociologiju, socijalnu psihologiju i socialnu antropologiju*, 13, 1, 5-20.
Williams, R. (1983). Keywords: A Vocabulary of Culture and Society. New York: Oxford University Press.
Zagorac, I., Škerbić, M. M. (2018). Sport, igra, svrhovitost. *Crkva u svijetu*, 53, 3, 359-374.

THE PRESENCE OF VIOLENCE AMONG THE FANS AT FOOTBALL MATCHES OF FK PARTIZAN AND FK CRVENA ZVEZDA

Filip Gvozdenović[1], Sandra Radenović[1], Lazar Tomić[1], Slađana Mijatović[1]
[1] University of Belgrade, Faculty of Sport and Physical Education, Belgrade, Serbia

Introduction

Soccer is the most popular sport on the planet with over 500 million registered players (Milanović, Pantelić, Čović, Sporiš & Krustrup, 2015), and for this reason many say it is "the most important sideline in the world". In addition, the number of fans of certain football clubs around the world indicates the unquestionable popularity of this sport. According to data from 2012, only one English football club - Manchester United (Manchester United) has as many as 659 million registered fans worldwide, which makes it the most popular football club in the world (Milovanović & Radenović, 2020). Throughout the history of club football in Serbia, two football clubs stood out, FC "Crvena zvezda" and FC "Partizan". Zvezda was founded on March 4, 1945, and from the moment of its founding, the club retained the stadium and premises of SK "Yugoslavia", a club that was active in our region until the beginning of World War II. From then until today, the club has won 33 domestic championships, 26 national cups, two national supercups, one league cup and two Mitropa cups. The greatest success was recorded in 1991 by winning the Champions Cup title, and later in the same year, Zvezda became the world club football champion. The club plays its matches at the stadium, which since 2014 has been named after the legend of the club, former player Rajko Mitić, with a capacity of 51,755 seats. Partizan was founded on October 4, 1945. In its history, the club has won 27 domestic championships, 12 national cups, one Yugoslav Super Cup, while its greatest success on the international stage was achieved in 1966, when it was defeated in the Champions Cup final by Real Madrid. Matches are played at the "Partizan Stadium", with a capacity of 32,710 seats. Mutual matches of these teams attract the special attention of football fans both in Serbia and around the world. The rivalry between the clubs is huge, and so far 261 matches have been played in all competitions. The first "Eternal Derby" between the city rivals was held on January 5, 1947 at the Partizan Stadium. In the period so far, Red Star has won 112 matches, Partizan has won 81 matches, and 68 matches have ended in a draw.

The huge rivalry between these teams, unfortunately for true fans of football and sports in general, is often a reason for some fans of both camps to display aggressive behavior. In a broader context, aggressive behavior can be expressed by a real or imaginary action, made by physical or verbal action, which leaves consequences both on the one who exhibits aggressive behavior and on the person who is subjected to some form of violent behavior (Koković, 2010). In a narrower sense, aggression is defined as a form of behavior aimed at damaging or injuring another living being that is motivated to avoid such treatment (Baron & Richardson, 1994). Aggressive behavior, i.e. violence in sports, means any word or action of an athlete, coach, judge, parent, spectator or other participant that causes injury to those involved in sports activity (Bačanac, Petrović, Manojlović, 2009). According to sociological research by Milojević et al. (2013), violent behavior is most often caused by members of marginalized social groups. The same research showed that hooligans are on average 22 years old, are mostly unemployed and do not have a clear social perspective.

The results of a study conducted by the "IFO" institute, in which the subject of research was violence in football, indicated that in German cities the number of violent acts increases by a fifth on the days of football matches in professional leagues (Gvozdenović, 2022). According to police statistics on criminal acts, the playing of matches in the first and third tier of national competitions leads to an increase in the number of violent acts by 21.5% compared to days when there are no organized matches. During the monitoring, in a period of 4.5 years, it is estimated that 38,268 forms of aggressive behavior were committed during football events, which caused a cost of around €194 million in the form of court and medical costs (Gvozdenović, 2022).

In the area of our territory, the increase in violence is particularly noticeable on the days of the derby match. Koković (2010) concludes that the relationship between sport and violence is still an unknown for contemporary sociology. One of the ways to solve the social control of aggressiveness is precisely the analysis of historical events in conflicts between fans. Therefore, the goal of this study is to determine, based on the analysis of recorded incident cases during matches in which the football teams of Red Star or Partizan participated, the main reasons for the manifestation of violence within the matches.

Methods

For the purposes of this research, the classical historical method and the method of theoretical analysis were used. Initially, information was collected about the history of the conflict between FC "Partizan" and FC "Crvena zvezda" fans, which was available from the archives of the sports associations of the most trophy-winning clubs in our region. Then, an analysis of relevant theoretical considerations about fan conflicts was made, on the basis of which adequate conclusions were formed about the causes of conflicts at sports events on the territory of Serbia.

Results

The psychological cause of joining a hooligan group can indeed be frustration caused by a social situation, but it can also be a consequence of boredom, adventurism, curiosity and a whole series of other, primarily psychological motives, which are basically also frustration. When explaining the causes of violence in stadiums, the so-called "crowd psychology", where the individual feels more secure, given that the crowd covers his anonymity. In the crowd, the individual feels much more powerful and due to the hidden anonymity, his sense of personal responsibility weakens, and because of this, individuals in the crowd can do such things, which they might never do individually (Le Bon, 1989).

In the domestic public, both in newspaper articles and in some expert discussions, the war and the economic crisis are most often mentioned as the social circumstances that have had the greatest impact on the escalation of violence at sports events in recent years. But when you take into account the situation in other European countries and the scale of violence at sports events in them, it seems that such an attitude is not correct. The examples of European countries such as England, Italy, Belgium, whose territories have not been at war in the last sixty years and which lived in material well-being until the beginning of the world economic crisis in 2008, and at the same time had a significant problem with violence at sports events, speak in favor of this. that the causes of violence cannot be only in war and economic crisis (Gvozdenović, 2022).

Unemployment, chronic existential insecurity, hopelessness, lack of perspective and high economic inequality have been empirically confirmed many times as dimensions that have a significant negative relationship with the degree of social and interpersonal tolerance. The causes of violence at sports events are intolerance towards the fans of the opposing club, poor security of the sports event, bad results of the club you support, unsportsmanlike behavior of players and excessive consumption of alcohol and drugs, as well as poor infrastructure in stadiums.

The increase in violence is particularly high on derby days, when local rival teams are playing, which coincides with the matches and the rivalry that exists between fans of Crvena zvezda and Partizan. The victims are mostly young men between the ages of 18 and 29. Almost a fifth of the increase in violent acts on match days can be attributed to attacks on police officers. The perpetrators of violence did not know almost 70% of the victims beforehand (Gvozdenović, 2022).

Discussion

England is considered to be the birthplace of football hooliganism on the European continent. Over time, the English way of cheering began to be imitated by extreme fans in the Netherlands, Italy, Spain and other European countries.

As far as our country is concerned, the conflicts between extreme fan groups claimed ten human lives in the period from 1999 to 2009, which makes our country, according to that indicator, in the first place in Europe. In 2009, the Ministry of Youth and Sports of the Republic of Serbia, in cooperation with the Association of Sports Journalists of Serbia, carried out a research entitled 'Media, sport, violence', in which texts published in the Serbian media in 2008, which were devoted to violence, were analyzed. and around the sports field. The aforementioned research indicated that every 136 days, one fan was killed in Serbia, and all the victims and attackers were between the ages of 17 and 25 (Đurđević, 2010).

Ever since the rivalry between Red Star fans and Partizan fans has existed, several fans have lost their lives in those clashes. The only fan, and hopefully the last, who lost his life in the stadium was Aleksandar Radović, a seventeen-year-old boy. This unfortunate event happened in 1999 at the 113th eternal derby at the 'JNA' stadium, when a ship's signal rocket hit seventeen-year-old Radović in the neck, who died not long after. The derby continued as if nothing had happened, and after the murder of Radović, 154 people were detained and interrogated, 12 of whom had rockets in their hands. However, the court proceedings did not determine exactly who fired the rocket that hit Radović, and the fans were ultimately charged with causing a general danger, not murder (Gvozdenović, 2022).

Conclusion

Countless newspaper articles have been written about violence at sports events and the behavior of fans in our region, many TV reports have been broadcast, and some sociological studies have been published. Despite this, the public's hunger for information about extreme fans and their behavior (provocative for that public) and the many explanations of the phenomenon are by no means conclusive. Each new incident, or fan outburst, further enhances the interest in the issue and multiplies attempts to finally answer the many intriguing questions that are raised in this regard. There is no doubt that in recent years the Republic of Serbia has faced the appearance of

hooliganism at sports events, that the phenomenon is developing qualitatively and quantitatively, and this problem will be present in the future as well. In addition to the low quality of the game and a significantly reduced standard of living, the decline of interest in sports was also influenced by the fact that fan incidents became significantly more frequent and serious than before, and as such prevented many fans of sports from going to sports arenas. On the other hand, it can already be seen at first glance, how the crisis of the sports audience in recent years is least felt in the stands where extreme fans gather. Some young people, who otherwise would not be immediately interested in watching matches, find the behavior of extreme fan groups attractive and exciting, and it is this behavior that attracts them to sports facilities. All this led to the formation of an aggressive subculture of violent fan groups, which had the effect of constantly causing incidents at sports events, considering that the motive of coming to a sports event is not to cheer for the club, but to show violence and discharge a negative charge. Solving the problem of hooliganism at sports events is not an easy or simple task at all. Through high-quality security assessments of the degree of risk of incidents, monitoring and prevention of the intentions of extreme fans, their isolation and effective intervention, with the participation and coordinated cooperation of competent state authorities, sports organizations and clubs, educational institutions and the media, hooliganism at sports events could be are reduced to socially acceptable frameworks. In combating violence at sports events, repressive measures should not be completely neglected, on the contrary, but the proactive approach of the police and preventive measures should be given priority. This approach allows the mutual interference of different, rival fan groups, not to result in conflicts and the emergence of violence, that is, that fans can support their favorites together and establish good, or at least acceptable, relations between them.

Of the countries of the former Yugoslavia, the strictest legislation is in Serbia, followed by Croatia, where extremely severe punishments are prescribed for crimes related to sports events. However, the ratio of threatened and imposed sentences is a special issue, because judicial policy in Serbia is generally extremely lenient, which is also the case in criminal proceedings with this criminal offense, where a large disproportion is observed. The results obtained in the empirical research show that Serbia has a big problem with hooliganism at sports events. Even more devastating is the fact that a serious percentage of young people (14.7%) join organized fan groups, which are carriers of hooligan behavior (Gvozdenović, 2022). With the previous repressive approach towards the youth in Serbia, we cannot expect a better situation on the ground in the coming period. That is why it is necessary to create preventive programs for the mentioned population, which will offer them a way out of the current situation (Milojević, Simonović, Janković, Otašević, Turanjanin, 2013).

References

Bačanac, Lj., Petrović, N., i Manojlović, N. (2009). Stepen i oblici nasilja u sportu Srbije – priručnik za roditelje mladih sportista. Beograd: Ministarstvo za omladinu i sport.

Baron, R.A., & Richardson, D. R. (1994). Human aggression. New York: Plenum Press.

Gvozdenović, F. (2022). Prisustvo nasilja među navijačima na fudbalskim utakmicama FK Partizan i FK Crvena Zvezda. Master rad. Beograd: Fakultet sporta i fizičkog vaspitanja Univerziteta u Beogradu.

Đurđević, N. (2010). Krivična odgovornost za nasilje i nedolično ponašanje na sportskim priredbama u Republici Srbiji. Zbornik radova Pravnog fakulteta u Splitu, 47 (2), 285-308.

Koković, D. (2010). Društvo, nasilje, sport. Novi Sad: Mediterran Publishing.

Le Bon, G. (1989). Psihologija gomila. Zagreb: Globus.
Milanović, Z., Pantelić, S., Čović, N., Sporiš, G., & Krustrup, P. (2015). Is Recreational Soccer Effective for Improving VO2max? A Systematic Review and Meta – Analysis. *Sport Medicine*, 45, 1339 – 1353.
Milovanović, I., Radenović, S. (2020). Savremene tendencije u sociologiji sporta: od konstituisanja do „razmrvljene" discipline. *Sociologija*, LXII (2): 237-254.
Milojević S., Simonović B., Janković B., Otašević B., Turanjanin V. (2013). Mladi i huliganizam na sportskim priredbama. Beograd: OEBS.

PRISUSTVO NASILJA MEĐU NAVIJAČIMA NA FUDBALSKIM UTAKMICAMA FK PARTIZAN I FK CRVENA ZVEZDA

Filip Gvozdenović[1], Sandra Radenović[1], Lazar Tomić[1], Slađana Mijatović[1]
[1] Univerzitet u Beogradu, Fakultet sporta i fizičkog vaspitanja, Beograd, Srbija

Uvod

Fudbal je najpopularniji sport na planeti sa preko 500 miliona prijavljenih igrača (Milanović, Pantelić, Čović, Sporiš & Krustrup, 2015), pa iz tog razloga mnogi kažu da predstavlja „najvažniju sporednu stvar na svetu". Osim toga, broj navijača određenih fudbalskih klubova širom sveta, ukazuje na neupitnu popularnost ovog sporta. Prema podacima iz 2012. godine, samo jedan engleski fudbalski klub – Mančester Junajtid (Manchester United) ima čak 659 miliona registrovanih navijača širom sveta, što ga čini najpopularnijim fudbalskim klubom na svetu (Milovanović & Radenović, 2020). Kroz istoriju klupskog fudbala u Srbiji izdvojila su se dva fudbalska kluba, FK „Crvena zvezda" i FK „Partizan". Zvezda je osnovana 4. marta 1945. godine i od trenutka osnivanja u svom posedu je klub zadržao stadion i prostorije SK „Jugoslavija", kluba koji je bio aktuelan do početka Drugog svetskog rata na našim prostorima. Od tada pa sve do danas klub je osvojio 33 domaća šampionata, 26 nacionalnih kupova, dva nacionalna superkupa, jedan liga kup i dva Mitropa kupa. Najveći uspeh je zabeležen 1991. godine osvajanjem titule Kupa šampiona, a kasnije iste godine Zvezda je postala svetski klupski prvak u fudbalu. Klub utakmice odigrava na stadionu koji od 2014. godine nosi ime po legendi kluba, bivšem igraču Rajku Mitiću, sa kapacitetom od 51755 sedećih mesta. Partizan je osnovan 4. oktobra 1945. godine. Klub je u dosadašnjoj istoriji osvojio 27 domaćih šampionata, 12 nacionalnih kupova, jedan superkup Jugoslavije, dok je svoj najveći uspeh na internacionalnoj sceni ostvario 1966. godine kada je poražen u finalu kupa šampiona od ekipe Real Madrida. Mečeve igra na „stadionu Partizana", kapaciteta od 32710 sedećih mesta. Međusobni mečevi ovih timova privlače posebnu pažnju ljubitelja fudbala kako u Srbiji, tako i širom sveta. Rivalstvo između klubova je ogromno, a dosad je odigran 261 meč u svim takmičenjima. Prvi „Večiti derbi" između gradskih rivala je održan davnog 5. januara 1947. godine na stadionu Partizana. U dosadašnjem periodu Crvena zvezda je završila meč kao pobednik na 112 utakmica, Partizan je slavio u 81 susretu, a nerešnim ishodom je završeno 68 utakmica.

Ogromno rivalstvo ovih timova, na žalost pravih ljubitelja fudbala i sporta uopšteno, često kod pojedinih navijača oba tabora predstavlja povod za ispoljavanje agresivnog ponašanja. U širem kontekstu, agresivno ponašanje se može izražavati stvarnom ili umišljenom radnjom, načinjenom fizičkim ili verbalnim delovanjem, koja ostavlja posledice i na onog ko ispoljava agresivno ponašanje i na osobu nad kojom je načinjen neki od oblika nasilnog ponašanja (Koković, 2010). U užem smislu, agresivnost se definiše kao oblik ponašanja čiji je cilj oštećenje ili povređivanje drugog živog bića koje je motivisano da takav tretman izbegne (Baron & Richardson, 1994). Pod agresivnim ponašanjem, odnosno nasiljem u sportu podrazumeva se svaka reč ili postupak sportiste, trenera, sudije, roditelja, gledaoca ili drugog učesnika koji nanosi povredu onima koji su uključeni u sportsku aktivnost (Bačanac, Petrović, Manojlović, 2009). Prema sociološkom istraživanju Milojevića i sar. (2013), nasilno ponašanje je najčešće prouzrokovano od strane pripadnika

marginalizovanih društvenih grupa. Isto istraživanje je pokazalo da su huligani starosne granice u proseku od 22 godine, najčešće su nezaposleni i nemaju jasnu društvenu perspektivu.

Rezultati studije koju je sproveo institut „IFO“ u kojoj je predmet istraživanja predstavljalo nasilje u fudbalu, ukazali su da u nemačkim gradovima broj nasilnih dela raste za petinu u danima odigravanja fudbalskih utakmica u profesionalnim ligama (Gvozdenović, 2022). Prema statistici policije o kriminalnim delima, odigravanje utakmica u prvom i trećem rangu nacionalnih takmičenja dovodi do povećanja zastupljenosti nasilnih dela za 21.5% u odnosu na dane kada nema organizovanih utakmica. Za vreme praćenja, u periodu od 4.5 godine procena je da je izvršeno 38268 oblika agresivnog ponašanja tokom fudbalskih manifestacija, što je prouzrokovalo trošak od oko 194 miliona € u vidu sudskih i medicinskih troškova (Gvozdenović, 2022).

Na prostoru naše teritorije, porast nasilja je posebno primetan u danima odigravanja derbi utakmice. Koković (2010) zaključuje da odnos sporta i nasilja i dalje predstavlja nepoznanicu za savremenu sociologiju. Jedan od načina za rešavanje društvene kontrole agresivnosti jeste upravo analiza istorijskih dešavanja u konfliktima između navijača. Prema tome cilj ove studije je da se na osnovu analize zabeleženih incidentnih slučajeva prilikom održavanja mečeva na kojim su učestvovali fudbalski timovi Crvene zvezde ili Partizana, utvrde osnovni razlozi za ispoljavanje nasilja u okviru utakmica.

Metode

Za potrebe ovog istraživanja upotrebljen je klasičan istorijski metod i metod teorijske analize. Prvobitno su prikupljene informacije o istoriji sukoba navijača FK „Partizan“ i FK „Crvena zvezda“ kojim su raspolagale arhive sportskih društava najtrofejnijih klubova na našim prostorima. Zatim je napravljena analiza relevantnih teorijskih razmatranja o sukobima navijača na osnovu koje su formirani adekvatni zaključci o uzrocima sukoba na sportskim manifestacijama na teritoriji Srbije.

Rezultati

Psihološki uzrok pridruživanja huliganskoj grupi zaista može da bude frustracija izazvana socijalnom situacijom, ali isto tako, to može da bude posledica dosade, avanturizma, radoznalosti i čitavog niza drugih, prevashodno psiholoških motiva, koji su u osnovi takođe frustracijski. U objašnjenju uzroka nasilja na stadionima, često se ističe tzv. „psihologija gomile”, gde se pojedinac oseća sigurnije, s obzirom na to, da masa pokriva njegovu anonimnost. U masi se pojedinac oseća mnogo moćnije i zbog prikrivene anonimnosti kod njega slabi i osećaj lične odgovornosti, pa zbog toga pojedinci u masi mogu da učine takve stvari, koje pojedinačno možda ne bi nikada uradili (Le Bon, 1989).

U domaćoj javnosti, kako u novinskim člancima, tako i u nekim stručnim raspravama, rat i ekonomska kriza najčešće se pominju kao društvene okolnosti koje su poslednjih godina najviše uticale na eskalaciju nasilja na sportskim priredbama. No, kada se uzme u obzir situacija u ostalim evropskim državama i razmere nasilja na sportskim priredbama u njima, čini se da takav stav nije ispravan. Primeri evropskih država poput Engleske, Italije, Belgije na čijim teritorijama nije bilo rata u poslednjih šezdeset godina i koje su do početka svetske ekonomske krize 2008. godine živele u materijalnom blagostanju, a istovremeno su imale značajan problem sa nasiljem na sportskim

priredbama, govori u prilog tome da uzroci nasilja ne mogu biti samo u ratu i ekonomskoj krizi (Gvozdenović, 2022).

Nezaposlenost, hronična egzistencijalna nesigurnost, bezizlaznost, besperspektivnost i visoka ekonomska neujednačenost, mnogo puta su se empirijski potvrdili kao dimenzije koje stoje u značajnoj negativnoj vezi sa stepenom socijalne i interpersonalne tolerancije. Uzroci nasilja na sportskim manifestacijama su i netrpeljivost prema navijačima protivničkog kluba, loše obezbeđenje sportske priredbe, loši rezultati kluba za koji se navija, nesportsko ponašanje igrača i preterano konzumiranje alkohola i droga, kao i loša infrastruktura na stadionima.

Porast nasilja je posebno visok u danima derbija, kada igraju lokalni rivalski timovi, što se poklapa sa utakmicama i rivalstvom koje postoji između navijača Crvene zvezde i Partizana. Žrtve su uglavnom mladići između 18 i 29 godina. Skoro jedna petina povećanja nasilnih dela u danima utakmica može se pripisati napadima na policajce. Počinioci nasilja nisu poznavali od ranije gotovo 70 % žrtava (Gvozdenović, 2022).

Diskusija

Smatra se da je postojbina fudbalskog huliganizma na evropskom kontinentu Engleska. Vremenom su engleski način navijanja počeli da imitiraju ekstremni navijači i u Holandiji, Italiji, Španiji i ostalim zemljama Evrope.

Što se tiče naše zemlje, sukobi ekstremnih navijačkih grupa odneli su deset ljudskih života u periodu od 1999. do 2009. godine, čime je naša zemlja, po tom pokazatelju, na prvom mestu u Evropi. Ministarstvo omladine i sporta Republike Srbije je u saradnji sa Udruženjem sportskih novinara Srbije, obavilo tokom 2009. godine istraživanje pod nazivom 'Mediji, sport, nasilje', u kome su analizirani tekstovi objavljeni u srpskim medijima 2008. godine, koji su posvećeni nasilju, na i oko sportskog borilišta. Navedeno istraživanje je ukazalo na to, da je na svakih 136 dana, ubijen po jedan navijač u Srbiji, a sve žrtve i napadači starosti su od 17 do 25 godina (Đurđević, 2010).

Od kada postoji rivalstvo između navijača Crvene zvezde i navijača Partizana, nekoliko navijača je izgubilo svoje živote u tim sukobima. Jedini navijač, a nadamo se i poslednji, koji je svoj život igubio na stadionu bio je Aleksandar Radović, sedamnaestogodišnji dečak. Ovaj nemili događaj desio se 1999. godine na 113. večitom derbiju na stadionu 'JNA' kada je brodska signalna raketa pogodila sedamnaestogodišnjeg Radovića u vrat koji je nedugo zatim preminuo. Derbi je nastavljen kao da se ništa nije dogodilo, a posle ubistva Radovića privedene su i saslušane 154 osobe, od kojih je njih 12 imalo rakete u rukama. Međutim, sudski postupak nije tačno utvrdio ko je ispalio baš onu raketu koja je pogodila Radovića, a navijači su na kraju optuženi za izazivanje opšte opasnosti, a ne za ubistvo (Gvozdenović, 2022).

Zaključak

O nasilju na sportskim priredbama i ponašanju navijača na našim prostorima napisano je bezbroj novinskih tekstova, emitovano je mnogo TV reportaža, objavljena i poneka sociološka studija. Uprkos tome, glad javnosti za informacijama o ekstremnim navijačima i njihovom ponašanju (provokativnom za tu javnost) i mnoga objašnjenja te pojave, nikako nisu konačna. Svaki novi incident, ili navijački ispad dodatno potencira interes za tu problematiku i umnožava pokušaje, da se konačno odgovori na brojna intrigantna pitanja koja se sa tim u vezi postavljaju. Nema sumnje

da se Republika Srbija poslednjih godina suočila sa pojavom huliganizma na sportskim priredbama, da se pojava kvalitativno i kvantitativno razvija, te će taj problem biti prisutan i u budućnosti. Pored slabog kvaliteta igre i osetno smanjenog životnog standarda, na opadanje interesa za sport, uticala je i činjenica da su navijački incidenti postali znatno češći i ozbiljniji nego pre, pa su kao takvi sprečili mnoge poklonike sporta da idu na sportska borilišta. Sa druge strane, već na prvi pogled može se uočiti, kako se kriza sportske publike poslednjih godina najmanje oseća na tribinama gde se okupljaju ekstremni navijači. Pojedini mladi ljudi, koji inače ne bi bili neposredno zainteresovani za gledanje utakmica, smatraju ponašanje ekstremnih navijačkih grupa atraktivnim i uzbudljivim i upravo takvo ponašanje ih privlači u sportske objekte. Sve je to uslovilo formiranje agresivne potkulture nasilnih navijačkih grupa, što je imalo za posledicu stalno izazivanje incidenata na sportskim manifestacijama, s obzirom na to, da motiv dolaska na sportsku priredbu nije navijanje za klub, već ispoljavanje nasilja i pražnjenje negativnog naboja. Rešavanje problema huliganizma na sportskim manifestacijama nije nimalo lak, niti jednostavan zadatak. Kvalitetnim bezbednosnim procenama stepena rizika od nastajanja incidenata, praćenjem i predupređivanjem namera ekstremnih navijača, njihovom izolacijom i efikasnom intervencijom, uz učešće i koordiniranu saradnju nadležnih državnih organa, sportskih organizacija i klubova, vaspitno-obrazovanih ustanova i medija, huliganizam na sportskim priredbama bi mogao da se svede u društveno prihvatljive okvire. U suprotstavljanju nasilju na sportskim priredbama ne treba potpuno zanemariti represivne mere, naprotiv, ali proaktivnom pristupu policije i preventivnim merama treba dati prednost. Ovakav pristup omogućava, da međusobno mešanje različitih, suparničkih navijačkih grupa, ne mora da rezultira sukobima i nastajanjem nasilja, odnosno da navijači mogu zajedno da podrže svoje miljenike i da se uspostave dobri, ili bar prihvatljivi odnosi među njima.

Od zemalja bivše Jugoslavije, najstroži zakonodavac je u Srbiji, potom u Hrvatskoj, gde su za izvršenje krivičnih dela u vezi sa sportskim priredbama propisane izuzetno stroge kazne. Ali, posebno je pitanje odnosa zaprećenih i izrečenih kazni, jer je sudska politika u Srbiji generalno izuzetno blaga, što je slučaj i u krivičnim postupcima sa ovim krivičnim delom, gde se primećuje velika disproporcija. Rezultati dobijeni u empirijskom istraživanju pokazuju da Srbija ima veliki problem sa huliganizmom na sportskim priredbama. Još više poražava podatak, da se ozbiljan procenat mladih (14.7%) priključuje organizovanim navijačkim grupama, koje su nosioci huliganskog ponašanja (Gvozdenović, 2022). Dosadašnjim represivnim pristupom prema mladima u Srbiji, u narednom periodu ne možemo očekivati bolju situaciju na terenu. Zbog toga je neophodno, da se za navedenu populaciju naprave preventivni programi, koji će im ponuditi izlaz iz trenutne situacije (Milojević, Simonović, Janković, Otašević, Turanjanin, 2013).

Literatura

Bačanac, Lj., Petrović, N., i Manojlović, N. (2009). Stepen i oblici nasilja u sportu Srbije – priručnik za roditelje mladih sportista. Beograd: Ministarstvo za omladinu i sport.

Baron, R.A., & Richardson, D. R. (1994). Human aggression. New York: Plenum Press.

Gvozdenović, F. (2022). Prisustvo nasilja među navijačima na fudbalskim utakmicama FK Partizan i FK Crvena Zvezda. Master rad. Beograd: Fakultet sporta i fizičkog vaspitanja Univerziteta u Beogradu.

Đurđević, N. (2010). Krivična odgovornost za nasilje i nedolično ponašanje na sportskim priredbama u Republici Srbiji. Zbornik radova Pravnog fakulteta u Splitu, 47 (2), 285-308.

Koković, D. (2010). Društvo, nasilje, sport. Novi Sad: Mediterran Publishing.

Le Bon, G. (1989). Psihologija gomila. Zagreb: Globus.

Milanović, Z., Pantelić, S., Čović, N., Sporiš, G., & Krustrup, P. (2015). Is Recreational Soccer Effective for Improving VO2max? A Systematic Review and Meta – Analysis. *Sport Medicine*, 45, 1339 – 1353.
Milovanović, I., Radenović, S. (2020). Savremene tendencije u sociologiji sporta: od konstituisanja do „razmrvljene" discipline. *Sociologija*, LXII (2): 237-254.
Milojević S., Simonović B., Janković B., Otašević B., Turanjanin V. (2013). Mladi i huliganizam na sportskim priredbama. Beograd: OEBS.

SOCIOECONOMIC CHARACTERISTICS AND SUCCESS OF EUROPEAN COUNTRIES AT THE OLYMPIC GAMES, WORLD AND EUROPEAN CHAMPIONSHIPS IN RHYTHMIC GYMNASTICS (1992 – 2021)

Josipa Radaš[1], Gordana Furjan – Mandić[1], Rebeka Stojković[2]
[1] University of Zagreb, Faculty of Kinesiology, Zagreb, Croatia
[2] Rhythmic Gymnastics Club „RONDO“, Osijek, Croatia

Introduction

In the first half of the 20th century, emerged a new branch of sports called *“hudozenstvena gimnastika”*. It is most developed in the countries of the former Soviet Union after the World War II and received final recognition in Los Angeles in 1984 (Wolf - Cvitak, 2004). According to Furjan - Mandic (2007), it is defined as "conventional sport that contains aesthetically designed and choreographically arranged acyclic movement structures, defined by the Code of Points". It was also considered an artistic sport, as a combination of modern dance and ballet (Milenkovic, 2021) because it contains beauty, elegance and harmony of movements and strives for perfectly coordinated and precisely performed movements of the body and apparatus (Jastrembskaia and Titov, 1999). Amazing the audience with various skills with a rope, hoop, ball, clubs and ribbon, rhythmic gymnastics has long crossed the borders of Eastern Europe and is now practiced all over the world. However, success still remains in the countries of the Eastern bloc. Therefore, the issue of socioeconomic influence on the success and dominance of the same in this sport is mentioned. Although major competitions, such as the Olympic Games, were created for individual and team champions, and not for the glorification of the winning country (Olympic Movement, 2007), tables of won medals are regularly updated and dominate the media (Custonja and Skoric, 2011). The aim of this paper is to compare the influence of geographical, demographic and economic characteristics of European countries, more specifically, their surface area, number of inhabitants and gross domestic product with success in major competitions and to determinate if there is a statistically significant connection between their success at the European and World Championships and the Olympic Games with some from the characteristics.

Methods

The sample consists of 13 European countries that have won at least one medal at the major competitions and are shown in table 1. With its largest surface area, Russia takes the first place, overwhelmingly winning both in the number of gold medals won and in the number of inhabitants. France has the largest BPD of the ones shown, but wins "only" 11 medals, and Spain is close behind, winning 36. Ukraine has the smallest GDP but is in third place in terms of medals won. The most successful conqueror according to the total number is Russia with 479 medals won, followed by Belarus (217), Ukraine (200) and Bulgaria (146).

The observed variables in the paper are the area of the country expressed in square kilometers, the number of inhabitants of the country expressed in millions and the gross domestic product (GDP), which is defined as a measure of the degree of wealth of the country expressed in US dollars (Mankiw, 2006). The total number of medals won, regardless of placement, is a criterion

variable in the period from 1992 to 2021. The results were processed in the IBM SPSS 26 program by analysis of basic descriptive parameters, correlation, Pearson's correlation coefficient to observe the connection of variables and the Shapiro-Wilks test to determine the normality of the distribution.

Table 1. Medal winning countries by total number

	SURFACE	POPULATION	GDP	MEDALS WON
RUSSIA	17098,242	143,436145	10126,7	479
BELARUS	207,6	9,435251	6424,2	217
UKRAINE	603,5	48,240902	3724,9	200
SPAIN	505,922	46,815915	27056,4	36
BULGARIA	110,879	7,36457	10079,2	146
FRANCE	551,695	64,300821	39037,1	11
ITALY	301,336	59,433744	31770,0	77
GREECE	131,99	10,816286	17647,4	19
HUNGARY	93,028	9,937628	15980,1	2
ROMANIA	238,391	20,121641	12915,2	6
GERMANY	357,114	80,219695	46252,7	6
AZERBAIJAN	86,6	8,922447	4221,4	29
ISRAEL	20,77	7,41218	44177,6	53

Results

The obtained results show that in the 13 observed countries the average surface area is 1562.08 km^2, the average number of inhabitants is 39.73 million, and the gross domestic product (GDP) is 20724.07 dollars, while the average of the total number of medals won is 98.54 (Table 2). Correlation analysis obtained the values between the country's area, population and GDP and the total number of medals won by a certain country (Table 3). There is a statistically significant relationship between the area of the country and the total number of medals won by the country from 1992 to 2021 (r=0.84). There is also a statistically significant relationship between the number of inhabitants and the total number of state medals won from 1992 to 2021 (r=0.59) (Figure 1). However, here is no statistically significant relationship between the country's GDP per inhabitant and the total number of medals won by the country from 1992 to 2021 (r=-0.44) (Figure 2).

Table 2. Descriptive analysis of variables

Variables	Sample	Mean	Minimum	Maximum	St. deviation	p
Surface area (km^2)	13	1562,08	20,770	17098,24	4671,88	0,00
Population (mil.)	13	39,73	7,365	143,44	40,39	0,01
GDP	13	20724,07	3724,900	46252,70	15230,51	0,10
TOTAL	13	98,54	2,000	479,00	136,34	

Table 3. Correlation of variables

	Variables	**Variables marked correlations are statistically significant at the p < 0,05 level**		
	Surface are	Population	GDP	Total
Surface area	1			
Population		1		
GDP	-0,2	0,19	1	
Total	**0,84***	**0,59***	-0,44	1

*statistical significance (p<0.05)

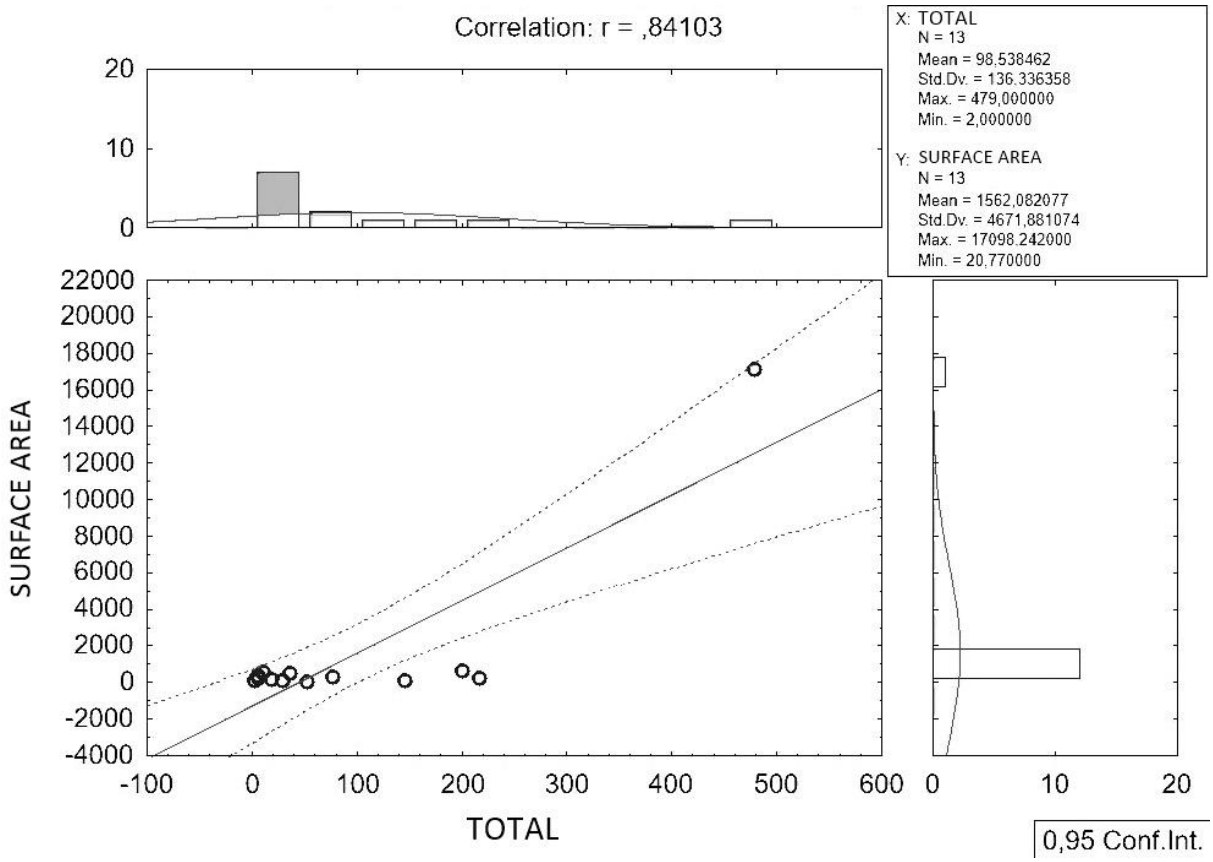


Figure 1. The relationship between the country's surface area and the total number of medals won

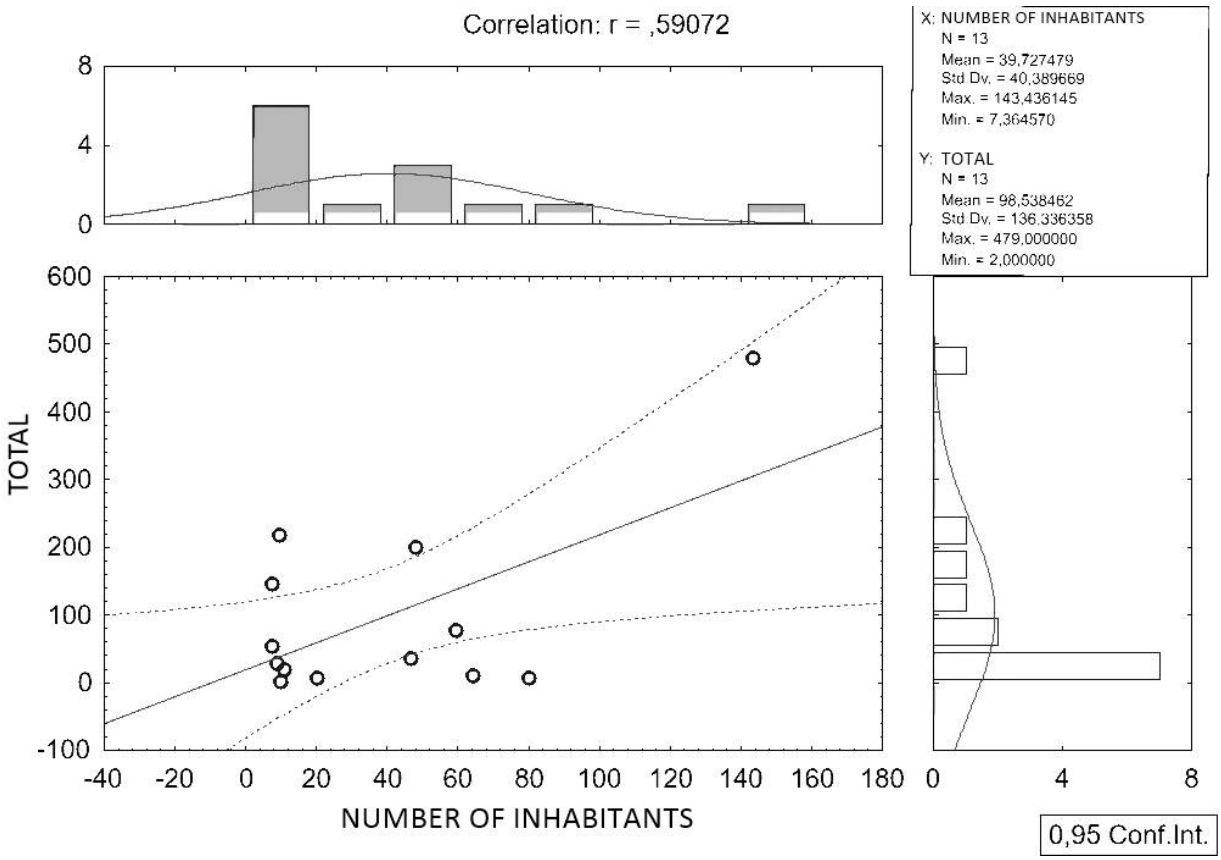


Figure 2. The relationship between the total number of medals won and the number of inhabitants

Discussion

In countries with a larger surface area and those with a larger population, there are many more potential athletes, especially for rhythmic gymnastics, which is extremely developed in the countries with the highest number of medals won than in the rest of the world. The obtained positive correlation is explained by the fact that the leading countries, in this case Russia, Belarus and Ukraine, nurture their traditions and their national sports, such as rhythmic gymnastics, more than Western European countries. It is a Russian "tradition" to enroll girls in rhythmic gymnastics training and boys in hockey (Miletić, 2007). After all, the roots of rhythmic gymnastics lie in the republics of the former Soviet Union. The first school of artistic movement, as a forerunner of today's rhythmic gymnastics, was founded in St. Petersburg (Wolf – Cvitak, 2004). The total size or area of the country is statistically significantly related to success in major competitions. Russia also wins here, which with its large surface of 17,098,242 km^2 is more than ten times higher than the average value. In second place is Ukraine, extremely smaller than Russia, but in third place according to its performance. Out of the first half of the countries according to their area, only two of them do not belong to the list of the first half according to success. These are France and Germany, but it is interesting that they also stand out in the already mentioned connection according to the number of inhabitants.

The hypothesis of a statistically significant connection between the number of inhabitants and medals won is confirmed by Russia with an extremely high population and the highest success,

because its number of medals won is 479, which is twice as much as Belarus, which is in second place, and Ukraine, which is third. The exceptions are Germany and France, which have a much higher population than the average, but a small number of medals won (6 and 11) compared to the average. It should also be taken into account that in Russia more than seven million women are interested in rhythmic gymnastics.

Gross domestic product (GDP) proved to be a variable that is not statistically significantly related to success in sports (r = -0.44). Germany has the highest GDP, but it is not in the first half according to the number of medals won. While Russia, which achieves the highest values in terms of area, number of inhabitants and the total number of medals won, ranks only ninth here. The only countries whose GDP is above the average and are in the first half according to performance are Israel, Germany and Spain. The poorest country according to economic characteristics is Ukraine, and it is the third according to the number of medals won. The four dominant countries in terms of performance (Russia, Ukraine, Belarus and Bulgaria) are far below the overall GDP average, which means that it does not statistically significantly affect success in rhythmic gymnastics.

Russia can thank its great success in rhythmic gymnastics to a developed training system and specific training processes that date back to the USSR period - and which require dedication from an early age. Traces of such training can be seen in the following two representatives, also republics of the Soviet Union, Ukraine and Belarus. These are countries with a lower GDP but invest more in their traditional sports. Interesting research would be to observe the increase in the performance of other countries and to find the reason why, for example, Italy has significantly increased the total number of medals won in major competitions since the Olympic Games in Rio de Janeiro. One of the interesting things is that the two leading countries in rhythmic gymnastics are banned from participating in major competitions and this will be the first time in the last 23 years that the all-around gold will go to another representative.

Conclusion

The number of medals won at major competitions is slowly increasing in other countries and spreading beyond the former Soviet Union. Italy and Israel have had a significant increase in the number of medals in the last five years, especially because for the first time in history an Israeli woman won the Olympic all-around gold. Regardless of the country's GDP, which does not statistically significantly affect success, female athletes continue to win and increase the total number of medals won. Countries with a larger population certainly have a greater chance of success and the same applies to countries with a larger surface area. From what is shown, it can be seen that both rich and poor countries have an equal chance for success in rhythmic gymnastics.

References

Čustonja, Z. i Škorić, S. (2011). Winning medals at the olympic games – does Croatia have any chance?. Kinesiology 43(1), 107-114.

Gotal, S. (2017). *Povezanost osvojenih medalja na svjetskim i europskim nogometnim prvenstvima sa brojem stanovnika, veličinom zemlje i BDP-om* (Diplomski rad).

Furjan-Mandić, G. (2007). Ritmička gimnastika: priručnik. Zagreb: Kineziološki fakultet Sveučilišta u Zagrebu

Jastrembskaia, N., Titov, Y. (1999). Rhythmic gymnastics. Champaign, II: Human kinetics.

Krističević, T., Petrović, Ž., i Milanović D. (2018). Povezanost osvojenih medalja kuglača europskih zemalja na Svjetskim prvenstvima s njihovim brojem stanovnika, veličinom zemlje i bruto društvenim proizvodom. 27. Ljetna škola kineziologa Republike Hrvatske, 522-527.
Mankiw, G. (2006). Osnove ekonomije. Zagreb: Mate: Zagrebačka škola ekonomije i menadžmenta.
Milanović, M. i Babić., J. (2019). Jesu li površina zemlje, broj stanovnika i bruto društveni proizvod europskih zemalja značajni čimbenici osvojenih medalja u vaterpolu na velikim svjetskim natjecanjima?. 28. Ljetna škola kineziologa Republike Hrvatske, 591-596.
Miletić, Đ. (2007.) Estetska gibanja. Split, Sveučilište u Splitu: GAF.
Milenković, E. (2021). *Konstrukcija specifičnog testa za procjenu koordinacije u ritmičkoj gimnastici* (Diplomski rad). Preuzeto s https://urn.nsk.hr/urn:nbn:hr:117:874624
Olympic Movement (2007). *Olympic Charter* /on-line/.
Petak, R. (2017). Povezanost osvojenih medalja europskih država na Olimpijskim igrama s brojem stanovnika, veličinom zemlje i bruto društvenim proizvodom (Diplomski rad). Zagreb: Kineziološki fakultet Sveučilišta u Zagrebu.
Sinković A., Sinković, V. i Milanović, D. (2021). Povezanost ekonomskih, geografskih i demografskih obilježja zemalja svijeta s osvojenim teniskim turnirima Grand slam u pojedinačnoj konkurenciji od 1992. do 2019. 29. Ljetna škola kineziologa Republike Hrvatske, 849 – 854.
Rathke, A., & Woitek, U. (2007). *Economics and Olympics: An efficiency analysis* /on-line/.
Rhythmic gymnastics results,
Tadić, V., Milanović, M. i Lukenda, Ž.(2019). Povezanost osvojenih medalje boksača europskih zemalja na europskim prvenstvima s brojem stanovnika, veličinom zemlje i bruto društvenim proizvodom. Odgovor kineziologije na suvremeni način života: zbornik radova Zagreb: Hrvatski kineziološki savez, 618 – 623.
Wolf-Cvitak, J. (2004). Ritmička gimnastika. Zagreb: Kugler.

ABUSE AND INSTIGATION OF CONFLICTS BETWEEN MMA FIGHTERS: THE CASE OF NURMAGOMEDOV AND MCGREGOR

Sandra Radenović[1], Nemanja Milojević[1], Miloš Marković[1], Goran Kasum[1]
[1] University of Belgrade, Faculty of Sport and Physical Education, Belgrade, Serbia

Introduction

We can define sport as a complex social, cultural, and historical phenomenon that has numerous characteristics and specificities that distinguish it both in a certain society and on a global level. Sport is a phenomenon that permeates all societies of the world, and through which we can see the norms and values of a certain society and culture (Milovanović, 2017). Like all social phenomena, sport carries with it positive and negative factors that determine and make it more or less: socially acceptable, popular, and mass, ethically, and morally correct and health-oriented. Sport as a complex phenomenon and all its characteristics are the subject of the study of the sociology of sport, as well as numerous social-humanistic disciplines. Contemporary research in the sociology of sport observes sport as a form of culture, looks at sport in everyday life, considers the commercialization of sport, and looks at sport as a spectacle. It is considered that the scope of the sociology of sport primarily includes the following questions: sport as an agent and product of society and social development, the role of sport in the entire social life, the social position of participants in sport, the attitude of the wider social community towards sport, social relations within sport, etc. Sociology of sport indicates the place and importance of sport in contemporary society, its social nature and cultural value and conditioning. Finally, we should also mention that the application of sociological knowledge is increasingly visible in the management of sport as a social institution, as well as in the study of its possibilities in the realization of individual and social needs (Radenović, 2021; Koković, 2007).

With the professionalization of sport, it becomes a primary occupation, and an existential solution, not only for the athletes themselves, but also for people who do not directly compete, but are an indispensable part and factor of every sports organization and every sports event. A particularly pronounced need to turn a sports event into a commercial spectacle is found in economically profitable martial arts such as boxing, boxing without gloves and Mixed Martial Arts (MMA) (Milojević, 2021).

In order to promote matches, promoter organizations, dependent solely on the economic profit that matches bring, encourage, and allow verbal violence and conflicts between competitors, which in certain cases cross the boundaries of ethical behavior within the sport itself and socially acceptable norms (Milojević, 2021). We may define violence in sports as any word or action of an athlete, coach, judge, parent, spectator, or any other participant in a sporting activity that causes injury to those involved in the sporting activity (Radenović, 2021).

In the relevant literature, there are papers that deal with conflicts in the field of sports in the context of verbal aggression (Dixon, 2007; Omine, 2017), but less known papers deal with the issue of promoting MMA fights, more precisely, conflicts that arise before the fight itself, during promotion of the fight and after the fight itself. This paper deals with the case of conflict between two MMA fighters, Khabib Nurmagomedov and Conor McGregor, the evolution from verbal to

religious, social, family, and physical conflict. The role of the UFC promotion company in inciting and abusing their conflict in order to promote the fight and make a profit is discussed.

Method

The method of theoretical analysis and the classic historical method were used in the paper.

Results

The conflict between two fighters can be a universal story about the sports rivalry of two athletes, but in its essence, this conflict went beyond the framework of socially acceptable behavior, it touched on religious beliefs, families, and friends of the actors, and in the last instance, violations of US law. What sets their relationship apart from similar sports rivalries in the broadest sense is precisely the crossing of the so-called "red" lines in promoting fights and the use of all means in order to achieve the greatest possible interest in the fight among the public (Milojević, 2021).

Their first contact and relationship were friendly, they competed in different categories, there was no conflict of interest, and they treated each other quite kindly. They also agreed to organize joint training sessions and to help each other in preparing for matches. Namely, as fighters of different styles, they had something to learn from each other (Milojević, 2021).

However, the problem that often occurs with top fighters, and in general, top athletes, is their ego, something with which, and without which, they probably wouldn't even be able to succeed in the world of professional sports. He carries them for a while and pushes them forward, gives them a feeling of invincibility and self-confidence, but later it certainly starts to interfere with their reasoning and clear assessment of the environment, situations, and hence leads them into delusions that can cost them dearly (Milojević, 2021). Conor McGregor has slowly taken an excellent position within the UFC organization itself. He was recognized as a potentially big star, and with the help of his own abilities and the logistical support of the UFC, he began to build a status that had not been seen before in the world of MMA sports. With his image, victories and fighting style, he captivated the entire public that follows this sport. He became an expert at building rivalries, and very easily managed to turn an ordinary MMA fight into a life-or-death spectacle. Very quickly he started making big money for himself, the company, and his direct opponents. Everyone wanted to fight him, even if they were unprepared, because promotion and earnings were guaranteed, as well as a chance to build their own name with the help of his name (Milojević, 2021). In his strong rise, none of the opponents could withstand the mental pressure he imposed during the promotion of his matches. During that time, Khabib Nurmagomedov had a series of health problems that pushed him out of the center of events as a less active fighter. In order to get into the game and draw the public's attention to himself, he stated in a couple of interviews that he would have nothing against fighting Conor and that he would outclass him in that encounter. He felt that McGregor's focus should not be on seeking an opportunity to fight for the lightweight title without defending the featherweight crown first (Homistek, 2015). The only question is whether Khabib really had any desire to deal with Conor in that interview, or if it was something his manager thought up as a way to provoke Conor into fighting one of his featherweight clients (Milojević, 2021). UFC 229 is scheduled for October 6, 2018, in Las Vegas Nevada, USA. In the period between the incident and the fight itself, a mental and verbal battle began between the

fighters and their teams. Conor McGregor tried in every way to destabilize and "get into the head" of Khabib Nurmagomedov, looking for different ways to achieve this. Khabib has never fought during the Ramadan, which is very important for Muslims, and during which important UFC events are held. Many reproached him for this and classified it as a group of excuses for inactivity, but no one publicly or directly, the media simply emphasized that he would not fight for those reasons, and it was certainly not right for the fighters who were suited to fight with him then, and who were not Muslims. Conor's coach, John Kavanagh, said that since Khabib refuses to fight during Ramadan: "Jesus loves knockouts, while Muhammad does not love summer and MMA, choose your religion carefully young fighters." (Kavanagh, 2016). Immediately when he saw the reactions in the media, he apologized for that statement, but it remained as the beginning of a direction in which the entire promotion took place later, the involvement of a sports match in topics that do not belong to that event (Milojević, 2021). Conor wanted to collect as much compromising content and information regarding Khabib and his father as possible. He offered money for any content of this type, all in order to be ready for the first press conference and the direct confrontation between the two fighters. Namely, Conor McGregor had a strategy to throw Nurmagomedov out of his mental balance with private, political, and religious matters and inflict his first defeat before the fight itself (Milojević, 2021). One got the impression that McGregor came to the press conference in an intoxicated state, and with behavior corresponding to such a state. Namely, he connected Nurmagomedov with the arrested Russian oligarchs who allegedly sponsor his training camp, accused him that his own people do not like him and that they will defeat him in the name of the Russian people. He characterized the Dagestanis as weak and timid people, especially men, and he called Khabib's father a cowardly coward who hides behind the Chechen leader Kadyrov, who is the tyrant of his people. He used the press conference to promote his new brand of "Proper 12" whiskey, which added to the bad atmosphere between the two fighters, because Khabib, as a religious Muslim, does not consume alcohol. At one moment Conor poured him a glass of whiskey and placed it in front of him, provocatively urging him to try it. To all these provocations, Nurmagomedov remained cool and more reserved than usual, knowing that he has no chance to outdo his opponent, primarily because of the language barrier, and then because it is difficult to follow Conor's "trash talk". He was advised by his team not to engage in excessive discussions and talk with him, but the pressure and tension were growing in Khabib, which will manifest because of promoting the fight in this way, without reasonable control of the organization. We could hear from Nurmagomedov that he will physically harm his opponent, that he cannot wait for the doors of the octagon to close, that he will give him lessons in life and sports, that in the end he will be refined and make him a humble man (Milojević, 2021).

Finally, regarding the match itself as a sporting event, Nurmagomedov controlled the match throughout all rounds, and finally celebrated by forcing a submission in the fourth round. During the match in dominant positions, he provoked McGregor that now they can talk, to say something now when they are alone in the Octagon. But the culmination of the entire promotional story is reflected in the worst possible scenario for the MMA sport and the entire MMA community. Khabib Nurmagomedov, having won, under a rush of adrenaline, and obviously not enough physically spent during the fight itself, and mentally exhausted by the accumulated frustration towards McGregor and the UFC, easily jumps over the fence of the octagon and jumps among the members of Conor's team, who are partly in the audience to fight with them. In the general commotion,

members of Khabib's team join in and attack Conor's corner, even jumping into the octagon and attacking Conor himself, who is tired and exhausted from the match. Somehow, the situation is brought under control, but the damage is so big that the situation in the hall cannot be kept under control, so the safety of the audience is also threatened. The fighters are escorted to the locker rooms without the ceremony of announcing the winner and handing over the belt. The event was attended by the governor of the state of Nevada, which added to the damage and severity of the incident itself (Milojević, 2021). It seems that nobody has not been able to predict that Nurmagomedov, until then calm and measured in his statements and behavior, without a history of problematic actions, would succumb to the pressure of the whole story from the moment the fight was scheduled until its end. At the post-fight press conference, he did not answer questions from the press, but he gave a statement saying he was sorry for the whole situation, apologized to the UFC, the fans and the state of Nevada, and said he was provoked by McGregor's behavior and behavior of his team, reacted inappropriately and inappropriately for one professional athlete, noting that he is most afraid of his father's reaction, and the disappointment he caused to him with his actions. Both fighters were fined and banned from competing for a period in that American state. The passions did not calm down even later, so the animosity is still present today, again there are often provocations from McGregor's side, while Khabib always tried to use McGregor's name in a negative context.

Discussion

In most of the sports there is some form of verbal violence that occurs to a greater or lesser extent between athletes. Conflicts during numerous sporting events, whether they are matches or fights, have become a frequent phenomenon. Basketball matches, football matches, water polo matches are not exempted, even at tennis matches there are verbal conflicts and various forms of outbursts of aggression. However, nowhere like in combat sports such as boxing or MMA, the organizers do not force and do not allow outbursts of aggressive behavior, because that way the match is sold better.

In this particular case, there is no controversy that the tensions between the fighters should subside, but it is preferable that they rise to a height that is very dangerous, both for the fighters and for the observers.

Regarding the promotion of the fight between Conor McGregor and Khabib Nurmagomedov, their employer UFC, following the entire logistical situation, concluded that it will be the biggest fight in MMA history so far. The two most popular fighters, at the peak of their careers, with mutual animosities, will certainly bring the highest earnings in the history of the company and this sport. Their characters, cultural characteristics, specificities and differences, views on sports and life in general, were used for promotional purposes, with or without their knowledge. At the moment when there was not even a word about their mutual fight, the UFC began to create a scenario. During the promotion of fights, it is always allowed, or more precisely, desirable, for fighters to mutually insult each other, try to disparage or psychologically burden their opponent. Sometimes they are acting for the sake of greater publicity, and sometimes the fighters really do not like each other, but until this case, families, religion, and other private matters did not interfere in a specific promotional story. Even some fighters privately reproached their opponents when there is no "bad blood", to take courage and start using sharper rhetoric in front of the media. Some fighters refused

fights with too polite opponents because they believed that they would not be able to earn enough money because the fight would not attract enough attention, and the risk of defeat is always there. Generally, this is the nature of the martial arts business, and in the era of the Internet and mass media, self-promotion is very important, so it can be observed that there really is no such thing as bad publicity (Milojević, 2021).

However, the problem arises when there is no measure and limitation in inappropriate behavior and when there are double standards, i.e., when the rules are not the same for everyone. In this sense, the UFC knew how to fire fighters who made unsportsmanlike moves, who attacked the opponent after the match, who simply did not play by the company's rules, etc. But when someone becomes a big star and brings big profits to the organization, those rules do not apply to him or her (Milojević, 2021). Conor McGregor is a typical example of the MMA fighter who went too far with his actions and was completely amnestied by his employer. Let us mention that next to him there is also Jon Jones, who had big problems with the law and doping, and the UFC did not initiate any proceedings against him, but always looked to save him, as its excellent investment, from excessive responsibility and punishment. Similarly, right before the fight with Nurmagomedov, McGregor began to run into increasing personal problems and problems with the law. Thus, he is accused of physical and sexual attacks, used opiates and similar incidents. He was not even warned by the UFC, probably because such a situation suits the one who can cover up such things and later has a stronger negotiating power, and in this case that is definitely the UFC (Milojević, 2021). When the match is already scheduled for 06.10.2018, the UFC director Dana White did not try to stop McGregor from using personal, ethnic, and religious slurs against Khabib, but simply let McGregor be McGregor, capitalizing on his bigotry to promote the fight. The UFC is the most responsible for the riots after the fight due to the accumulated frustration of Nurmagomedov. They failed in the organizational field, by not reacting with a punitive policy, and by not taking a firmer stance on McGregor's exaggerations during the promotion. Following the numbers of views of promotional interviews, they probably saw even more the correctness of their own marketing campaign, and continued to intensify the conflict, making it possible that everything is allowed as it is in "love and war". Thus, the racial and religious rivalries of fight's sale became a proven fact. Habib clearly emphasizes his Islamic affiliation and has become over time for all Muslims around the world a kind of icon of popular culture. The only question was whether someone would attack McGregor or his family due to religious extremism because there was no shortage of threats against him. He himself took the position that he will defeat Khabib on behalf of the Russian (mostly Christian) people, because they do not consider him as "theirs" (Milojević, 2021). Regarding the fight itself, there was nothing out of the ordinary for MMA fights, until the moment it ended, and Khabib Nurmagomedov lost control and created an incident that can clearly be interpreted as a violation of the laws of the country where the fight took place. Could someone else attack anyone on the street in front of witnesses and go unpunished under the criminal law? Difficult (Milojević, 2021).

In the context of a specific sporting event, UFC 229 sold 2,400,000,000 PPV (pay-per-views) broadcasts and filled all the stands. Khabib Nurmagomedov was fined for his behavior after the match, and both fighters were banned from competition for a period of 6-9 months by the sports commission of the state of Nevada, USA. The UFC did not punish them or warn them (Milojević, 2021). They expected to make a story for the rematch as soon as possible and to break the previous earnings record. Life and sports circumstances rejected such a scenario, and it is unlikely that a

similar story will ever be repeated. Nurmagomedov entered the arena two more times and defended his belt both times, without any controversy or inappropriate behavior. After the second defense, he officially retired, thus ending his story as the MMA fighter, retiring with a record of 29-0. McGregor returned to fighting with less success, he also suffered a serious leg injury, and, it can be said without exaggeration, he continued to disrespect his opponents and he continued with verbal aggression without a punitive policy from the UFC as an employer.

Conclusion

MMA is a recent, contemporary sport whose fighters are often the personification of modern gladiators, and in the context of the entertainment industry, it does not always provide space for values and ethical principles such as justice, equality, honesty, mutual respect.

McGregor, raised in poor conditions, living on welfare, as someone with nothing to lose, comes to the very top of this sport, and becomes the richest and most influential MMA fighter, and officially the highest-paid athlete according to Forbes in 2020 (Milojević, 2021). Everything he did, he thought he was doing to make life better for his family, and the tools he had were ideal for promoting his matches and making a profit for the company and himself. The mistake was only in the extent, more precisely, in the limits that were exceeded, and he was not adequately punished by the employer for it, and in the end he himself suffers the damage of injuries and accumulated frustrations (Milojević, 2021).

Regarding Nurmagomedov, of the many advantages he had in comparison to other fighters, it can be concluded without exaggeration, that the greatest was the mentoring role and figure of his father. Having lost his father, he had no one left to impress, and saw no reason to compete without his father's participation. Nor can Nurmagomedov's behavior be justified by other people's behavior towards him because if winning the match is not enough, then his life values and their toughness must also be examined (Milojević, 2021).

We may conclude that currently, the most responsible for the state and future of MMA is the UFC. The considered case of development and instigation of the conflict between Nurmagomedov and McGregor indicates the fact that this promotion company does not choose means for the sake of extra profit. The question remains whether and when the UFC will turn to creating a sport that rests on the foundations of valid sports ethics for the development of this modern sport in the direction of long-term positive changes. In this sense, both mentioned fighters are so influential that they have a chance to build new generations of MMA fighters with the possibility of giving their specific 'stamp', and in the context of developing valid sports ethics.

References

Dixon, N. (2007). Trash talking, respect for opponents and good competition. Sport, ethics and philosophy, 1 (1), 96-106. Homistek, H. (2015).

Kavanagh, J. (2016). Jesus loves knockouts but Mohammed wasn't a fan of summertime MMA? - Choose your religion wisely young fighters! TWITTER 2016 @Coach Kavanagh,

Koković, D. (2007). Sociologija sporta U: *Sociološki rečnik* (ur. Mimica, A., Bogdanović, M.). Beograd: Zavod za udžbenike, pg. 567-568.

Milojević, N. (2021). Zloupotreba i podstrekivanje konflikata između MMA boraca u svrhu promocije borbi i ostvarivanja profita – studija slučaja. (master rad). Beograd: Fakultet sporta i fizičkog vaspitanja.

Milovanović, Ivana (2017). *Uvod u sociologiju i sociologiju sporta*. Novi Sad: Univerzitet u Novom Sadu Fakultet sporta i fizičkog vaspitanja.
Omine, M. (2017). Ethics of Trash Talking in Soccer. *International Journal of Sport and Health Science*, 15, 120-125.
Radenović, S. (2021). *Sport i društvo – Sociologija sa sociologijom sporta*. (treće dopunjeno i izmenjeno izdanje). Beograd: Fakultet sporta i fizičkog vaspitanja Univerziteta u Beogradu.

ZLOUPOTREBA I PODSTREKIVANJE KONFLIKATA IZMEĐU MMA BORACA: SLUČAJ NURMAGOMEDOV I MEK GREGOR

Sandra Radenović[1], Nemanja Milojević[1], Miloš Marković[1], Goran Kasum[1]
[1] Univerzitet u Beogradu, Fakultet sporta i fizičkog vaspitanja, Beograd, Srbija

Uvod

Sport možemo odrediti kao jedan kompleksan društveni, kulturni i istorijski fenomen koji poseduje brojne karakteristike i specifičnosti koje ga odlikuju kako u određenom društvu, tako i na globalnom nivou. Sport je fenomen koji prožima sva društva sveta, a kroz koji možemo sagledati norme i vrednosti određenog društva i kulture (Milovanović, 2017). Kao i svi društveni fenomeni, sport sa sobom nosi pozitivne i negativne faktore koji ga određuju i čine manje ili više: društveno prihvatljivim, popularnim i masovnim, etički i moralno ispravnim i zdravstveno usmerenim. Sport kao jedan složen fenomen i sve njegove karakteristike predmet su izučavanja sociologije sporta, kao i brojnih društveno-humanističkih disciplina. Savremena istraživanja u sociologiji sporta posmatraju sport kao oblik kulture, razmatraju sport u svakodnevnom životu, izučavaju komercijalizaciju sporta, te razmatraju sport kao spektakl. Smatra se da delokrug sociologije sporta obuhvata prevashodno sledeća pitanja: sport kao činilac i proizvod društva i društvenog razvoja, uloga sporta u celokupnom društvenom životu, društveni položaj učesnika u sportu, odnos šire društvene zajednice prema sportu, društveni odnosi unutar sporta itd. Sociologija sporta ukazuje na mesto i značaj sporta u savremenom društvu, na njegovu društvenu prirodu i kulturnu vrednost i uslovljenost. Najzad, pomenimo i to da je sve vidljivija primena sociioloških saznanja pri upravljanju sportom kao društvenom institucijom, kao i u proučavanju njegovih mogućnosti u realizaciji individualnih i društvenih potreba (Radenović, 2021; Koković, 2007).

Profesionalizacijom sporta, on postaje primarno zanimanje, i egzistencijalno rešenje, ne samo za same sportiste, već i za ljude koji se direktno ne takmiče, ali su neizostavni deo i faktor svake sportske organizacije i svakog sportskog događaja. Naročito izražena potreba da se od sportske priredbe pravi komercijalni spektakl nalazi se u ekonomski isplativim borilačkim disciplinama kao što su: boks, boks bez rukavica, i mešovite borilačke veštine (engl. Mixed Martial Arts), odnosno MMA (Milojević, 2021).

U cilju promocije mečeva, promoterske organizacije, zavisne isključivo od ekonomske dobiti koju mečevi donose, podstrekuju i dopuštaju verbalno nasilje i konflikte između takmičara, koji u određenim slučajevima prelaze granice etike ponašanja u okviru samog sporta i društveno prihvatljivih normi (Milojević, 2021). Pod nasiljem u sportu podrazumevamo svaku reč ili postupak sportiste, trenera, sudije, roditelja, gledaoca ili nekog drugog učesnika u sportskoj aktivnosti koji nanosi povredu onima koji su uključeni u sportsku aktivnost. (Radenović, 2021).

U relevantnoj literaturi mogu se naći radovi koji obrađuju konflikte u oblasti sporta u kontekstu verbalne agresije (Dixon, 2007; Omine, 2017), ali su manje poznati radovi koji se bave problematikom promocije MMA borbi, tačnije, konfliktima koji nastaju pre same borbe, tokom promocije borbe i nakon same borbe. U ovom radu je obrađen slučaj konflikta između dvojice MMA boraca, Habiba Nurmagomedova (rus. Хабиб Абдулмана́пович Нурмагоме́дов) i Konora Mek Gregora (engl. Conor McGregor), prerastanje ovog konflikta iz verbalnog u verski, socijalni,

porodični, fizički. Obrađena je uloga promoterske kuće UFC u podstrekivanju i zloupotrebi njihovog konflikta u cilju promovisanja borbe i ostvarivanja profita.

Metode

U radu je korišćen metod teorijske analize i klasičan istorijski metod.

Rezultati

Konflikt između dvojice boraca može biti i univerzalna priča o sportskom rivalstvu dvojice sportista, ali je u svojoj suštini ovaj konflikt prevazišo okvire društveno prihvatljivog ponašanja, dotakao se religijskih uverenja, porodica i prijatelja aktera, a u krajnjoj instanci i kršenja zakona SAD. Ono što njihov odnos izdvaja od sličnih sportskih rivalstava u najširem smislu, jeste upravo prelaženje takozvanih „crvenih" linija u promovisanju borbi i upotrebi svih mogućih sredstava da bi se za borbu u javnosti ostvarilo što veće interesovanje (Milojević, 2021).

Prvi njihov kontakt i odnos bio je prijateljski nastrojen, takmičili su se u različitim kategorijama, nije bilo sukoba interesa, i prilično ljubazno su se odnosili jedan prema drugom. Dogovarali su se i da organizuju zajedničke treninge, te da jedan drugom pomognu u pripremama za mečeve. Naime, kao borci različitih stilova imali su šta da međusobno nauče jedan od drugog (Milojević, 2021).

No, problem koji se često kod vrhunskih boraca, i uopšte, vrhnskih sportista neretko javlja, jeste njihov ego, nešto sa čim, i bez čega, verovatno ne bi ni mogli uspeti u svetu profesionalnog sporta. On ih jedno vreme nosi i gura napred, daje im osećaj nepobedivosti i samopouzdanja, ali im kasnije zasigurno počinje da smeta u rasuđivanju i jasnoj proceni okruženja, situacija, pa ih otuda dovodi u zablude koje ih mogu skupo koštati (Milojević, 2021). Konor MekGregor je polako zauzeo odličnu poziciju unutar same organizacije UFC. Prepoznat je kao potencijalno velika zvezda, te je počeo da uz pomoć sopstvenih sposobnosti i logističke podrške UFC-a, izgrađuje status do tada neviđen u svetu MMA sporta. Zaokupirao je svojim imidžom, pobedama i stilom borenja celokupnu javnost koja prati ovoj sport. Postao je stručnjak za izgradnju rivalstva, i vrlo lako je uspeo da od obične MMA borbe napravi spektakl kao da je reč o borbi na život ili smrt. Vrlo brzo je počeo da zarađuje veliki novac sebi, kompaniji i svojim direktnim protivnicima. Svi su želeli borbu sa njim, makar i nespremni, jer je promocija i zarada bila zagarantovana, kao i šansa da se uz pomoć njegovog imena izgradi sopstveno ime (Milojević, 2021). U tom njegovom silovitom usponu niko od protivnika nije mogao da izdrži mentalni pritisak koji je nametao prilikom promovisanja svojih mečeva. Za to vreme Habib Nurmagomedov je imao niz zdravstvenih problema koji su ga izbacili iz centra događanja kao malo aktivnog borca. Da bi se ubacio u igru i skrenuo pažnju javnosti na sebe, u par intervjua je izjavio kako ne bi imao ništa protiv da se bori sa Konorom i da bi ga u tom susretu deklasirao. Smatrao je da MekGregorov fokus ne treba da bude na traženju prilike da se bori za titulu u lakoj kategoriji, a da pre toga ne odbrani tron u perolakoj kategoriji (Homistek, 2015). Pitanje je samo da li je Habib stvarno imao želju da se bavi Konorom unutar tog intervjua, ili je to nešto što je zamislio njegov menadžer kao način da isprovocira Konora da se bori sa nekim od njegovih klijenata iz pero lake kategorije (Milojević, 2021). UFC 229 zakazan je za 6. oktobar 2018. godine u Las Vegasu Nevada, SAD. Tokom perioda između incidenta i same borbe, krenula je mentalna i verbalna borba između boraca i njihovih timova. Konor MekGregor je na sve načine

pokušao da destabilizuje i „uđe u glavu“ Habibu Nurmagomedovu, tržeći različite načine na koje će to postići. Habib se nikada nije borio u vreme Ramazanskog praznika, veoma značajnog za ljude islamske veroispovesti, a u tom periodu održavaju se značajne UFC priredbe. Mnogi su mu to zamerali i svrstavali u grupu izgovora za neaktivnost, ali niko javno ili direktno, u medijima se prosto naglašavalo da se neće boriti iz tih razloga, a borcima kojima je odgovaralo da se bore tada sa njim, a nisu muslimani, sigurno nije bilo pravo. Konorov trener Džon Kavanag (John Kavanagh), izjavio je da pošto Habib odbija borbe u vreme Ramazana: „Isus voli nokaute, dok Muhamed ne voli leto i MMA, pažljivo birajte svoju religiju mladi borci“ (Kavanagh, 2016). Odmah kada je video kakve su reakcije u medijima, izvinio se povodom te izjave, ali ona je ostala kao početak jednog smera u kojem se kasnije odvijala celokupna promocija, uplitanje sportskog meča u teme koje ne priliče tom događaju (Milojević, 2021). Konor je želeo da prikupi što više kompromitujućih sadržaja i informacija u vezi sa Habibom i njegovim ocem. Nudio je novac za bilo kakve sadržaje takvog tipa, a sve u cilju da spreman dočeka prvu pres konferenciju i direktno suočavanje dvojice boraca. Naime, Konor MekGregor imao je strategiju da privatnim, političkim i religijskim stvarima izbaci Nurmagomedova iz mentalne ravnoteže i prvi poraz mu nanese pre same borbe (Milojević, 2021). Stekao se utisak da je MekGregor na konferenciju za novinare došao u alkoholisanom stanju, i sa ponašanjem koje odgovara takvom stanju. Naime, Nurmagomedova je povezao sa uhapšenim ruskim oligarsima koji navodno sponzorišu njegov pripremni kamp, optužio ga je da ga sopstveni narod ne voli i da će ga pobediti u ime ruskog naroda. Dagestance je okarakterisao kao slabe i plašljive ljude, naročito muškarce, a Habibovog oca nazvao je plašljivom kukavicom, koja se krije iza čečenskog lidera Kadirova, koji je tiranin svog naroda. Pres konferenciju je iskoristio za promociju svog novog brenda „Proper 12“ viskija, što je dodatno unelo lošu atmosferu između njih dvojice, jer Habib kao religiozni musliman ne konzumira alkohol. U jednom trenutku Konor mu je sipao čašu viskija i stavio je ispred njega, provokativno nagovarajući ga da proba. Na sve ove provokacije Nurmagomedov je ostao hladan i suzdržaniji nego inače, znajući da nema nikakvu šansu da se nadglasa sa protivnikom, prvenstveno zbog jezičke barijere, a posle i zbog toga što je teško ispratiti Konorov „trash talk“. Savetovan je od strane svoga tima da se ne upušta u prevelike diskusije priču sa njim, a zapravo u Habibu je rastao pritisak i tenzija koja će se na kraju ispoljiti kao posledica promovisanja borbe na ovaj način, bez razumne kontrole organizacije. Od Nurmagomedova se moglo čuti kako će fizički naškoditi protivniku, da jedva čeka da se vrata oktagona zatvore, da će mu pružiti lekcije iz života i sporta, da će ga na kraju upristojiti i učiniti poniznim čovekom (Milojević, 2021).

Najzad, kada je reč o samom meču kao sportskom događaju, Nurmagomedov je kontrolisao meč tokom svih rundi, i na kraju slavio prisiljavanjem na predaju u četvrtoj rundi. Tokom meča u dominatnim pozicijama, provocirao je MekGregora da sada mogu da pričaju, da kaže nešto sada kada su sami u oktagonu. No, kulminacija celokupne promoterske priče ogleda se u najgorem mogućem scenariju po MMA sport i celokupnu MMA zajednicu. Habib Nurmagomedov, ostvarivši pobedu, pod naletom adrenalina, a očigledno nedovoljno fizički potrošen tokom same borbe, te mentalno iscrpljen nakupljenom frustracijom prema MekGregoru i UFC-u, sa lakoćom preskače ogradu oktagona i skače među članove Konorovog tima koji su delom u publici da se obračuna i sa njima. U opštem metežu uključuju se i članovi Habibovog tima koji napadaju takođe Konorov ugao, čak uskaču u oktagon i napadaju samog Konora koji je premoren i iscrpljen mečom. Nekako se situacija stavlja pod kontrolu, ali šteta je toliko velika da se situacija u hali ne može držati pod

kontrolom, pa je i bezbednost publike ugrožena. Borci bivaju sprovedeni do svlačionica bez ceromonije proglašenja pobednika i predaje pojasa. Događaju je prisustvovao i guverner savezne države Nevada što je dalo dodatno na šteti i težini samog incidenta (Milojević, 2021). Niko izgleda nije mogao da predvidi da će Nurmagomedov, do tada smiren i odmeren u izjavama i ponašanju, bez istorije problematičnog delanja, tako podleći pritisku cele priče koja se odvijala od momenta zakazivanja borbe pa da njenog kraja. Na konferenciji za novinare nakon borbe, nije odgovarao na novinarska pitanja, već je dao saopštenje u kome je naveo da mu je žao zbog cele situacije koja se desila, izvinio se UFC-u, navijačima i državi Nevada, te je naveo da je isprovociran ponašanjem MekGregora i njegovog tima, reagovao neprimereno i nedolično jednom profesionalnom sportisti, uz napomenu da se najviše plaši reakcije svoga oca, i razočarenja koje mu je priredio svojim postupkom. Obojica boraca dobili su znatne novčane kazne i zabranu takmičenja na neki period u toj američkoj državi. Strasti se ni kasnije nisu smirile, pa je i danas prisutan animozitet, opet sa MekGregorove strane neretko su prisutne provokacije, dok se i Habib uvek trudio da provuče MekGregorovo ime u negativnom kontekstu.

Diskusija

U većini sportova postoji neki oblik verbalnog nasilja koje se u većoj ili manjoj meri dešava između sportista. Sukobi tokom brojnih sportskih događaja, bez obzira na to da li je reč o utakmicama ili borbama su postali česta pojava. Nisu izuzete ni košarkaše, fudbalske, vaterpolo utakmice, čak i na teniskim mečevima dešavaju se verbalni konflikti i različiti oblici izliva agresije. Međutim nigde kao u borilačkim sportovima poput boksa ili MMA, organizatori ne forsiraju i ne dopuštaju izlive agresivnog ponašanja, jer se na taj način meč bolje prodaje.

U konkretnom slučaju, nema polemike da se tenzije između boraca stišaju, nego je poželjno da se podignu na visinu koja je jako opasna, kako za borce, tako i za posmatrače.

Kada je reč o promociji borbe između Konora MekGregora i Habiba Nurmagomedova, njihov poslodavac UFC, prateći celu logističku situaciju, došao je do zaključka da će se raditi o najvećoj borbi u dosadašnjoj MMA istoriji. Dva najpopularnija borca, na vrhuncu karijera, sa međusobnim animozitetima, doneće sigurno najveću zaradu u istoriji kompanije i ovog sporta. Njihovi karakteri, kulturološka obeležja, specifičnosti i razlike, pogledi na sport i život uopšte, iskorišćeni su u promotivne svrhe, sa ili bez njihovog znanja. U trenutku kad o njihovoj međusobnoj borbi nije bilo ni reči, krenulo je pravljenje scenarija od strane UFC-a. Prilikom promocije borbi uvek je dozvoljeno, tačnije, poželjno)da borci međusobno vređaju jedan drugoga, pokušavaju da omolovaže ili psihološki opterete svog protivnika. Nekada se tu radi o glumi zarad većeg publiciteta, a nekada se borci zaista ne vole, ali sve do ovog slučaja nisu se mešale porodice, religija, i druge privatne stvari u konkretnu promotivnu priču. Čak su neki borci privatno zamerali svojim protivnicima kada nema te „zle krvi“, da se ohrabre i krenu u oštriju retoriku pred medijima. Pojedini borci su odbijali borbe sa previše uljudnim protivnicima jer su verovali da neće uspeti da zarade dovoljno novca jer borba neće privući dovoljno pažnje, a rizik od poraza uvek postoji. Generalno takav je borilački posao u svojoj prirodi, a u eri interneta i masovnih medija, jako je bitna samopromocija, tako da se može primetiti da zapravo ne postoji loša reklama (Milojević, 2021).

Ipak, problem nastaje kada ne postoji mera i ograničenje u neprimerenom ponašanju i kada postoje dvostruki aršini, odnosno kada pravila nisu ista za sve. U tom smislu, UFC je znao da otpusti borce koji su pravili nesportske poteze, da nasrnu na protivnika nakon meča, da prosto ne igraju po

pravilima kompanije itd. No, kada neko postane velika zvezda i donosi veliki profit organizaciji, ta pravila ne važe za njega, ili nju (Milojević, 2021). Konor MekGregor je tipičan primer MMA borca koji je otišao najdalje sa svojim postupcima i ostao potpuno amnestiran od strane poslodavca. Pomenimo da je pored njega tu i Džon Džouns (Jon Jones) koji je imao velikih problema sa zakonom i dopingom, a UFC nije pokrenuo nikakav postupak protiv njega, već je uvek gledao da ga, kao svoju odličnu investiciju, sačuva od prevelike odgovornosti i kazne. Slično, MekGregor je neposredno pred borbu sa Nurmagomedovim počeo da upada u sve veće privatne probleme i probleme sa zakonom. Tako biva optužen za fizičke i seksualne napade, korišćene opijata i slične izgrede. Od strane UFC nije ni opomenut, verovatno jer takva situacija odgovara onome ko može takve stvari da zataška i kasnije ima jaču pregovaračku moć, a to je svakako u ovom slučaju UFC (Milojević). Kada je meč već zakazan za 06.10.2018. god., direktor UFC Dejna Vajt (Dana White) nije pokušao da zaustavi MekGregora da koristi lična, etnička i religiozna podmetanja Habibu, već je jednostavno dozvolio MekGregoru da bude MekGregor, kapitalizujući njegov fanatizam da promoviše borbu. UFC je najodgovorniji i za nerede nakon borbe usled nagomilane frustracije Nurmagomedova. Zakazali su na organizacionom polju, nereagovanjem kaznenom politikom, i nezauzimanjem čvršćeg stava na MekGregorova preterivanja tokom promocije. Prateći brojeve pregleda promotivnih intervju, verovato su još više uvideli ispravnost sopstvene marketing kampanje, i nastavili su sa pojačavanjem konflikta, omugućivši da je sve kao u „ljubavi i u ratu“, dozvoljeno. Tako je rasno i versko rivalstvo prodaje borbe postala dokazana činjenica. Habib jasno ističe svoju islamsku pripadnost i postao je vremenom za sve muslimane širom sveta neka vrsta ikone popularne kulture. Bilo je pitanje samo da li će neko usled verskog ekstremizma napasti MekGregora ili njegovu porodicu, jer pretnji prema njemu nije manjkalo. On je sam zauzeo stav da će u ime ruskog (većinski hrišćanskog) naroda da pobedi Habiba, jer njega oni ne smatraju „svojim“ (Milojević, 2021). Kada je reč o samoj borbi, unutar nje nije bilo ništa neoubičajeno za MMA borbe, do trenutka kada se ona završila i kada je Habib Nurmagomedov izgubio kontrolu i takođe napravio incident koji je se jasno može tumačiti kao kršenje zakona države u kojoj se borba odigrala. Da li bi neko drugi mogao na ulici napasti bilo koga pred svedocima i ostati po kaznenom zakonu nekažnjen? Teško (Milojević, 2021).

U kontekstu konkretnog sportskog događaja, UFC 229 je prodao 2.400.000.00 PPV (pay-per-views) prenosa i napunio tribine do kraja. Habib Nurmagomedov je novčano kažnjen za svoje ponašanje nakon meča, a obojica boraca dobili su zabranu takmičenja na period od 6-9 meseci, od sportske komisije države Nevada, SAD. UFC ih nije kaznio, niti opomenuo (Milojević, 2021). Očekivali su da što pre naprave priču za revanš i da probiju dosadašnji rekord zarade. Životne i sportske okolnosti su takav scenario odbacile i teško da će se slična priča ikada ponoviti. Nurmagomedov je još dva puta ulazio u borilište i oba puta odbranio svoj pojas, bez ikakvih kontroverzi i nepriličnog ponašanja. Nakon druge odbrane se službeno penzionisao, i time završio svoju priču MMA borca, povukavši se sa skorom od 29-0. MekGregor se sa manje uspeha vratio borbama, doživeo je i tešku povredu noge, te je, može se bez pretrivanja reći, nastavio sa nepoštovanjem protivnika i verbalnom agresijom bez kaznene politike od strane UFC kao poslodavca.

Zaključak

MMA je mlad, savremen sport u kome su borci često personifikacija modernih gladijatora, a u kontekstu industrije zabave, u ovom sportu nema uvek mesta za vrednosti i etičke principe poput pravde, jednakosti, poštenja, uzajamnog poštovanja.

MekGregor, odrastao u oskudnim uslovima, živeći od socijalne pomoći, kao neko ko nema šta da izgubi, dolazi na sam vrh ovog sporta, i postaje najbogatiji i najuticajniji MMA borac, i zvanično sportista sa najvećom zaradom prema Forbsu u 2020. godini (Milojević, 2021). Sve što je činio, mislio je da čini da poboljša život svojoj porodici, a alat koji je imao bio je idealan za promovisanje svojih mečeva i sticanje profita za kompaniju i za sebe. Greška je bila samo u meri, tačnije, u granicama koje su prelažene, a nije adekvatno kažnjen od strane poslodavca za to, a na kraju i sam trpi štetu povreda i nagomilanih frustracija (Milojević, 2021).

Kada je reč o Nurmagomedovu, od dosta prednosti koje je imao u odnosu na druge borce, bez preterivanja se može zaključiti da je najveća bila mentorska uloga i figura njegovog oca. Izgubivši oca, nije imao više koga da impresionira, i nije video motiv da se takmiči, bez da njegov otac učestvuje u tome. Ponašanje Nurmagomedova se takođe ne može opravdati tuđim ponašanjem prema njemu jer ako pobeda u meču nije dovoljna, onda se moraju ispitati i njegove životne vrednosti i njihova čvrstina (Milojević, 2021).

Možemo zaključiti da je trenutno najodgovorniji za stanje i budućnost MMA upravo UFC. Razmotreni slučaj razvijanja i podstrekivanja konflikta između Nurmagomedova i Mek Gregora ukazuje na činjenicu da ova promoterska kuća ne bira sredstva zarad ekstra profita. Ostaje pitanje da li će se i kada UFC okrenuti stvaranju sporta koji počiva na temeljima valjane etike sporta radi napredovanja ovog mladog sporta u smeru pozitivnih promena na duže staze. U tom smislu, obojica pomenutih boraca su toliko uticajni da imaju šansu da grade nove generacije MMA boraca uz mogućnost davanja svog specifičnog pečata, a u kontekstu razvijanja valjane etike sporta.

Literatura

Dixon, N. (2007). Trash talking, respect for opponents and good competition. Sport, ethics and philosophy, 1 (1), 96-106.

Homistek, H. (2015). Khabib Nurmagomedov tells Conor McGregor to stay at 145, says he wants to stay busy in 2016,

Kavanagh, J. (2016). Jesus loves knockouts but Mohammed wasn't a fan of summertime MMA? - Chooseyour religion
wisely young fighters! TWITTER 2016 @Coach Kavanagh,

Koković, D. (2007). Sociologija sporta U: *Sociološki rečnik* (ur. Mimica, A., Bogdanović, M.). Beograd: Zavod za udžbenike, str. 567-568.

Milojević, N. (2021). Zloupotreba i podstrekivanje konflikata između MMA boraca u svrhu promocije borbi i ostvarivanja profita – studija slučaja. (master rad). Beograd: Fakultet sporta i fizičkog vaspitanja.

Milovanović, Ivana (2017). Uvod u sociologiju i sociologiju sporta. Novi Sad: Univerzitet u Novom Sadu Fakultet sporta i fizičkog vaspitanja.

Omine, M. (2017). Ethics of Trash Talking in Soccer. International Journal of Sport and Health Science, 15, 120-125.

Radenović, S. (2021). Sport i društvo – Sociologija sa sociologijom sporta. (treće dopunjeno i izmenjeno izdanje). Beograd: Fakultet sporta i fizičkog vaspitanja Univerziteta u Beogradu.

THE SOCIAL EFFECT OF A SPORTING EVENT THROUGH THE EXAMPLE OF THE ORGANIZATION OF THE "EUROPEAN YOUTH CHAMPIONSHIP IN TABLE TENNIS 2022"

Goran Kasum[1], Goran Kocić[2], Bojana Milićević Marinković[3]
[1] University of Belgrade, Faculty of Sport and Physical Education, Belgrade, Serbia
[2] Table Tennis Academy "Kocić", Belgrade
[3] University "Union - Nikola Tesla", Faculty of Sports, Belgrade, Serbia

Introduction

Taking into account the various challenges that the organizer faces when planning large sports events, this study will try to bring closer and clarify the organizational structure and the implementation of tasks in order to effectively realize sports events such as the European Youth Table Tennis Championship in 2022. Sport is complex and effective in many social spheres, in addition to an adequate budget for the organization of a large sporting event, a good organizational scheme and human resources management are also necessary, as well as a good selection of leaders who will manage the event (Rađo, Sadžak, 2009).

Sports events are considered to be one of the oldest organized events in the history of mankind, going back to ancient Greece, i.e. the Olympic Games. Even at that time, there was a need for certain concepts of organizing and realizing sports events that gathered the masses, provided the observers with joy and enjoyment, and created a certain interaction between all the actors in the event. When it comes to top sporting events of an international character, the very concept of organizing must be at the highest level and in every sense supported by the state authorities of the country in which it is organized (Kasum, 2021). Smaller sports events can be organized independently, with more or less support from the local government, but the organization of large international competitions is practically impossible without significant support from the Government and relevant ministries.

The Table Tennis Federation of Serbia, from its existence until today, has shown exceptional organizational skills and successes by realizing numerous international competitions: European Championship for seniors, Balkan Championships, Pro Tour for seniors and younger age categories, Super League of Serbia. The main goal of the implementation of these events is the popularization of table tennis and the involvement of as many young people as possible in this sport, as well as a positive impact on the local community and its tourism development, strengthening and deepening of international cooperation, raising the competitive level of the most promising younger competitors, procurement of specific equipment of highly standardized competitive quality and creating conditions and opportunities for the future organization of major international events in the Republic of Serbia.

The project on the organization of large sports events is prepared in accordance with the Law on Sports, by-laws related to sports events at the level of the ministry and local community, as well as based on previous experiences, and in this case the requirements, i.e. instructions of the European Table Tennis Federation (ETTU) which authorizes the national federation to organize major sports events such as the European Table Tennis Youth Championship.

Methods

The problem of this paper is a comprehensive analysis of the European Table Tennis Youth Championship, which was held in 2022 in Belgrade. The paper used the observation method, i.e. the descriptive method, and the data were taken from the official website of the European Table Tennis Union and the report of the Professional Service of the competition.

Results

The Table Tennis Association of Serbia organized in the period from 06.06. until June 15, 2022, the European Table Tennis Championship for young people in "Stark Arena" in Belgrade. The realization of this championship was a significant national and city project, which the Table Tennis Federation of Serbia very successfully carried out in cooperation with the Ministry of Youth and Sports of the Republic of Serbia, the Secretariat for Sports and Youth of the City of Belgrade, public enterprises of the city and sponsors who gave immeasurable support in the realization of this events.

Thanks to the past experiences of the national table tennis association and its organizational abilities, the European Table Tennis Federation (ETTU) assigned the organization of this tournament to the Association with the aim of affirming table tennis, primarily among the younger age categories, which represented the vision of the organization of this event. The mission of this sports event was to contribute to raising the sport of table tennis to a higher level both in terms of competition and organization, promoting the value of this sport while creating good competitive results of the national team, with the ultimate goal of influencing table tennis, raising the image of Serbia, of the city of Belgrade, introducing the world to the tradition, culture, customs and way of life of our country.

Based on the importance of sport for health and quality of life, social integration, international prestige and affirmation, national pride, sense of belonging, morality and other values of general interest, in the desire to not only maintain, but also open new perspectives for the development of sport, it is necessary to the state participates in the creation of conditions through a well-designed system of organizing professional, organizational and management tasks, both at the local and state level. Also, it should be emphasized that an internationally achieved sports result contributes to the international promotion of the country, i.e. a top sporting success in a developed country.

Table 1. Competition Organization Concept

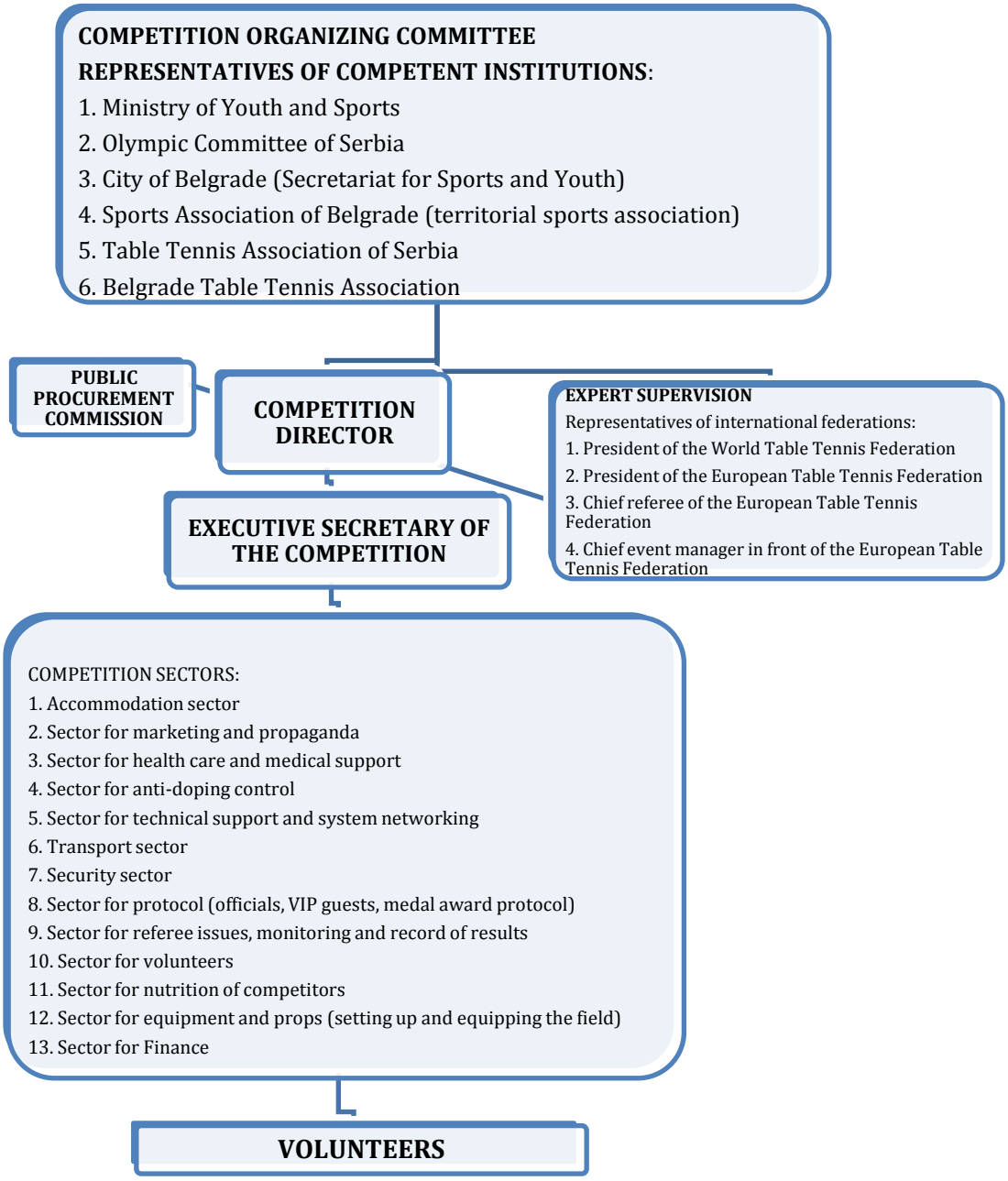


Table 2. Participants of the European Table Tennis Youth Championship

Category	Total no
Country	41
Sportsman	525
Delegate	120
Judge	74
ETTU, ITTF members and VIP guests	30
Audience (number of visitors for a period of 10 days)	Over 1500 visitors per day
Number of hotels (teams and judges)	4
Volunteers	52
Part-time employees	52
General sponsor	Dunav osiguranje doo
Sponsors in goods and services	4
Medals (divided by categories)	180
Media (daily broadcasts on TV Arena Sport)	50 hours of broadcasting

Discussion

The ten-day period of the event shows that the event gathered a large number of participants, 525 athletes from 41 countries, required enormous organizational efforts, but also as a final result created a positive image of the host as one of the best organized major tournaments in table tennis and gave an introduction to re-candidacy of the national association for the next major sports competitions. Considering that the COVID 19 pandemic was not yet officially over, the organizer of the competition implemented all the necessary measures in order to suppress the spread of the pandemic, but he was not officially obliged by the international federation to implement the COVID protocols and the delegations were not obliged to have negative Covid tests. Ensuring immediate health care and solving the participants' health problems during the championship is ensured by the daily presence of medical staff equipped to provide immediate medical assistance by the "City of Belgrade Ambulance". Anti-doping control was carried out by a member of the European Table Tennis Federation (Professional Service, 2022).

The European Table Tennis Youth Championship is held every year. The age category that participated in the 2022 championship in Belgrade was cadets and juniors (men and women) and refers to competitors from 11 to 19 years old. This competition consisted of a team and individual competition, where a total of 82 teams from 41 countries competed. During the duration of the championship, accompanying contents were held, which include, among other things, technical meetings of representatives of the delegations of participating countries, the board of directors and commissions of the world and European table tennis federations, judges' meetings, evaluations of judges, social activities of participants and daily meetings of organizers by sector. The competition program was implemented in the large hall of the "Stark Arena" where 24 competition tables were set up, and the warm-up and training room was set up in the "Small Arena" located within the same facility with a total of 24 tables. The schedule of training and matches is determined every day by the general manager of the European Table Tennis Federation.

The official opening ceremony of the championship was not organized because the European Table Tennis Federation did not even require the opening protocol from the organizers, while the ceremony announcing the winners in the team and individual competition was realized

after the final matches in accordance with all the rules and procedures that characterize major sports events.

Figure 1. Championship logo

The logo of the "European Youth Table Tennis Championship" represents the "sparrow" which is the symbol of the city of Belgrade as a table tennis athlete in the colors of the country of Serbia.

The organization and implementation of a sports event must pay special attention to the safety of the sports event. The security of the sports event is a very important segment and issue that includes all the participants of the event, and primarily its organizers and implementers, and is included in the time before, during and after the end of the competition.

A sports competition always represents a potential risk for its actors (both the athletes and the wider audience that immediately follows it). The task of event management is to take all necessary measures to prevent possible risks. These activities do not require the organizer to take immediate (direct) action on the "source" of endangerment, but ask him to enable potentially endangered persons to have a responsible attitude towards the dangers accompanying the sports competition (Đurđević, 1997).

Security during the implementation of a sports event is an important segment for its management with very demanding tasks such as public security of the sports facility, security of equipment and props used during the event and medical and health security of all event participants, which includes anti-doping control.

"Sports without sports events or sports competitions would not represent such an attractive phenomenon that has become a distinct sociological phenomenon in the modern world" (Nešić, 2006).

Conclusion

The organization of the European Table Tennis Youth Championship aimed to increase the capacity of human and material resources of the table tennis sport, from the national federation to sports clubs and organizations in order to organize future major sports events in this sport. In this way, it influences the strengthening of the position of the national association, then the sport itself,

its position on the market and the creation of a brand that will help that sport to strengthen and be recognizable.

The purpose of organizing a sports event such as the European Youth Table Tennis Championship is related to improving the image of the organizer, which is the Table Tennis Association of Serbia, developing the sport at all levels from local to national in all age categories, strengthening the national team, creating better financial conditions from funding from the budget until the sponsor approaches.

This kind of sports events influence the development and popularity of table tennis in the Republic of Serbia. The inclusion of a large number of individuals and legal entities (catering facilities, hotels, taxi services, etc.), representatives of public authorities in the preparation and implementation of the event, as well as the media coverage of the event, have an overall effect on increasing interest in playing table tennis. Also, the pre-competition promotional activities that announce this type of event, the presence of younger age categories at the competition, have a positive effect on the motivation of children and the school population for more active participation and practice of table tennis. In the process of preparing a large sports event of this type, capital is invested in sports and public infrastructure, the acquisition of the necessary equipment and props, thereby influencing the creation of the possibility of organizing even larger and more massive table tennis competitions, as well as the organization of training camps and international sports events.

The social effect of organizing a sports event is of general interest, and the effects are as follows:

1. Contributes to the improvement of the brand status of the city of Belgrade in order to be recognizable in the international environment (strengthening the tourist offer of the city, its culture and tradition);
2. Strengthening the city's economic capacity in terms of infrastructure investments in order to improve the city's sports and accommodation infrastructure;
3. Increasing income from various types of taxes;
4. Involvement of a large number of volunteers, which affects better socialization and interpersonal relations;
5. Increase in the level of employment;
6. Nurturing and developing other values of the sport in which the event is organized, with the aspiration that the focus must always be on fair play, sports ethics, equality and respect for all the rights of athletes.

References

Bižić, V. (2012). Pojam sportskog liderstva i njegova primena u sportskim organizacijama u Srbiji. Socioekonomika, 1(2), 417-422.

Biočanin, R., Drašković, D. (2018). Investicije i ekonomičnost gradnje sportskih objekata za međunarodna sportska nadmetanja. U Međunarodna naučna konferencija „Mediji i ekonomija“ Zbornik radova 4 (203-217), Banja Luka. Doi: 10.7251/BLCMES1801203B.

Đurđević, N. (1997). Komentar Zakona o sportu, NIP Student, Beograd.

ETTU (2022). European Youth Championships Archive.

Ilić, R., Bošković, B., Radovanović, G. (2013). Upravljanje rizicima na sportskim događajima. Sport, nauka i praksa, Vol.3(43-58), UDK. 005.334:796.062.

Kasum, G. (2021). Rvanje – Srpska Olimpijska vrednost, Fizička kultura, 75(1), 44-45.

Nešić, M. (2006-07). Menadžment sportskih događaja. Novi Sad: TIMS.

Nešić, M. (2008). Bezbednost sportskog događaja i uloga klupskog menadžera. Poslovna ekonomija, 12 (2), 128-140.
Rađo, I., Sadžak, M. (2009). Globalno liderstvo. Sarajevo: Fakultet sporta i tjelesnog odgoja. Olimpijski komitet BIH.
Professional Service (2022). Report from the European Table Tennis Championship for youth. Belgrade: Internal document.
Tomić , M. (2007). Planiranje u sportu. Sportski menadžment (291-415). Beograd: Data status.

DRUŠTVENI UČINAK SPORTSKOG DOGAĐAJA KROZ PRIMER ORGANIZACIJE „EVROPSKOG PRVENSTVA ZA MLADE U STONOM TENISU 2022“

Goran Kasum[1], Goran Kocić[2], Bojana Milićević Marinković[3]

[1] Univerzitet u Beogradu, Fakultet sporta i fizičkog vaspitanja

[2] Stonoteniska akademija „Kocić“, Beograd

[3] Univerzitet „Union – Nikola Tesla“, Fakultet za sport, Beograd, Srbija

Uvod

Uzimajući u obzir razne izazove sa kojima se organizator susreće prilikom planiranja velikih sportskih događaja, ova studija će pokušati da približi i pojasni organizacionu strukturu i realizaciju zadataka u cilju efikasne realizacije sportskih manifestacija kao što je bilo Evropsko prvenstvo za mlade u stonom tenisu 2022.godine. Sport je kompleksan i učinkovit u mnogim društvenim sferama da pored adekvatnog budžeta za organizaciju velikog sportskog događanja neophodna je i dobra organizaciona šema i rukovođenje ljudskim resursima, kao i dobar odabir lidera koji će da rukovodi događajem (Rađo, Sadžak, 2009).

Sportski događaji se smatraju jednim od najstarijih organizovanih priredbi u istoriji čovečanstva, koji potiču još iz antičke Grčke odnosno Olimpijskih igara. Još u to vreme javila se potreba da određenim koncepcijama organizovanja i realizacije sportskih događaja koji su okupljali mase, pružali posmatračima radost i uživanje, i stvaranje određene interakcije između svih aktera u događaju. Kada su u pitanju vrhunski sportski događaji međunarodnog karaktera, sama koncepcija organizovanja mora biti na najvišem stepenu i u svakom smislu podržana od državnih vlasti zemlje u kojoj se organizuje (Kasum, 2021). Manje sportske događaje moguće je organizovati i samostalno, uz manju ili veću podršku lokalne samouprave, ali organizacija velikih međunarodnih takmičenja praktično je neizvodljiva bez značajne podrške Vlade i resornog ministarstva.

Stonoteniski savez Srbije, od svog postojanja pa do danas, pokazao je izuzetne organizacijske sposobnosti i uspehe realizacijom brojnih međunarodnih takmičenja: Prvenstvo Evrope za seniore, Balkanska prvenstva, Pro tour za seniore i mlađe uzrasne kategorije, Super liga Srbije. Osnovni cilj realizacije ovih događaja je popularizacija stonog tenisa i uključivanje što većeg broja mladih u ovaj sport, kao i pizitivan uticaj na lokalnu zajednicu i njen turistički razvoj, jačanje i produbljivanje međunarodne saradnje, podizanje takmičarskog nivoa najperspektivnijih takmičara mlađih uzrasta, nabavka specifične opreme visoko standardizovanog takmičarskog kvaliteta i stvaranje uslova i mogućnosti za buduću organizaciju velikih međunarodnih događaja u Republici Srbiji.

Projekat o organizaciji velikih sportskih događaja izrađuje se u skladu sa Zakonom o sportu, podzakonskim aktima vezanim za sportske događaje na nivou ministarstva i lokalne zajednice, kao i na osnovu prethodnih iskustava, a u ovom slučaju zahteva tj. uputstva Evropske stonoteniske federacije (ETTU) koja odobrava nacionalnoj federaciji organizaciju velikih sportskih događaja kao što je Evropsko prvenstvo za mlade u stonom tenisu.

Metode

Problem ovog rada predstavlja sveobuhvatna analiza Evropskog prvenstva za mlade u stonom tenisu, koje je održano 2022. godine u Beogradu. U radu je korištena metoda opservacije, odnosno deskriptivna metoda, a podaci su preuzeti sa zvaničnog sajta Evropske stonoteniske unije i izveštaja Stručne službe takmičenja.

Rezultati

Stonoteniski savez Srbije organizovao je u periodu od 6.06. do 15.06.2022.godine Evropsko prvenstvo za mlade u stonom tenisu u „Štark Areni" u Beogradu. Realizacija ovog šampionata predstavljala je značajan nacionalni i gradski projekat, koji je Stonoteniski savez Srbije veoma uspešno sproveo u saradnji sa Ministarstvom omladine i sporta Republike Srbije, Sekretarijatom za sport i omladinu Grada Beograda, javnim preduzećima grada i sponzorima koji su dali nemerljivu podršku u realizaciji ovog događaja.

Zahvaljujući dosadašnjim iskustvima nacionalnog stonoteniskog saveza i njegovim organizacionim sposobnostima, Stonoteniska evropska federacija (ETTU), dodelila je organizaciju ovog turnira Savezu u cilju afirmacije stonog tenisa pre svega među mlađim uzrasnim kategorijama, što je predstavljalo viziju organizacije ovog događaja. Misija ovog sportskog događaja bila je doprinos da se stonoteniski sport podigne na viši nivo kako u takmičarskom tako i u organizacionom smislu, promocija vrednosti ovog sporta uz stvaranje dobrih takmičarskih rezultata nacionalne reprezentacije, sa krajnjim ciljem uticaja ovog događaja na afirmaciju stonog tenisa, podizanja imidža Srbije, grada Beograda, upoznavanje sveta sa tradicijom, kulturom, običajima i načinom života naše zemlje.

Polazeći od značaja sporta za zdravlje i kvalitet života, socijalnu integraciju, međunarodni prestiž i afirmaciju, nacionalni ponos, osećanje pripadnosti, moral i druge vrednosti od opšteg interesa, u želji da ne samo održi, već i otvori nove perspektive razvoja sporta, neophodno je da država učestvuje i stvaranju uslova i to dobro osmišljenim sistemom uređivanja stručnih, organizacionih i upravljačkih zadataka, kako na lokalnom, tako i na državnom nivou. Takođe, treba istaći da međunarodno postignuti sportski rezultat doprinosi međunarodnoj promociji države, odnosno vrhunski sportski uspeh u razvijenom svetu ima posebnu prizvodnu cenu i ekonomski efekat (Biočanin, Drašković, 2018). Naša zemlja ima dobar rejting u organizaciji velikih međunarodnih sportskih događaja već dugi niz godina, kao i ostvarivanja dobrih sportskih rezultata, realizacijom sportskih događaja pozitivno se ističe multikulturalnošću i ravnopravnošću i predstavlja sebe kao „dobrog domaćina i ambasadora" u celom svetu. Grad Beograd ima veliku prednost za organizovanje velikih sportskih manifestacija, što zbog iskustva, kao i dobre ponude velikog broja smeštajnih kapaciteta u hotelima, sportske infrastrukture kao što je „Štark Arena" koja omogućava apsolutne uslove za realizaciju događaja u svakoj vrsti sporta, dobrog položaja aerodroma što utiče na organizaciju transporta učesnika događaja i svega ostalog što je neophodno za uspešnost organizacije.

Međunarodne sportske federacije utvrđuju sve jače standarde za sprovođenje velikih sportskih događaja i manifestacija visokog ranga, što se pre svega odnosi na uslovnost sportskih objekata kako bi se obezbedio kvalitet takmičenja i komfor za učesnike i publiku. U slučaju organizacije „Evropskog prvenstva za mlade u stonom tenisu" za odabir smeštajnih objekata i

takmičarske infrastrukture nije bilo smetnji i dileme, obzirom na iskustva domaćina i uslova koji su se ponudili.

Za uspešnost sportskog događaja neohpodna je dobro osmišljenja organizaciona struktura (Tabela 1) koja sadrži nivoe komandovanja, raspone kontrole i zasebne jedinice, timove ili radne grupe koje se bave različitim sektorima rada, budući da organizaciona struktura sportskog događaja mora da obuhvati najširu lepezu poslova i zadataka u vezi sa samim događajem koji se organizuje (Tomić, 2007; Bižić, 2012; Kuzović, 2017). Takođe, važan segment je svakodnevna kontrola sportskog događaja, kako pre početka, tokom trajanja pa do završetka događaja, a faze su sledeće: planiranje i priprema organizacije, izvršenja poslova i zadataka, kontrole troškova, a sve sa ciljem da izazove pravovremenu reakciju menadžmenta da svaki uočeni nedostatak ili problem pravovremeno reši i otkloni.

Tabela 1. Koncept organizacije takmičenja

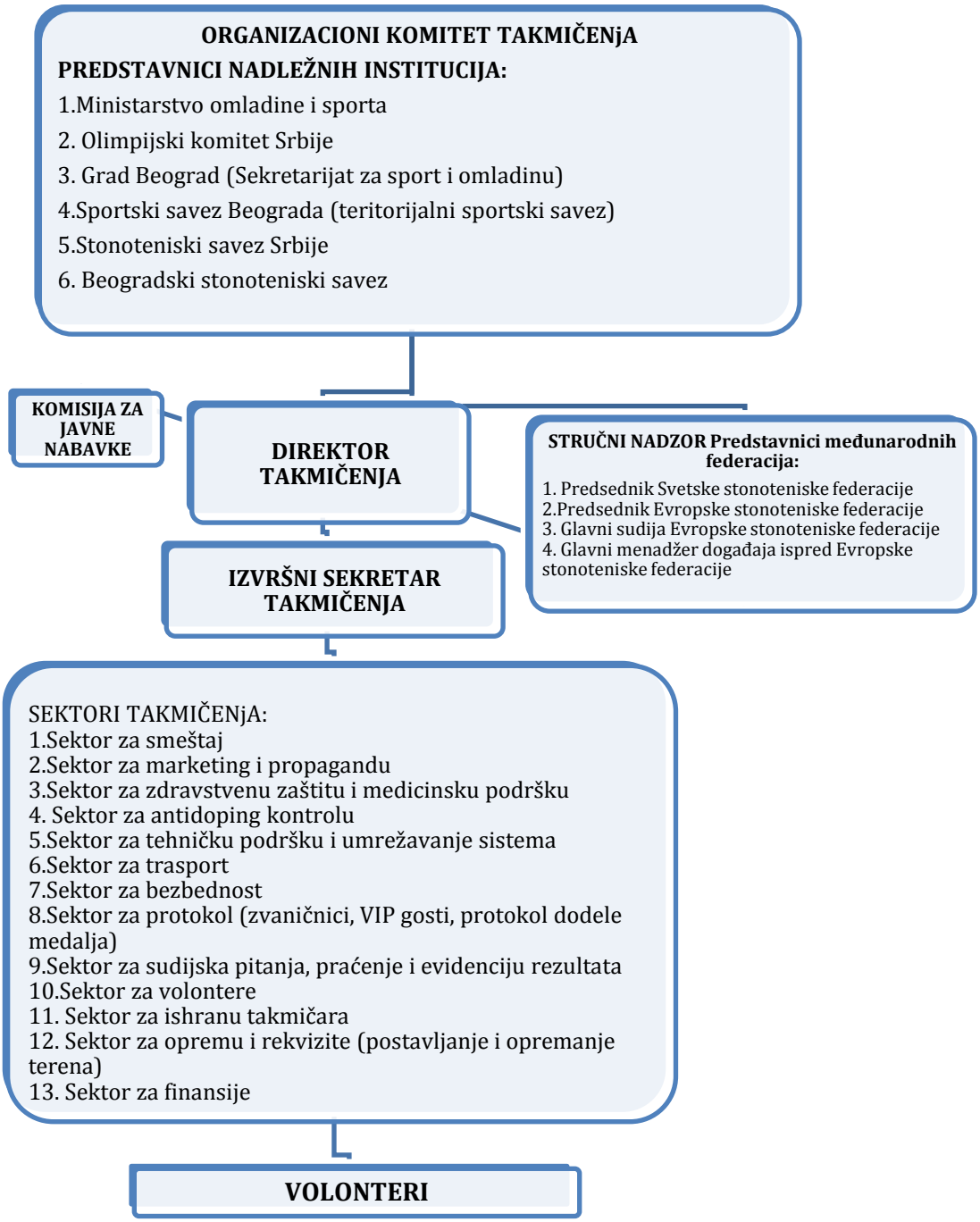


Tabela 2. Učesnici Evropskog prvenstva za mlade u stonom tenisu

Kategorija	**Ukupan broj**
Zemalja	41
Sportista	525
Delegata	120
Sudija	74
ETTU, ITTF članovi i VIP gosti	30
Publika (broj posetilaca za period od 10 dana)	Preko 1500 posetilaca dnevno
Broj hotela (ekipe i sudije)	4
Volonteri	52
Honorarno angažovana lica	52
Generalni sponzor	Dunav osiguranje doo
Sponzori u robi i uslugama	4
Medalje (podeljene po kategorijama)	180
Mediji (svakodnevni prenosi na tv ArenaSport)	50 sati emitovanja

Diskusija

Period od deset dana trajanja događaja pokazuje da je događaj okupio veliki broj učesnika, 525 sportista iz 41 zemlje (ETTU, 2022) , zahtevao je ogromne organizacione napore ali i kao krajnji rezultat stvorio pozitivnu sliku o domaćinu kao jedno od najbolje organizovanih velikih turnira u stonom tenisu i dalo uvod za ponovnu kandidaturu nacionalnog saveza za naredna velika sportska takmičenja. Obzirom da pandemija COVID 19 još uvek nije bila zvanično završena, organizator takmičenja sproveo je sve potrebne mere u cilju suzbijanja širenja pandemije, ali zvanično nije bio u obavezi od strane međunarodne federacije da sprovodi COVID protokole i delegacije nisu bile u obavezi da imaju negativne kovid testove. Osiguranje neposredne zdravstvene zaštite i rešavanja zdravstvenih problema učesnika tokom trajanja prvenstva, obezbeđeno je svakodnevnim prisustvom medicinskog osoblja opremljenog za pružanje neposredne medicinske pomoći od strane „Hitne pomoći grada Beograda“. Sprovođenje antidoping kontrole realizovao je član Evropske stonoteniske federacije (Stručna služba, 2022).

Evropsko prvenstvo za mlade u stonom tenisu održava se svake godine. Uzrasna kategorija koja je učestvovala u 2022.godini na prvenstvu u Beogradu bila je kadeti i juniori (muškarci i žene) i odnosi se na takmičare od 11 do 19 godina. Ovo takmičenje se sastojalo iz ekipnog pojedinačnog takmičenja, gde je nastupilo ukupno 82 ekipe iz 41 zemlje. Tokom trajanja prvenstva održavali su se prateći sadržaji koji između ostalog obuhvataju tehničke sastanke predstavnika delegacija zemalja učesnika, borda direktora i komisija svetske i evropske stonoteniske federacije, sudijske sastanke, evaluacije sudija, društvene aktivnosti učesnika i svakodnevnih sastanci organizatora po sektorima. Takmičarski program realizovan je u velikoj dvorani „Štark Arene“ gde su bila postavljena 24 takmičarska stola, a sala za zagrevanje i treninge bila je postavljena u „Maloj Areni“ koja se nalazi u okviru istog objekta sa ukupno 24 stola. Satnica treninga i mečeva utvrđena je svakog dana od strane glavnog menadžera Evropske stonoteniske federacije.

Ceremonija svečanog otvaranja prvenstva nije bila organizovana jer Evropska stonoteniska federacija nije ni zahtevala od organizatora protokol otvaranja, dok je ceremonija proglašenja

pobednika u ekipnoj i pojedinačnoj konkurenciji, realizovana je po završetku finalnih mečeva u skladu sa svim pravilima i procedurama koje karakteriše velike sportske događaje.

Slika 1. *Logo prvenstva*

Logo „Evropskog prvenstva za mlade u stonom tenisu“ predstavlja „vrapca“ koji je simbol grada Beograda kao sportistu stonotenisera u bojama države Srbije.

Organizacija i sprovođenje sportskog događaja posebnu pažnju mora obratiti na bezbednost sportskog događaja. Bezbednost sportskog događaja predstavlja veoma važan segment i pitanje koje obuhvata sve učesnike događaja, a prevashodno njegove organizatore i realizatore, i obuhvaćeno je vremenom pre, za vreme i nakon završetka takmičenja.

Sportsko takmičenje uvek predstavlja potencijalni rizik za njegove aktere (kako sportiste, tako i širi auditorijum koji ga neposredno prati). Zadatak menadžmenta događaja jeste da preduzme sve potrebne mere za predupređenje mogućih rizika. Ove aktivnosti ne zahtevaju od organizatora neposredno (direktno) delovanje na „izvor“ ugrožavanja, već traže od njega da omogući potencijalno ugroženim licima odgovoran odnos prema opasnostima koje prate sportsko takmičenje (Đurđević, 1997).

Bezbednost tokom realizacije sportskog događaja predstavlja važan segment za njegov menadžment sa veoma zahtevnim zadacima kao što je javna bezbednost sportskog objekta, bezbednost opreme i rekvizita koji se koriste tokom odvijanja događaja i medicinsko-zdravstvena bezbednost svih učesnika događaja koja obuhvata i antidoping kontrolu.

“Sport bez sportskih događaja ili sportskih takmičenja ne bi predstavljao toliko privlačnu pojavu koja je u savremenom svetu postala izraziti sociološki fenomen” (Nešić, 2006).

Zaključak

Organizovanje Evropskog prvenstva za mlade u stonom tenisu, težilo je podizanju kapaciteta ljudskih i materijalnih resursa stonoteniskog sporta, od nacionalnog saveza do sportskih klubova i organizacija u cilju organizovanja budućih velikih sportskih događaja u ovom sportu. Na taj način utiče se na jačanje pozicije nacionalnog saveza, zatim samog sporta, njegove pozicije na tržištu i stvaranje brenda koji će pomoći da taj sport jača i bude prepoznatljiv.

Svrha organizacije sportskog događaja kao što je Evropsko prvenstvo za mlade u stonom tenisu odnosi se na poboljšanje imidža organizatora, a to je Stonoteniski savez Srbije, razvoja sporta na svim nivoima od lokalnog do nacionalnog u svim uzrasnim kategorijama, jačanje reprezentacije, stvaranje boljih finansijskih uslova od finansiranja iz budžeta do približavanja sponzora.

Ovakav vid sportskih događaja utiču na razvoj i popularnost stonog tenisa u Republici Srbiji. Uključivanjem velikog broja fizičkih i pravnih lica (ugostiteljski objekti, hoteli, taksi službe i dr.), predstavnika javnih vlasti u pripremi i realizaciji događaja, kao i medijska pokrivenost događaja, sveukupno utiču na povećanje interesovanja za bavljenjem stonim tenisom. Takođe, predtakmičarskim promotivnim aktivnostima koje najavljuju ovakav vid događaja, prisutnost mlađih uzrasnih kategorija na takmičenju, pozitivno utiču na motivaciju dece i školske pupulacije za aktivnijim učešćem i upražnjavanjem stonog tenisa. U procesu pripreme velikog sportskog događaja ovog tipa, kapitalno se ulaže u sportsku i javnu infrastrukturu, nabavku potrebne opreme i rekvizita, čime se utiče na stvaranje mogućnosti organizovanja još većih i masovnijih takmičenja u stonom tenisu, kao i organizacije trenažnih kampova i međunarodnih sportskih događaja.

Društveni učinak organizovanja sportskog događaja predstavlja opšti interes, a efekti su sledeći:

1. Doprinosi poboljšanju statusa brenda grada Beograda u cilju prepoznatljivosti u međunarodnom okruženju (jačanje turističke ponude grada, njegove kulture i tradicije);
2. Jačanje ekonomskih kapaciteta grada u smislu infrastrukturnih investicija u cilju unapređenja sportske i smeštajne infrastrukture grada;
3. Povećanje prihoda od raznih vrsta poreza;
4. Uključivanje velikog broja volontera što utiče na bolju socijalizaciju i međuljudske odnose;
5. Porast nivoa zaposlenosti;
6. Negovanje i razvoj drugih vrednosti sporta u kom se događaj organizuje, sa težnjom da uvek u fokusu mora biti fer plej, sportska etika, ravnopravnost i poštovanje svih prava sportista.

Literatura

Bižić, V. (2012). Pojam sportskog liderstva i njegova primena u sportskim organizacijama u Srbiji. Socioekonomika, 1(2), 417-422.

Biočanin, R., Drašković, D. (2018). Investicije i ekonomičnost gradnje sportskih objekata za međunarodna sportska nadmetanja. U Međunarodna naučna konferencija „Mediji i ekonomija“ Zbornik radova 4 (203-217), Banja Luka. Doi: 10.7251/BLCMES1801203B.

Đurđević, N. (1997). Komentar Zakona o sportu, NIP Student, Beograd.

ETTU (2022). European Youth Championships Archive.

Ilić, R., Bošković, B., Radovanović, G. (2013). Upravljanje rizicima na sportskim događajima. Sport, nauka i praksa, Vol.3(43-58), UDK. 005.334:796.062.

Kasum, G. (2021). Rvanje – Srpska Olimpijska vrednost, Fizička kultura, 75(1), 44-45.

Nešić, M. (2006-07). Menadžment sportskih događaja. Novi Sad: TIMS.

Nešić, M. (2008). Bezbednost sportskog događaja i uloga klupskog menadžera. Poslovna ekonomija, 12 (2), 128-140.

Rađo, I., Sadžak, M. (2009). Globalno liderstvo. Sarajevo: Fakultet sporta i tjelesnog odgoja. Olimpijski komitet BIH.

Professional Service (2022). Report from the European Table Tennis Championship for youth. Belgrade: Internal document.

Tomić , M. (2007). Planiranje u sportu. Sportski menadžment (291-415). Beograd: Data status.

LIST OF REVIEWERS / SPISAK RECENZENATA

Prof. Ivana Milanović, PhD;

Prof. Saša Jakovljević, PhD;

Prof. Sanja Mandarić, PhD;

Prof. Milivoj Dopsaj, PhD;

Prof. Goran Nešić, PhD;

Assoc. prof. Vladimir Mrdaković, PhD;

Assoc. prof. Miloš Marković, PhD;

Assoc. prof. Branka Marković, PhD;

Assoc. prof. Ana Orlić, PhD;

Assis. prof. Olivera Knežević, PhD;

Assis. prof. Aleksandra Popović, PhD;

INDEX OF AUTHORS / INDEKS AUTORA

CIP - Каталогизација у публикацији - Народна библиотека Србије, Београд
796/799(082)
37.091.3::796(082)

MEĐUNARODNA naučna konferencija Development of Integrative Fitness - DIF konferencija (21 ; 2022 ; Београд)
Međunarodna konferencija Nauka o sportu, fizičkom vaspitanju i zdravlju : zbornik radova / XXI Međunarodna naučna konferencija Development of Integrative Fitness - DIF konferencija, 09. i 10. decembar 2022, Beograd, Srbija; urednici Ivana Milanović, Nikola Majstorović. - Belgrade : University, Faculty of Sport and Physical Education = Beograd : Univerzitet, Fakultet sporta i fizičkog vaspitanja, 2023

(Beograd : Birograf). - 363 str. : ilustr. ; 30 cm

Tiraž 50. - Str. 4-5: Foreword = Predgovor / Ivana Milanović. - Bibliografija uz svaki rad. - Registar.

ISBN 978-86-89773-82-8

а) Спорт -- Зборници б) Физичко васпитање -- Зборници

COBISS.SR-ID 115553545