UNIVERSITY OF BELGRADE
FACULTY OF SPORT AND PHYSICAL EDUCATION
REPUBLIC OF SERBIA, BELGRADE
DECEMBER 06 - 07th. 2024.

XXII INTERNATIONAL SCIENTIFIC CONFERENCE
"PHYSICAL ACTIVITY AND HEALTH - PLEDGE FOR LIFE"

PROCEEDING BOOK

Editor's
MILINKO **DABOVIĆ**
IVA **BUBANJA**
VLADIMIR **MILETIĆ**

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2024.

Impressum

Publisher
University of Belgrade - Faculty of sport and physical education

For the Publisher
Prof. Sanja MANDARIĆ, PhD, Dean

Editors
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Design
Pro OUTDOOR Team, Belgrade

Printed by
Black and White copy, Belgrade

Edition
30 copies

Organiser
University of Belgrade - Faculty of sport and physical education

Webmaster
Nenad PELEMIŠ

ISBN
978-86-89773-93-4

Web site
www.fsfvconference.rs

e-mail
conference@fsfvconference.rs

CIP - Каталогизација у публикацији
Народна библиотека Србије, Београд

796/799(082)
796:613(082)
613.71/.74(082)

INTERNATIONAL Scientific Conference "Physical Activity and Health - Pledge for Life" (22 ; 2024 ; Beograd)
Proceeding book / XXII International Scientific Conference "Physical Activity and Health - Pledge for Life", Republic of Serbia, Belgrade, December 06 - 07th. 2024. ; editors Milinko Dabović, Iva Bubanja, Vladimir Miletić ; [organiser] University of Belgrade, Faculty of sport and physical education. - Belgrade : University, Faculty of sport and physical education, 2025 (Belgrade : Black and White copy). - 220 str. : ilustr. ; 29 cm

Radovi na srp. i engl jeziku. - Tiraž 30. - Bibliografija uz svaki rad. - Registri.

ISBN 978-86-89773-93-4

a) Физичка култура -- Зборници b) Спорт -- Здравље -- Зборници v) Рекреација -- Здравље -- Зборници

COBISS.SR-ID 178759433

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UDK 796.41.012.1-053.5

Effects of the acquiring basic acrobatic gymnastics elements on the motor abilities of primary school children

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Introduction

Today, a child is seen as a whole human being with different needs and possibilities. Given this, child development is a complex phenomenon with several interrelated dimensions which is developing parallel and affects each other (physical, emotional, cognitive and social development). It is important to point out that although all processes of growth and development take place in a certain order for each individual period of life, every child is an individual and there is always the possibility of deviating from the developmental group where it belongs according to its age (Matkovic, 2022). According to Neljak (2009), development of motor abilities begins immediately after birth. Around the age of ten, this process slowly ends, which is why the children are capable to easily learn various movements, but cannot perform them in a highly coordinated way. Some motor abilities are less amenable to training, that is, they are to a greater extent innate, for example, speed, coordination and explosive power, compared to repetitive strength and flexibility. Depending on whether it is more or less innate motor ability, the development of these is possible during whole life, but those abilities that are more innate should be developed earlier because the time predestined for their development ends earlier (Prskalo & Sporiš, 2016). In physical education classes, almost every school contains basic equipment that can be used in basic gymnastics, such as a Swedish box, Swedish ladders, balance beam and few mats, which exactly have been used in training program for this research. Using gymnastic equipment, children realize movements and perform exercises that are unavailable for them in everyday life. It is almost impossible to find any other sports discipline with such variability of movement as in gymnastics (Bala, 1993). In this paper, we focused on developing and assessing two motor abilities that are the most important in basic sports such as gymnastics – coordination, defined as the ability of performing complex movements, solving motor tasks and speed of the adoption of new ones (Miletić, 2005) and flexibility, known as the ability to perform the maximum amplitude of movement in a particular joint (Alter, 2004). The aim of this study was to determine the effects of a four – week gymnastics training (Table 1) on the changes in specific motor abilities in children within the school sports society.

Methods

The sample consisted of 74 fifth and sixth grade pupils attending the Saint Anne's primary school from Osijek. Data were collected during 2023./24. school year while the pupils participated in extra curricular activities within the school sports society. After the initial measurement, gymnastics program lasted four weeks and then the final measurement started. The basic descriptive statistical parameters were calculated for all variables. Normality of distribution was determined by the Kolmogorov-Smirnov test. In order to determine the statistical significance of the difference between the initial and final measurement Student's t-test for paired samples was applied. The obtained test results were analyzed using the statistical package Statistica for Windows, version 14.0. For the coordination and flexibility assessment, the following tests were used: forward bend on a bench (FBB), forward bend sitting (FBS), rolling the ball with non-dominant hand (RONDH) and polygon with a turn test (PTT).

Forward bend on a bench (FBB)

The forward bend on a bench (FBB) test evaluates the flexibility of the lower back and hips, while the knees are stretched. To perform the test, a 40-cm-high bench is needed, on which a board with an 80-cm-long centimeter strip is attached to the front. The fortieth centimeter of the strip is at the level of the upper surface of the bench. In the starting position the student is standing barefoot on a bench with his feet together. Legs are fully extended and the tips of the feet are placed to the edge of the bench. The student stretches out his arms and places the palm of the right hand on the back of the left one so the middle fingers overlap. He performs the maximum forward bend by slow descent. The task is completed when he touches the maximum possible value on the centimeter tape with his fingertips and maintains the position until the result is read (Radas et al., 2023).

Forward bend sitting (FBS)

The forward bend sitting (FBS) test also evaluates the flexibility of the lower back and hips, while the knees are stretched. The subject is sitting on the floor with her back leaning against the wall. The legs are maximally extended. The task is to perform the maximum possible forward bend and with her fingertips touch the highest number on the centimeter tape placed on the floor between the legs, which are hip-width apart. The task is performed three times in a row and the result is the average value reached (Radas et al., 2023).

Rolling the ball with non-dominant hand (RBND)

The purpose of this test is to assess upper extremity coordination, which is defined as the ability to manipulate objects in a space with obstacles. Three parallel lines are marked on the ground, three meters apart. There is one stand placed exactly in the middle of each line. The student starts on the first line, facing the direction of movement and lightly leans the ball with non – dominant hand. On the signal, student rolls the ball on the ground changing the direction between and around the stands. The task is performed in four lengths and completed after the examinee crosses the finish line. It is performed three times with 30 seconds breaks and the result is the average value reached (Tomljenovic, 2018).

Polygon with a turn test (PTT)

The test assess the student`s coordination. Four lines are marked on the floor (start, finish and two auxiliary lines). The lines are 3 meters apart. A frame of a Swedish box is placed on the second auxiliary line. The student starts in a four-legged position, facing the direction of movement with his palms on the starting line. At the examiner's signal he moves as fast as he can to the first auxiliary line. After crossing the auxiliary

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line, he turns 180° and continues to move backwards. Then he passes through the frame of the Swedish box. The task is completed when he crosses the finish line with all parts of his body. It is performed 3 times and the arithmetic mean of three repetitions is used for further statistical processing (Metikos et al., 1989).

Table 1. Gymnastics training program for children during four weeks

Week	Duration	Elements
1st	2x45 minutes	Forward and backward rolls Handstand on the floor Handstand on the floor – forward roll Cartwheel on dominant and non-dominant side Flexibility exercises – stretching, splits on the floor
2nd	2x45 minutes	Combined forward and backward rolls Cartwheel on dominant and non-dominant side One handstand – cartwheel – dominant side Flexibility exercises – stretching, splits on the floor
3rd	2x45 minutes	Rolling forwards and backwards (connected in series 3x) Cartwheels (connected in series 3x) Flight forward rolling Flexibility exercises – stretching, splits on the floor
4th	2x45 minutes	Rolling forwards and backwards (connected in series 3x) Cartwheels (connected in series 3x) Flight forward rolling Somersault forwards Flexibility exercises – stretching, splits on the floor

Results

The obtained results show that out of 74 subjects, the most flexible achieved a result of 61,10 centimeters in the final measurement of the FBB test. The average score is only 35,59. In the FBS test, which also assesses flexibility, the average result is 58,61 centimeters, while the best student reached 100,00. In RONDH test, the best coordination had the student finishing the test in 9,00 seconds, which is almost three times better than the slowest student, whose result was 34,43 seconds (Table 2). However, the children have significantly improved their results in both motor abilities. The difference between the initial and final measurements shows statistical significance ($p<0.05$). Children also improved their results in the FBB ($p=0,000241$) and FBS ($p=0,000008$) tests. Also, they developed their coordination, as shown by the test results RONDH ($p=0,000000$) and PTT ($p=0,000001$) (Table 3).

Table 2. Descriptive analysis of variables

Variables	Descriptive Statistics				
	Valid N	Mean	Min	Max	SD
FBB1	74	35,44	17,70	61,00	8,40
FBB2	74	35,59	18,00	61,10	8,41
FBS1	74	58,53	29,90	100,00	15,01
FBS2	74	58,61	21,00	99,90	15,20
RONDH1	74	19,30	9,20	34,43	5,85
RONDH2	74	18,95	9,00	34,00	5,83
PTT1	74	14,81	7,90	28,70	5,67
PTT2	74	14,45	7,45	28,08	5,56

Table 3. Student's t-test for paired samples

Variables	p
FBB	0,000241
FBS	0,000008
RONDH	0,000000
PTT	0,000001

Discussion

Until they start school, children develop coordination through exploring, playing and having fun, while later, coordination exercises require a higher level of concentration and physical fitness, so we can affect in two different ways: by learning new structures of the movements or by performing already familiar structures of the movements, but in different conditions (Moznik & Krističević, 2011). For children of this age, many authors recommend more difficult elements, since this is a period of life when there is a delay and even a decrease in the level of coordination (Trost-Bobic et al., 2021, Moznik

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& Krističević, 2011). However, that statement is acceptable only for artistic gymnasts, so in this paper we took a step back and practiced the basic acrobatic elements with the children in primary school. For them, acrobatic elements were new movement structures and also very hard to accomplish correctly. It was the correct decision, because 26 subjects did not master the elements at all, which is 34,67% of the sample. Thirteen children managed to cope only with tasks which included forward and backward rollings, which is 17,33%. Out of seventy-five children, three were already engaged in artistic and rhythmic gymnastics, so they had above-average results in all tests. At the end of each gymnastics training, there was stretching program that really increased the final measurement results in flexibility tests (FBB and FBS). The stretching tasks were the performance of splits on the ground in the frontal and lateral plane on both legs. If the student was flexible enough to touch the ground with the pubic bone, the task was modified and the front leg placed on a slight elevated surface. Described positions are maintained for 20-30 seconds. One of the tasks was the performance of the gymnastics bridge. If the student wasn't able to do it, he is allowed assistance or a «small» bridge position in which the shoulders are placed on the ground. More flexible students with the highest scores in initial measurements were able to walk in the bridge position. All these exercises resulted in a significant increase in flexibility. Let's take into account that only three students out of the entire sample are involved in gymnastics, this is a big improvement and just another proof of how much gymnastics can affect children's motor abilities in a short time, whether they are involved in sports or not. It is important that all elements are performed in strictly controlled conditions with quality equipment and supervision of qualified and educated teacher, because in physical education classes, despite learning new motor knowledge and developing motor abilities, safety is still the most important.

Conclusion

Gymnastics plays an important role in the educational system due to the large number of movements that are important for the development of motor abilities. Implementing gymnastics in physical education classes, children who are not included in sports have the opportunity to realize movements that they do not encounter every day, and athletes to perform exercises that are not used in their sport. In future research, it would be good to compare the development of motor abilities after practicing rhythmic gymnastics training program, because in addition to music and dance structures, which also develop coordination, the aesthetic component also comes to light and encourages students' creativity.

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The influence of body composition on motor abilities in young school-aged children

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Introduction

Attitudes and habits toward physical activity are formed during childhood and often persist into adulthood (Larsen et al., 2017). Engaging in regular physical activity during childhood provides numerous benefits, including maintaining overall health, preventing chronic diseases, and enhancing mental and physical well-being (Bencke et al., 2002; Pedersen & Saltin, 2006). Additionally, there is growing evidence suggesting that an increasing number of children lead physically inactive lifestyles (Kavey et al., 2003; Morrison et al., 2012). Physical inactivity, recognized as a multifaceted phenomenon influenced by various factors, is widely regarded as one of the primary contributors to the development of chronic diseases (Eisenmann, 2006; McAllister et al., 2009). However, a key factor influencing children's physical activity levels is their motor abilities (Wrotniak, Epstein, Dorn, Jones, & Kondilis, 2006). Developing a solid foundation of fundamental motor abilities during early and middle childhood is particularly important for promoting participation in physical activities, especially in recreational sports settings (Malina, 2001; Okely, Booth, & Patterson, 2001). Encouraging physical activity through structured programs and early education can play a pivotal role in fostering healthier habits and improving motor abilities in children, potentially mitigating the negative effects of physical inactivity (Goldfield, Harvey, Grattan, & Adamo, 2012). On the other hand, monitoring body composition and anthropometric characteristics is essential, as these serve as a foundation for improving motor abilities (Mijalković, Antonijević, Lilić, Stanković, & Stanković, 2024). Insufficient motor ability development and low physical activity levels have been linked to higher body fat percentages and elevated body mass indices in children (Deforche et al., 2003; Graf et al., 2004).

Several studies have explored the influence of body composition on motor abilities in younger school-aged children, identifying a significant impact of these variables on each other (Ceylan, Saygin, & Irez, 2014; Esmaeilzadeh & Ebadollahzadeh 2012; Kakebeeke et al., 2017; Milanese, Sandri, Cavedon, & Zancanaro, 2020; Webster, Sur, Stevens, & Robinson, 2021). Studies suggest that body composition plays a key role in shaping motor abilities in children (Gökmen et al., 2019; Goodway, Famelia, & Bakhtiar, 2014). Children with higher body mass index values and greater body fat percentages often exhibit lower levels of motor performance, characterized by reduced speed, strength, agility, and coordination, compared to their peers with optimal body composition (Morrison et al., 2012). Additionally, Lepes et al., (2014) observed that increased body mass and body fat percentages have a negative impact on motor abilities. Also, Esmaeilzadeh and Ebadollahzadeh (2012) reported a negative relation between body mass and repetitive strength, as evidenced by the number of sit-ups completed in one minute. Excessive body fat, moreover, can restrict efficient movement and hinder the development of motor skills in younger school-aged children (Webster et al., 2021). These findings emphasize the importance of early intervention in promoting healthy body composition and motor ability development to support long-term physical and cognitive growth in children.

Physical inactivity is becoming a growing public health risk (Kohl et al., 2012). Physical inactivity is increasingly recognized as a major contributor to numerous health issues, including childhood obesity, which has become a significant public health concern worldwide (Sallis & Glanz 2006). As a result, over a 42-year study period, the global prevalence of obesity increased by 4.9% for girls and 6.9% for boys, with no indication that most countries will reach a plateau anytime soon (Cvetković et al., 2018). Human characteristics, abilities, and physique undergo continuous changes in a relatively stable manner, in line with the established principles of physical development (Ellis, Figueredo, Brumbach, & Schlomer, 2009). Understanding the influence of body composition on motor abilities is crucial for developing effective intervention strategies aimed at improving physical fitness and reducing obesity-related risks in children. Therefore, the aim of this study was to determine the influence of body composition on motor abilities in young school-aged children.

Methods

Sample of participants

Eighty-eight young school-aged participants (age: 11.32 ± 0.65; body height: 146.24 ± 7.43cm; body mass: 41.39 ± 11.32 kg) took part in this cross-sectional study. The students attended the fourth grade of elementary school in Niš. All the children were healthy during the testing. The parents or guardians of the participants consented to their child's involvement in the study, as the participants were minors. The study adhered to the ethical guidelines set forth by the Declaration of Helsinki.

Testing procedure

The assessments of the participants were conducted at the sports center of the elementary school in Niš. Initially, the participants' anthropometric characteristics were measured. They wore minimal clothing and were barefoot during the assessments. To measure their height, the Martin GMP 101 anthropometer, with an accuracy of 0.01 cm, was used. The validity and reliability of this tool were previously established by McKenna, Straker, & Smith (2013). For evaluating body mass index, body mass, body fat and muscle mass percentages, the Omron BF511 bioelectrical impedance device (accuracy: 0.1 kg) was utilized. The validity and reliability of this instrument were confirmed by Dehghan & Merchant (2008).

The participants followed a 15-minute warm-up routine, which consisted of both static and dynamic stretching exercises, along with some light jogging. The warm-up protocol was followed by a motor abilities assessment. The battery of tests used to assess motor abilities included the following: 20-meter sprint for speed assessment, the arrowhead agility test, standing long jump for explosive lower limb power assessment, and the Yo-Yo endurance test. Speed was measured through sprint of 20 meters. Witty photocell gates (Microgate, Italy), accurate to 0.01 seconds, were used to record the times. The validity and reliability of the test weas confirmed by Rumpf, Cronin, Oliver, & Hughes (2011). The photocells were positioned at the starting line and 20

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meters (finish line). Participants were instructed to complete the distance as quickly as possible, starting from a standing position and running upon the signal from the measurer.

Arrowhead Agility Test was performed from a standing sprint position with one leg forward at the starting line, the participants were instructed to sprint as quickly as possible in an arrow-shaped pattern, first running to the right and then to the left. The arrow shape was marked with cones positioned at 5m and 10m in a straight line from the starting point, with an additional cone 5m to the side of the 5m cone. If the participants touched the cones or deviated from the intended path, they were asked to repeat the test. Time was recorded using photocells and an electronic timing system at the starting line, and the combined time for both runs was used as the final result for analysis (Bangsbo & Mohr 2012).

Explosive power of lower limb was assessed using the standing long jump. Participants began behind the starting line, in a standing position with their knees slightly bent. Upon the measurer's signal, they were instructed to jump as far as possible, utilizing the momentum from their arm swing. After each jump, the measurer measured the distance with a tape measure. The best result from three attempts was recorded. The standing long jump has been previously validated and found reliable by Ab Rahman, Kamal, Noor, & Geok (2021).

Additionally, endurance was evaluated using the Yo-Yo Intermittent Recovery Test Level 1 (Yo-Yo IR1). The cones were initially placed 16 meters apart, with each participant assigned their own cone to follow. Participants were instructed by the measurer to run to the opposite cone and back, based on the signal given. The test was considered complete only when the participant had covered a total distance of 32 meters (to the opposite cone and back). Participants were allowed to stop the test at any time, and they could afford to be late twice before being disqualified. The reliability and validity of the Yo-Yo IR1 have been established in previous research by Ahler, Bendiksen, Krustrup, & Wedderkopp (2012).

Data analysis

IBM SPSS Statistics 20 was used for data analysis in this study. In addition to descriptive statistics, the Kolmogorov-Smirnov test was used to assess the normality of the distribution. Furthermore, a linear regression analysis in SPSS examined how body composition affects motor abilities in young school-aged children.

Results

Descriptive statistics, the mean ± standard deviation and 95% CI for each outcome measure is presented (Table 1) .

Table 1. Descriptive statistics of the variables

Variables	Mean	SD	95% CI	
			Lower	Upper
Age	11.32	0.65	11.18	11.46
Body height	146.24	7.43	144.66	147.81
Body mass	41.39	11.32	38.99	43.79
Body mass index	18.87	3.37	18.15	19.58
Body fat percentage	20.75	7.36	19.19	22.31
Muscle mass percentage	34.25	2.52	33.72	34.79
20-meter sprint	4.22	0.31	4.15	4.28
Arrowhead	11.30	0.85	11.12	11.48
Standing long jump	140.99	20.61	136.62	145.35
YoYo (m)	398.18	221.69	351.21	445.15

Pearson correlation coefficients between body composition parameters and all motor skills outcomes, as well as regression analysis are shown in Table 2..

Table 2. Regression analysis between body composition parameters and motor abilities outcomes in young school-children aged

Variable	20-meter sprint		Arrowhead		Standing long jump		YoYo (m)	
	r	b	r	b	r	b	r	b
Body mass index	0.535**	0.303	0.374**	0.550	-0.373**	-0.127	-0.278**	.0.242
Body fat percentage	0.564**	0.122	0.330**	-0.360	-0.428**	-0.114	-0.267*	0.005
Muscle mass percentage	-0.498**	-0.308	-0.379**	-0.360	0.473**	0.358	0.197	0.101
R2	0.620		0.472		0.516		0.293	
p	0.000		0.000		0.000		0.056	

Legend: r - Pearson correlation coefficient p - level of significance; b – regression coefficients; ** Correlation is significant at the 0.01 level; * Correlation is significant at the 0.05 level; R2 - a statistical measure of how well the regression line approximates the actual data.

Significant regressions were found between sprint 20m and body composition parameters ($p \leq 0.01$; $R2 = 0.620$), between Arrowhead and body composition parameters ($p \leq 0.01$; $R2 = 0.472$) and between standing long jump and body composition parameters ($p \leq 0.01$; $R2 = 0.516$). The largest pearson corellation were between sprint 20m and body fat percentige ($r = 0.564$; $p \leq 0.01$) and sprint 20m and BMI ($r = 0.535$; $p \leq 0.01$).

Discussion

The aim of this study was to determine the influence of body composition on motor abilities in young school-aged children. The results of the study indicated that body composition has an influence on motor abilities in young school-aged children. According to our results, body composition had the greatest influence on the 20-meter sprint results, Arrowhead agility test and on explosive lower limb power in the standing long jump test. Among the components, muscle mass percentage has the strongest influence. On the other hand, body composition parameters did not have a significant influence on the results of the endurance test. Higher values of body composition parameters negatively influenced motor abilities, while lower values had a positive impact on motor performance. These findings confirm the significant role of

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body composition, particularly muscle mass, in determining motor performance in specific tasks.

The findings of our study suggest that there was a statistically significant influence of body composition on speed in young school-aged children. Specifically, children with higher body mass, body mass index and fat percentage ran the 20-meter sprint more slowly compared to children with lower values of these body composition parameters. Excess body fat, combined with a sedentary lifestyle and reduced physical activity levels among children and youth today, clearly indicates that a higher body fat percentage adversely influences the speed of young school-aged children (Lepes et al., 2014). The findings of this study indicated that body composition significantly influenced performance in the Arrowhead agility test among 11-year-old children. Specifically, higher body mass, body mass index and fat percentage had positive influence on test performance. Children with a more favorable body composition demonstrated superior ability to change direction quickly, which is a crucial component of agility. This aligns with previous findings emphasizing the importance of body composition in sports performance, particularly in tasks requiring rapid acceleration, deceleration, and changes of direction (Mendoza-Muñoz et al., 2020; Stanković, Đorđević, Zelenović, & Božić, 2020). Given the relevance of agility in various sports and daily activities, these findings highlight the need for targeted training and nutritional strategies to optimize body composition and enhance agility in children of this age group.

Additionally, the results of our research showed that body composition influenced the explosive power of the lower limbs. Participants with a higher percentage of muscle mass demonstrated greater explosive power in the standing long jump compared to those with a lower muscle mass percentage. Hraski and Horvat (2019) and Čech & Ružbarský (2020) demonstrated a statistically significant negative influence of body mass on the explosive power of the lower limbs in young school-aged children. These findings suggested that muscle mass played a pivotal role in actions requiring explosive power, while excess body mass might act as a limiting factor. This highlights the importance of optimizing body composition to enhance performance in activities that rely on lower limb explosive power, such as jumping and sprinting. It is recommended to focus on maintaining optimal levels of body composition parameters in children to achieve better results in the explosive power of the lower limbs.

The study did not establish a statistically significant influence of body composition on endurance in participants aged 11 years. The Yo-Yo Intermittent Recovery Test Level 1 (Yo-Yo IR1) was used to assess this ability, serving as a standardized method for measuring recovery capacity and endurance during interval physical activities. The results showed that participants' body composition did not have a significant influence on the test outcomes. One of the main reasons for this lack of influence could be attributed to the developmental characteristics of children at this age. Specifically, endurance as a motor ability is not yet fully developed or dominant in 11-year-old children (Stratton et al., 2007). At this stage, children undergo a period of intense growth and development, during which motor abilities such as speed, coordination, and explosive strength take precedence (Bompa & Carrera 2015). Endurance, as a complex motor ability, requires a higher level of physiological maturity, including adaptations in the cardiovascular and respiratory systems, which gradually develop during puberty (Boisseau & Delamarche 2000; Elferink-Gemser & Hettinga 2017; Seidel, Carius, Kenville, & Ragert, 2017). These results suggest that achieving significant improvements in endurance requires more time and a more specific approach, incorporating training phases focused on the development of aerobic capacity while considering the physiological capabilities of children.

Conclusion

This study identified a statistically significant influence of body composition on the motor abilities of younger school-aged children. Gaining a better understanding of these connections can aid in the development of training programs and strategies aimed at enhancing motor abilities and the improvment of body mass, body mass index, fat and muscle percentage in this group. By addressing these factors, it may be possible to promote healthier physical development and improve overall well-being in children.

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UDK 796.012.1-053.5

BMI Profiles and screen time habits in 1st and 2nd grade school-aged children

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Introduction

Childhood obesity has developed into a global epidemic and is a significant public health concern, according to the World Health Organization (WHO, 2014). Reducing sedentary behavior and boosting physical activity are crucial for supporting healthy growth and establishing lifelong habits. With soaring rates of obesity, chronic disease, and mental health disorders, cities around the world are grappling with the consequences of urban living on public health (Stefanovska Cvetkovska, 2024).

In today's world, digital screens are an integral part of children's daily routines, shaping how they learn, play, and interact with their environment. By 2018, nearly all teenagers (95%) had access to smartphones, and almost half reported being online constantly (Anderson & Jiang, 2018). This growing reliance on digital devices highlights the need to understand their impact on health, behavior, and education. The American Academy of Pediatrics (AAP) advises that screen time for kindergarten and school-aged children should be restricted to a maximum of 2 hours per day to help prevent obesity (Bar-On et al., 2001, Strasburger et al., 2013). Several studies have shown a positive link between TV watching and obesity, measured by body mass index (BMI) or body fat (DeMattia et al., 2007). One study found that school-age children who watched 2 hours of TV per day were 1.58 times more likely to be overweight compared to those who did not watch TV (Sisson et al., 2011). However, other research has shown weak or no connections between TV viewing and obesity.

This study explores overweight, obesity, and screen time among Macedonian schoolchildren, providing insights into early lifestyle behaviors and health impacts. The aim of this study is to examine the prevalence of overweight, obesity, and screen time among Macedonian school-aged children in the 1st and 2nd grades.

Overweight and obesity

Childhood obesity remains a significant public health challenge, particularly during the 1st and 2nd grades, a critical period when health habits are established (World Health Organization [WHO], 2016). Several factors contribute to the development of obesity, including poor dietary habits, insufficient physical activity, excessive screen time, and genetic predispositions (WHO, 2020).

In 2022, approximately 37 million children worldwide were classified as overweight. This condition has been particularly increasing in low- and middle-income countries.For children and adolescents aged 5–19, the number of overweight individuals reached 390 million in 2022. The prevalence of overweight has significantly risen, from 8% in 1990 to 20% in 2022. In 2022, the overweight rates were slightly higher in boys (21%) compared to girls (19%) (WHO,2023).

Effective prevention strategies focus on promoting physical activity and reducing screen time, both of which have been shown to play a key role in preventing childhood obesity (Telford et al., 2014). Figure 1 illustrates the trends in obesity prevalence among children in Macedonia over a three-year period, from 2018 to 2020. The data highlight fluctuations in the percentage of children classified as obese, providing insights into public health trends and the effectiveness of interventions during this period. Among all children surveyed, around 30% fall into overweight or obese categories The survey was conducted among 7-year-old children (WHO, 2022).

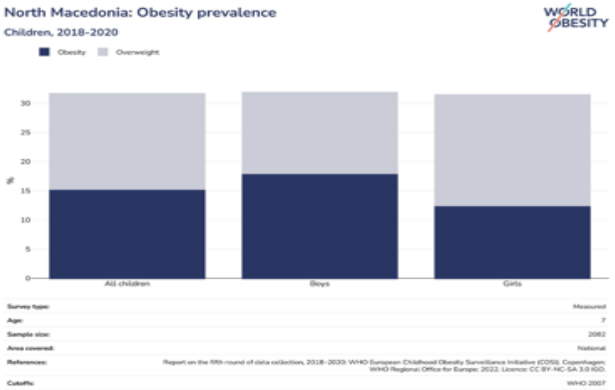

Figure 1. Childhood Obesity Prevalence in Macedonia (2018-2020) (World Health Organization, 2022)

Impact of screen time on health

Screen time has been associated with negative health and social outcomes, including inadequate sleep, increased rates of obesity, and decreased social integration. (Cha et al., 2018, Kenney & Gortmaker, 2017, Arundell et al., 2017). Media usage has several implications for a child's cognitive, language, physical, and socio-emotional development. Research indicates that media use may have a detrimental impact on sleep (Bruni et al., 2015). Studies have found that individuals with higher social media usage or those who keep mobile devices in their bedrooms are more likely to experience sleep disturbances (Buxton et al., 2015, Hale et al., 2018).

Additionally, exposure to light-especially blue light-and screen activity before bedtime can interfere with melatonin production, leading to delayed or disrupted sleep patterns (Wahnschaffe et al., 2013). Media usage close to or during bedtime has also been linked to disrupted sleep and poorer academic performance (Borghese et al., 2015).

Recommendations for screen media use in children, as outlined in Table 1, vary by age. According to the World Health Organization (WHO, 2019), screen time is not recommended for children under 1 year old. For children aged 2 to 4 years, it is recommended to limit screen time to no more than 1 hour per day, while those aged 5 to 14 years should limit it to no more than 2 hours daily. Adolescents aged 15 to 17 years should limit recreational screen time to less than 2 hours per day.

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The American Academy of Pediatrics (AAP, 2016) recommends avoiding digital media use for children under 1.5 to 2 years, except for video chatting. If introduced at 1.5 to 2 years, high-quality programming with parental co-viewing is advised. For children aged 2 to 5 years, less than 1 hour of high-quality programming with parental co-viewing is recommended. For all age groups, parents should set consistent limits on daily screen time and types of media used.

Table 1. Recommendations for screen media use in the pediatric population by age (WHO,2019), (Council on Communications and Media, 2016)

Age (years)	Screen Media Use (WHO, 2019)	Age (years)	Screen Media Use (AAP)
< 1 year	Screen time is not recommended	< 1.5-2 years	Avoid digital media use (except video chatting)
2-4 years	No more than 1 hour per day	1.5-2 years	If screen media is introduced to the child, choose high-quality programming and co-viewing with parent is recommended
5-14 years	No more than 2 hour per day	2-5 years	<1 hour of high-quality programming, co-viewing with parent recommended
15-17 years	Limit recreational screen time to less than 2 hours per day	All ages	Parents should set consistent limits on hours per day and types of media used

Methods

A total of 113 children participated in the study, comprising 67 boys and 46 girls. The children were from the 1st (61 children) and 2nd (52 children) grades. The research was conducted at Elementary School „Mirche Acev" in Skopje, North Macedonia.

Measurements: Weight and height were measured using the OMRON BF 511 body composition monitor.

Body Mass Index (BMI): BMI was calculated based on the World Health Organization (WHO, 2007) growth standards. In terms of body composition, the children were categorized into three groups: Normal weight, Overweight and Obesity.

Screen time: Parents completed the Children's Leisure Activities Study Survey (CLASS), developed by Telford et al. (2004), to assess children's screen time. Parents responded to questions regarding sedentary behaviors in children, specifically the amount of time (in hours per day) spent in front of screens (TV, computer, phones, tablets, video games, etc.) during weekdays and weekends. Screen time was categorized into two groups: ≤ 2 hours per day (TV, PC, mobile devices, tablets, etc.) and > 2 hours per day (TV, PC, mobile devices, tablets, etc.). According to current guidelines (Liu et al., 2016; Tremblay et al., 2011), children who reported 2 hours or less of screen time per day were considered to have met the recommendations, while those who spent more than 2 hours per day were classified as not meeting the recommendations.

The data were processed with the statistical package SPSS for Windows Version 25.0. Descriptive statistical methods were used to analyze the data, including measures of central tendency (mean), variability (std. deviation), range (minimum and maximum), and frequency distributions with percentages. These methods provided a clear overview of the dataset. The data were analyzed using the nonparametric Mann-Whitney U test to assess differences between groups. This test was chosen due to the non-normal distribution of the data. The Mann-Whitney U test was used to compare the time spent on screens between grade levels, as well as to evaluate differences in body mass index (BMI) across these groups. This approach allowed for a comprehensive assessment of the relationships between screen time, grade level, and BMI.

Results

A total of 113 children participated in the study, comprising 67 boys (59.3%) and 46 girls (40.7%). The participants were divided into two grade levels: 61 children (54%) from the 1st grade and 52 children (46%) from the 2nd grade. The study was conducted at Elementary School "Mirche Acev" in Skopje, North Macedonia.

Table 2 provides descriptive statistics for the sample, including age, gender, height, weight, BMI, and grade distribution. The average height was 122.15 cm (SD = 5.83), weight was 24.20 kg (SD = 4.78), and BMI was 16.10 (SD = 2.07). Gender distribution showed 59.3% boys (n = 67) and 40.7% girls (n = 46). Regarding grade levels, 54% of participants were in the 1st grade (n = 61), while 46% were in the 2nd grade (n = 52).BMI categories indicate that 81.4% of participants were within the normal weight range (n = 92), 15% were classified as overweight (n = 17), and 3.5% as obese (n = 4). These findings highlight the prevalence of healthy weight in the sample, though the presence of overweight and obesity warrants attention.

Table 2. Descriptive Statistics for Age, Gender, Height, Weight, and BMI of Participants

	N	Minimum	Maximum	Mean	Std. Dev.
Age	113	5,00	8,00	6,3363	,59177
Height	113	108,60	137,50	122,1451	5,83499
Weight	113	16,30	39,80	24,2044	4,78846
BMI	113	12,85	24,29	16,0953	2,06784
Valid N (listwise)	113				

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Gender	**Frequency**	**Percent**	**Valid Percent**	**Cumilative Percent**	
Boys	67	59,3	59.3	59,3	
Valid Girls	46	40,7	40,7	100,0	
Total	113	100,0	100,0		
Grades	**Frequency**	**Pecent**	**Valid Percent**	**Cumilative Percent**	
1st	61	54.0	54.0	54.0	
Valid 2nd	52	46.0	46.0	100.0	
Total	113	100.0	100.0		
BMI (total)	**Frequency**	**Percent**	**Valid Percent**	**Cumulative Percent**	
Normal weight	92	81,4	81,4	81,4	
Valid Overweight	17	15,0	15,0	96,5	
Obesity	4	3,5	3,5	100,0	
Total	113	100	100		

Table 3 presents the results of the Mann-Whitney U test conducted to compare BMI distributions between boys and girls. Boys had a mean rank of 58.20, while girls had a mean rank of 55.25. The test produced a Mann-Whitney U value and a p-value of 0.486, indicating no statistically significant difference in BMI distributions between the two groups. While the majority of both boys and girls are classified as normal weight, the data reveal a noticeable increase in the prevalence of overweight and obesity. Specifically, 17.9% of boys and 10.9% of girls are classified as overweight, while 3% of boys and 4.3% of girls are obese. These results highlight the need for greater attention to children with excess weight, as these percentages reflect a potential risk for long-term health issues.

Table 3. Mann-Whitney U test was used to compare BMI between boys and girls

	Gender	N	Mean Rank	Sum of Ranks
BMI	Boys	67	58,20	3899,50
	Girls	46	55,25	2541,50
	Total	113		
Boys		Frequency	Percent	Valid Percent
Normal weight		53	79,1	79,1
Overweight		12	17,9	17,9
Obesity		2	3,0	3,0
Total		67	100	100
Girls		Frequency	Percent	Valid Percent
Normal weight		39	84,8	84,8
Overweight		5	10,9	10,9
Obesity		2	4,3	4,3
Total		46	100	100

Test Statistics[a]

Mann-Whitney U	1460,500
Wilcoxon W	2541,500
Z	-,696
Asymp. Sig. (2-tailed)	,486

[a]Grouping Variable: Gender

The Mann-Whitney U test results, shown in Table 4, compare the Body Mass Index (BMI) between first and second-grade children. The analysis reveals no significant difference in BMI between the two groups ($Z = -0.758$, $p = 0.448$), indicating that the BMI distribution is similar across both grades. Table 5 presents the BMI distribution among 1st and 2nd grade children. In the 1st grade, the majority of children are categorized as normal weight (78.7%), with 18% classified as overweight and 3.3% as obese. In the 2nd grade, a larger proportion of children are normal weight (84.6%), while 11.5% are overweight and 3.8% are obese. These findings reflect a higher percentage of normal-weight children in the 2nd grade compared to the 1st grade. Additionally, the percentage of overweight children decreased from 18% in the 1st grade to 11.5% in the 2nd grade, while the percentage of obese children slightly increased from 3.3% to 3.8%.

Table 4. Mann-Whitney Test was used to compare BMI between first and second-grade children.

Grades		**N**	**Mean Rank**	**Sum of Ranks**
BMI	I	61	58,46	3566,00
	II	52	55,29	2875,00
	Total	113		

Test Statistics[a]

Mann-Whitney U	1497,000
Wilcoxon W	2875,000
Z	-,758
Asymp. Sig. (2-tailed)	,448

[a]Grouping Variable: Grades

Table 5. Body Mass Index (BMI) Distribution among 1st and 2nd grade children

BMI (I grade)		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Normal weight	48	78,7	78,7	78,7
	Overweight	11	18,0	18,0	96,7
	Obesity	2	3,3	3,3	100,0
	Total	61	100,0	100,0	

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BMI (II grade)		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Normal weight	44	84,6	84,6	84,6
	Overweight	6	11,5	11,5	96,2
	Obesity	2	3,8	3,8	100,0
	Total	52	100,0	100,0	

Table 6 presents the results of the Mann-Whitney U test comparing television (TV) and screen time (PC, smartphone, video games, tablet, etc.) between boys and girls during weekdays and weekends. No statistically significant differences were observed in TV time during weekdays (U = 1689.5, p = 0.740) or weekends (U = 1654.5, p = 0.604), nor in screen time for digital media during weekdays (U = 1647.5, p = 0.577) or weekends (U = 1644.5, p = 0.568). While boys exhibited slightly higher mean ranks for most measures, these differences were not statistically significant. However, the data show that overall screen time, including both TV and digital media, increases during weekends for both boys and girls. This rise in screen time during weekends is concerning and highlights the need for targeted interventions to promote healthier screen habits outside of school days.

Table 6. The Mann-Whitney U test was conducted to compare TV and Screen time (PC, smart phone, video games, tablet etc.) between boys and girls, both during the workdays (WD) and on weekends (W).

	Gender	**N**	**Mean Rank**	**Sum of Ranks**
TVtimeWD	Boys	66	60,90	4019,50
	Girls	53	58,88	3120,50
	Total	119		
TVtimeW	Boys	66	58,57	3865,50
	Girls	53	61,78	3274,50
	Total	119		
PCtelTABvgWD	Boys	66	61,54	4061,50
	Girls	53	58,08	3078,50
	Total	119		
PCtelTABvgW	Boys	66	61,58	4064,50
	Girls	53	58,03	3075,50
	Total	119		

Test Statistics[a]

	TVtimeWD	TVtimeW	PCtelTABvgWD	PCtelTABvgW
Mann-Whitney U	1689,500	1654,500	1647,500	1644,500
Wilcoxon W	3120,500	3865,500	3078,500	3075,500
Z	-,331	-,518	-,558	-,570
Asymp. Sig. (2-tailed)	,740	,604	,577	,568

Table 7 presents the results of the Mann-Whitney U test comparing screen time between grades during weekdays and weekends. While no statistically significant differences were observed between first- and second-grade children in screen time for television (TVtimeWD: U = 1631, p = 0.461; TVtimeW: U = 1582.5, p = 0.322) or digital media usage (PCtelTABvgWD: U = 1598.5, p = 0.365; PCtelTABvgW: U = 1712.5, p = 0.780), the overall screen time increased during weekends across both grades. Although second-grade students exhibited slightly higher mean ranks for all measures. This rise in screen time during weekends is concerning and warrants further attention.

Table 7. The Mann-Whitney U test was conducted to compare TV and Screen time (PC, smart phone, video games, tablet etc.) between 1st and 2nd grades children, both during the workdays (WD) and on weekends (W)

	Grades	**N**	**Mean Rank**	**Sum of Ranks**
TVtimeWD	I	56	57,63	3227.00
	II	63	62,11	3913.00
	Total	119		
	I	56	56,76	3178.50

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TVtimeW	II	63	62,88	3961.50
	Total	119		
	I	56	57,04	3194.50
PCtelTABvgWD	II	63	62,63	3945.50
	Total	119		
	I	56	59,08	3308.50
PCtelTABvgW	II	63	60,82	3831.50
	Total	119		

Test Statistics[a]

	TVtimeWD	TVtimeW	PCtelTABvgWD	PCtelTABvgW
Mann-Whitney U	1631.000	1582.500	1598.500	1712.500
Wilcoxon W	3227.000	3178.500	3194.500	3308.500
Z	-0.737	-0.991	-0.906	-0.280
Asymp. Sig. (2-tailed)	0.461	0.322	0.365	0.780

Discussion

The findings of this study provide important insights into the BMI distribution and screen time habits of young children in North Macedonia. The majority of the children were classified within the normal weight range, with 81.4% meeting this criterion. However, the presence of 15% overweight and 3.5% obese children underscores a growing concern that mirrors global trends in childhood obesity (World Health Organization [WHO], 2021). While no significant differences in BMI were observed between boys and girls, the higher prevalence of overweight among boys (17.9%) compared to girls (10.9%) is consistent with studies suggesting gender differences in obesity risk factors (Janssen et al., 2004). This finding highlights the need for targeted interventions, particularly for boys, to prevent the onset of long-term health complications associated with excess weight (Reilly & Kelly, 2011).The lack of significant differences in BMI between 1st and 2nd graders aligns with prior research indicating that age alone may not strongly influence BMI distributions in young children (Ogden et al., 2014). However, the slight increase in the prevalence of obesity among 2nd graders suggests a potential shift in weight status as children grow older. These trends call for early intervention strategies in school settings to address dietary habits and physical activity levels during the critical early years of development. According to data from the Institute of Public Health (IPH), childhood and adolescent obesity in North Macedonia has increased by 7.4% compared to 1990, indicating a persistently high level of obesity in the country (IPH, 2024). Recent data from the Institute of Public Health (IPH,2024) indicate that 30.5% of children aged 6 to 9 years in North Macedonia are classified as overweight or obese, with 13.8% falling into the obesity or severe obesity category. Notably, obesity is more prevalent among boys than girls. These findings align with global trends showing a continuous rise in obesity prevalence among young populations. The increasing rates of childhood obesity highlight the urgent need for comprehensive public health strategies focusing on nutrition, physical activity, and lifestyle modifications from an early age.

The analysis of screen time revealed a significant increase in overall time spent on television and digital devices during weekends. This finding aligns with previous studies indicating that children tend to engage more in sedentary, screen-based activities on non-school days (Stiglic & Viner, 2019). Although no statistically significant differences in screen time were observed between genders or grade levels, boys and second-grade students exhibited slightly higher mean ranks across all measures. These trends may suggest subtle behavioral differences in media consumption patterns that warrant further investigation. Prolonged screen time has been associated with adverse health outcomes, including increased BMI and decreased physical activity levels (Saunders et al., 2016). This underscores the importance of implementing public health campaigns and providing parental guidance to encourage a balanced approach to screen time while promoting outdoor play and physical activities, particularly during weekends. Access to sports facilities and green spaces is crucial for fostering physical activity and improving overall health outcomes (Stefanovska Cvetkovska, 2024). Access to sports facilities plays a pivotal role in fostering physical activity, social inclusion, and community well-being (Stefanovska Cvetkovska, 2024).

Conclusion

In conclusion, while the prevalence of normal weight in this sample is encouraging, the presence of overweight and obesity, coupled with increased weekend screen time, raises significant concerns about potential health risks and long-term consequences. These findings underscore the urgent need for implementing comprehensive school-based and community-level interventions aimed at promoting healthy lifestyles among children. Such programs should not only emphasize the importance of physical activity and balanced nutrition but also focus on reducing sedentary behaviors, particularly excessive screen time during weekends. Moreover, creating supportive environments for physical activity is essential. By integrating principles of sport and physical activity into the very fabric of urban design, cities can become catalysts for positive change, fostering environments that not only encourage physical activity but also enhance community health and well-being (Stefanovska Cvetkovska, 2024).Policymakers, educators, and parents must work collaboratively to address these challenges. Public health campaigns should aim to increase awareness of the risks associated with prolonged screen time and promote practical strategies for families to adopt healthier habits. By taking a proactive and multidisciplinary approach, it is possible to mitigate the risks of childhood obesity and inactivity, ensuring

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a foundation for healthier and more active generations to come. This comprehensive effort will not only improve individual health outcomes but also contribute to broader community well-being and resilience.

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UDK 796.012.1-053.4

Integrative development of fine and gross motor skills in preschool children-typological analysis

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Introduction

The period of preschool education represents an extremely important developmental period for children, marked by a strong integrative momentum of various anthropological dimensions. For the science of kinesiology, the development of motor skills, both fine and gross, is of particular importance (Bavčević, Androja & Bilić, 2022).

The aim of this research is to determine the types of children from the aspect of visual-motor integration (VMI) in relation to gross motor skills.

According to Findak (2001), motor abilities are characterized as latent motor structures that can be measured and described and are in charge of an endless number of apparent motor reactions. The development of other qualities and skills depends on motor skills. There is a genetic limit to motor abilities, which are genetically defined. Nevertheless, by carefully choosing workouts and training methods, we can affect mentioned abilities (Badrić, Prskalo & Sporiš, 2015; Prskalo, Jenko, Petračić, Šerbetar & Šuker, 2008).

The importance of motor skills can be reflected in the fact that if an individual does not develop certain skills to the level that is achievable, taking into account genetic limits, they will not be able to master the everyday tasks necessary for normal functioning.

Within kinesiology, there are different divisions of motor skills, and different authors use different classifications. One of the most important and obvious divisions is by precision and type of musculature (Stallings, 1973). When we talk about precision and type of musculature, we are talking about two types of motor skills: macro-motor skills and fine motor skills (Coker, 2017; Stallings, 1973). Macro-motor skills are those skills that use large muscle groups for their manifestation, such as running, jumping, javelin throwing, rowing, and many others. On the other hand, skills that are characterized by precise movements and the use of smaller and finer muscle structures are called fine motor skills. We have characterized fine motor skills as movements that involve fine muscle groups. Such movements most often occur in the hand and fingers (Gallahue & Ozmun, 1998; Zervas, 2006). Within fine motor skills of the hand, we can define graphomotor skills. Graphomotor skills are the ability to write and draw symbols using finger strength and control (Levine, 1987). Graphomotor skills are essential for students' academic success (Gallahue & Ozmun, 1998; Kaiser, Albaret & Doudin, 2009; Zervas, 2006).

To understand fine motor skills and their manifestations, it is important to define the underlying mechanisms. One of the underlying functions in performing writing and symbol drawing tasks is visual-motor integration. The term visual-motor integration most often refers to the coordination of the eyes and the muscles of the hands, or hands, which enables precise manual actions (Bavčević, 2015; Bavčević & Bavčević, 2015).

Methods

The sample consisted of 30 male and female children aged 3 to 7 years. Assessment of VMI was performed using the VMI test (Bavčević & Bavčević, 2015), while gross motor skill was assessed using coordination tests: Backwards Obstacle Course (MPOL), Sidesteps (MKUS) and Coordination with a Stick (MOP). The definition of VMI children's types was performed using K-means cluster analysis with the associated parameters of descriptive statistics and analysis of variance. Factor analysis was used to define a unique latent dimension in the domain of motor coordination variables. The differences between the clusters in this defined dimension were analyzed using analysis of variance. Post hoc analysis of differences was performed using the Scheffe test.

The visual-motor integration (VMI) test consists of two parallel broken lines 1.5 cm apart drawn on A4 paper. The drawn lines form a path broken into a total of 59 segments. The distance between the starting point and the end point is 178.5 cm (Figure 1).

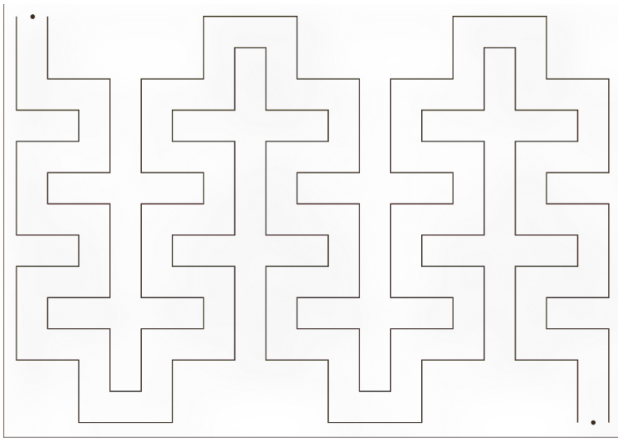

Figure 1. Graphical representation of the VMI test

The paper is placed in front of the examinee in a horizontal position. The examinee's task is to connect the starting and ending points in the shortest possible time by drawing a line with a pencil. The line must be drawn without interruption and without touching the outer lines of the track. The line is drawn with the dominant hand using a graphite pencil.

The examiner measures the time required to complete the task in seconds. After completing the task, the number of errors is determined. Any interruption in the line or touching the outer lines of the track is considered an error. The final result of the VMI test is the sum of the time required to complete the task and all errors multiplied by two. The formula for calculating the test result is given in Figure 2.

$$VMI = VMI_{time} + 2VMI_{errors}$$

Figure 2. Formula for calculating VMI test results.

The Backwards Obstacle Course test is performed on a smooth surface. At a distance of 10 m from the starting line, parallel to it, a finish line is drawn. Three meters from the starting line, the base part of the Swedish box is placed, and the upper part of the box is placed on it. The height of the Swedish box is 50 cm ± 2 cm. Six meters from the starting line, the box frame is placed across the width of the track. The places where the box and box frame are placed are marked with a line. The subject stands in front of the starting line,

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facing the direction of movement in a quadrupedal position, supported on the feet and palms. The subject's task is to cross the first obstacle at the start signal, from the specified position, by moving backwards, and pass through the second obstacle. During the task, the subject is allowed to follow the direction of movement with his/her eyes through his/her legs and turn his/her head. The task is completed when the subject crosses the finish line with both hands. After the task is completed, each result is recorded separately in tenths of a second from the start sign to crossing the finish line with both hands in all three attempts.

The test Sidesteps is performed in a room or open space on a flat and firm surface. The subject stands with both feet inside the lines, sideways to the first line. On the start signal, the subject moves as quickly as possible to the side using the side step-step technique, without crossing the legs, to the second line. When the outside foot steps on the line or crosses it, the subject stops and does not change body position, returning to the first line in the same way, which should also be touched with the foot or crossed over the line. When the subject crosses the four-meter distance six times in the described manner and stands on the line or crosses it with the outside foot, the task is completed. The assessment is performed by measuring the time in tenths of a second from the start signal to the completion of the sixth crossing of the four-meter path. After completing the task, the results in tenths of a second are entered for each of the three repetitions separately. The measurer demonstrates the task and uses the following tools during testing: a stopwatch, a space with minimum dimensions of 5x2m, two drawn lines 1 meter long at a distance of four meters, a picture of the task.

When performing the Coordination with a Stick test, the subject stands in the middle of the mat in a squat position, facing the narrow side of the mat. He holds the stick in front of him in a horizontal position and with his arms outstretched. The subject's task is to turn 180° on the signal «now», sit down, lie on his back, put both legs over the stick and pull his legs between his arms, and rise to a squat position so that the stick remains behind his back, assuming a standing position at attention. During the entire task, the subject must not drop the stick at any time, but must hold it with both hands at all times. If the stick is dropped, the task must be continued from the position in which the error occurred. The time is measured in tenths of a second from the start signal to the standing position at attention with the stick behind his back. The timekeeper sits half a meter in front of the wider part of the mat, gives the signal to start, measures the time, and can loudly direct the sequence of elements. For a successful performance of the test, the following aids are required: a stopwatch, a mat, a stick 100 cm long, a picture of the task.

Results

The following text presents the results of a study conducted on 30 male and female children aged 3 to 7 years.

Table 1. Descriptive statistics

Variable	Mean	SD	Min	Max	Skewness	Kurtosis	Max d	p
MPOL	28.970	9.085	14.483	49.377	0.534	-0.115	0.08253	> 0.20
MKUS	18.996	3.703	12.037	27.547	0.099	-0.146	0.09489	> 0.20
MOP	9.021	3.279	4.653	17.883	1.102	1.132	0.12661	> 0.20
VMI	64.217	21.710	34.907	120.050	0.887	0.294	0.13755	> 0.20

Legend: $D_{30, 0.05}$=0,24170

Table 1 shows the parameters of the descriptive statistics and the analysis of the normality of the distribution. The values of skewness and kurtosis are in the interval of ±2.00, which is considered acceptable (George & Mallery, 2016). An increased kurtosis value was recorded for the VMI variable. Applying the KS-test confirmed the normal distribution of data for all variables.

Table 2. Cluster analysis

	BELOW AVERAGE (n = 7)		AVERAGE (n = 13)		ABOVE AVERAGE (n = 10)	
Variable	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**
MPOL	33.490	6.673	31.911	9.014	21.983	6.732
MKUS	21.810	2.496	20.049	3.069	15.658	2.708
MOP	12.332	3.707	9.137	2.361	6.553	1.655
VMI	96.625	13.203	63.064	6.918	43.032	4.609

Using the K-means cluster analysis shown in Table 2, three clusters were isolated according to the degree of VMI. In the first cluster (Below average), n=7 respondents were grouped, within the second cluster (Average), n=13 respondents were grouped, and in the third cluster (Above average), the number of respondents was n=10.

Table 3. Analysis of Variance between clusters; Grouping variable: VMI

Between SS	Within SS	F	p
11857.300	1811.360	88.372	< 0,001

Table 3 shows the between-cluster analysis of variance. The

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findings confirm a statistically significant difference between the formed groups (F = 88.372, p = 0.001).

Table 4. Factor analysis

Variable	Loadings
MPOL	-0.922
MKUS	-0.939
MOP	-0.866
Eigenvalue	2.481
% Total variance	0.827

Factor analysis shown in Table 4 was applied with the aim of defining the latent dimension in the space of coordination variables. The isolated factor explains a total of 82.7% of the manifest variables variance. The definition of a single latent dimension allowed a simple further analysis of the differences between the clusters in the domain of motor coordination.

Table 5. Analysis of variance between clusters; Grouping variable: Factor

Multiple R	Multiple R2	F	p
0.680	0.463	11.637	< 0.001

Table 5 shows the between-cluster analysis of variance when using the factor as a grouping variable. The findings confirm a statistically significant difference between the formed groups (F = 11.637, p < 0.001).

Table 6. Post hoc analysis - Scheffe test

	Below average	Average	Above average
Below average		0,277	< 0.001
Average	0.277		
Above average	< 0.001	006	

Post hoc analysis of differences between clusters was performed using the Scheffe test. The obtained results are shown in Table 6. By successive analysis of the latent coordination dimension growth between the below-average, average and above-average groups, a statistically significant difference is observed between the last two groups. This points to a significant differentiation of highly coordinated children compared to the remaining participants. This represents important information for immediate kinesiology practice, especially in the approach to children with different motor coordination status.

Discussion

The obtained research findings confirm the connection between gross motor skills and fine motor skills represented through the level of visual motor integration. It is possible to notice that children with different coordination abilities show different levels of visual motor abilities, with an evident positive connection. In other words, respondents who showed a higher level of body coordination also show a higher level of visual motor integration. In addition, identical findings are shown for all three coordination variables, which indicates a comprehensive connection between the two observed aspects of motor control. The obtained conclusions are also confirmed by numerous previous studies (Africa & van Deventer, 2017; Bavčević, T., Bavčević & Bavčević, I., 2019; Bonifacci, 2004; De Villiers, 2019). All of the aforementioned studies indicate a high level of connection between gross motor skills and fine motor skills, especially of the graphic motor type, whether in students or preschool children.

Using the K-means cluster analysis, three clusters were isolated according to the degree of VMI.

Analysis of descriptive parameters of individual clusters confirms that children belonging to distinct groups have varying degrees of coordination skills.

Furthermore, it is possible to detect that the level of gross motor skills follows the level of fine motor development (Figure 3).

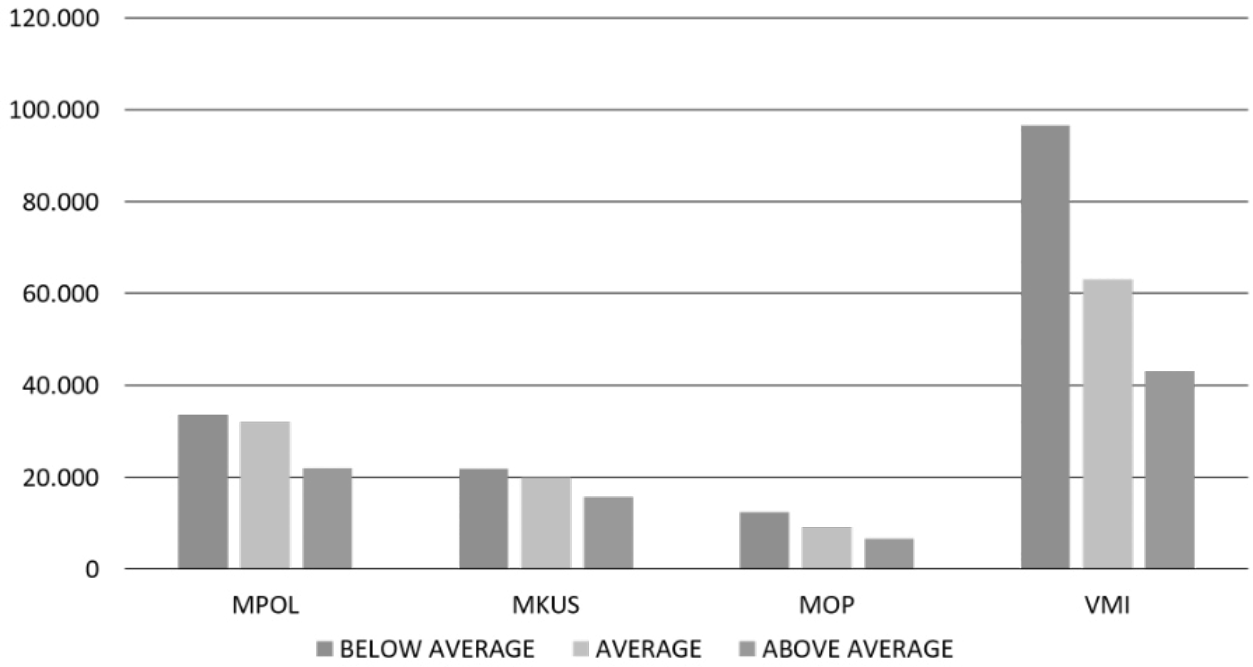

Figure 3. Mean values by clusters

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Through an in-depth analysis of the obtained findings, it is possible to observe specific differences between the groups in the area of motor control. A quantitative difference in motor coordination was recorded between all three groups, with the difference being statistically significant between the average and above average groups. This points to an interesting conclusion about the significant connection between gross motor skills and fine motor skills in subjects who achieve generally higher results. Such findings require deeper research. In accordance with the above, in the future, scientific interest should be directed towards a larger number of respondents, children of different ages, genders, and a wider range of motor variables, as well as a larger range of fine motor skills variables.

Conclusion

A child's ontogenetic development is extremely significant for the study and profession of kinesiology, particularly for kinesiological education. Understanding how children change as they grow and develop is crucial for kinesiological education planning and programming. Every aspect of growth and development that is seen is crucial for keeping an eye on children and pupils. The development and background mechanisms of motor abilities are among the most significant aspects of kinesiological education and kinesiology as core science.

One of the aforementioned background mechanisms is visual-motor integration, which is responsible for the manifestation of fine motor skills such as writing, which is essential for students' academic performance.

Taking into account previous research that has studied the connection and dynamics of gross motor skills and fine motor skills, the conclusion is that there is a common background mechanism responsible for the manifestation of the observed movements. This conclusion should be taken with caution and the discovered phenomena should be examined more deeply in future research. We can conclude that the obtained results confirm the connection between the two observed factors and provide valuable information that can be used in educational practice in the form of monitoring and kinesiological intervention.

The obtained findings confirmed the integrative nature of both fine and gross motor skills in preschool children. This points to the need of planning and programming of kinesiological activities that respect the integral motor development, with the aim of optimizing the educational effects at this age.

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UDK 796-053.6

Physical activity of 16-year-old adolescents – A pilot study

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Introduction

The period of adolescence is characterized by rapid growth and development, whether it is physical, emotional, cognitive, or social. Young people have the opportunity to choose their lifestyle and behavioral patterns. These patterns, often adopted during adolescence, tend to persist and carry over into adulthood (Pandolfo et al., 2016; Carlin et al., 2017; Lioret et al., 2020). During this period, certain behavioral patterns regarding physical activity (PA) are also established, which determine whether an individual will engage in PA in adulthood or not (Kumar, Robinson & Till, 2015; Padehban, Negarandeh & Nikpeyma, 2018). Recent studies recommend that children and adolescents should engage in PA of various forms, of moderate and/or vigorous intensity, for at least 60 minutes three times a week, and preferably every day (Bull et al., 2020; Chaput et al., 2020). The PA performed should primarily be appealing to children, thereby reducing the level of sedentary behavior and physical inactivity (Bull et al., 2020) which are common at this stage of life (Dumith et al., 2011).

Participation in regular forms of PA in the adolescent population leads to improvements in cardiorespiratory fitness and optimal development of muscles and bones (Gaba et al., 2017; Julijan-Almárcegui et al., 2015), positively affects the cardiovascular system (Mintjens et al., 2018), cognitive abilities and mental health (Biddle & Asare, 2011; OECD/WHO, 2023), and reduces the risk of developing chronic non-communicable diseases and obesity in later life (Brown et al., 2015; Canabrava et al., 2019; OECD/WHO, 2023). Nelson, Benson, and Jensen (2010) also demonstrated that a decreased level of PA during this period contributes to a range of negative effects throughout life.

Although the aforementioned and other studies demonstrate the positive effects of regular PA on the adolescent population, a trend of decreasing PA levels in this group is observed, starting as early as the age of 9 (Guthold, Stevens, Riley & Bull, 2020). According to some studies (OECD/European Commission, 2024), a dramatic decline in PA levels among adolescents occurs between the ages of 11 and 13, or between the ages of 11 and 14 (Sember et al., 2020). Adolescents spend an increasing amount of time in front of the TV and computers, significantly raising their screen time and contributing to a rise in sedentary activities (Pechtl, Kim & Jacobsen, 2022), with the note that there are significant variations between countries and regions (Rakić et al., 2021). Percentage-wise, the highest level of physical inactivity in the adolescent population was recorded in Greenland (around 60%), while the lowest was observed in Finland, Ireland, and Slovenia, with less than 10% (Rakić et al., 2021).

The proportion of adolescents who engage in at least 60 minutes of moderate PA daily in the neighboring countries is relatively low, averaging around 25% for adolescents and only 15% for adolescent girls, with the note that there are also significant variations between countries and regions (Rakić et al., 2021). Similar data can be found in previous studies, which have shown that only 33% of adolescents achieve the recommended goal of at least 60 minutes of PA per day (Foster, Moore, Singletary & Skelton, 2018). The authors note that boys were more physically active than girls and that, on average, around 29% of girls and 20% of boys were physically inactive (Rakić et al., 2021). Other studies indicate that gender is an important determinant that influences the level of PA in adolescents (Bauman et al., 2012). Within the Youth Risk Behavior Surveillance System (YRBSS) study, which tracks the level of PA in adolescents, data from 2021 revealed that 84.3% of girls and 68.3% of boys do not meet the recommended level of PA, and that boys are more physically active than girls (High School Youth Risk Behavior Survey, 2021). Differences in the level of PA between boys and girls, especially at moderate intensity, were also established in the study by Kretschmer et al. (2023), which indicates that boys are more physically active than girls. Differences between boys and girls in PA have also been established in most EU countries (Rakić et al., 2024), with it also being proven that boys are more physically active than girls. These differences were particularly pronounced in 15-year-old adolescents, where only 20% of boys and 10% of girls met the WHO recommendations for daily PA (Rakić et al., 2024). However, in some countries, the level of PA among adolescent boys and girls is approximately the same (Statistical Yearbook of Portugal 2002), or more favourable for adolescent girls (Freitas et al., 2007).

The aim of this research was to conduct a detailed analysis of the engagement of 16-year-old adolescents in physical activities, with a particular focus on participation in various forms of sports and recreational activities. The study was directed towards identifying the frequency, intensity, and types of physical activities in which adolescents are involved. Additionally, the goal was to assess the differences in engagement between boys and girls, in the context of recommendations for the minimum amount of physical activity, as well as to explore the level of sedentary behaviors among adolescents, which may have long-term consequences on both physical and mental health in adulthood. It is hypothesized that the adolescent population of 16-year-olds does not, on average, achieve the recommended level of at least 60 minutes of physical activity per day, with a higher percentage of physically inactive adolescent girls compared to boys. Significant differences in physical activity engagement are expected between male and female adolescents, with boys being more physically active, particularly in high-intensity sports activities.

Methods

Sample of participants

The sample of participants consisted of a total of 309 adolescents aged 16 years, including 167 boys and 142 girls. Before participating in the study, consent was obtained from the parents and/or guardians for their involvement in the study. After consent was given, the participants were informed about the procedure of the study and the data collection method.

The inclusion criteria for the study were: 1) participants aged 16 years ± 6 months; 2) no chronic illnesses; 3) voluntary consent to participate in the study; 4) good overall health.

UDK 796-053.6

Sample of variables

For the purposes of the study on determining the level of PA in the adolescent population in specific forms of sports and recreational activities, a modified questionnaire by Mitić et al. (2011) was used.

The modification of the questionnaire focused on reducing the number of questions. Participants provided data on their level of sports and recreational activities through self-reporting (survey). The questionnaire was adapted for the adolescent population by experts in the fields of sports and physical education and contained a total of seven items.

Statistical data analysis

For each statement, basic descriptive parameters were calculated by determining frequencies and percentages. The Chi-square test ($\chi 2$), was applied to determine the significance of differences between groups of participants (boys and girls). The level of statistical significance was set at .05. The results were processed using the Statistical Package for the Social Sciences for Windows (SPSS) (Version 12.0) (Chicago, IL, USA).

Results

The results of the basic descriptive statistics are presented in Table 1. Based on the obtained results, it was determined that about one-third of the sample (31.7%) engages in regular PA (3-4 times/week), 27.8% occasionally, while 40.5% never or rarely engage in PA. Adolescents are more physically active than adolescent girls, with 41.3% of them reporting regular PA, compared to 20.4% of adolescent girls.

When asked whether the participants are members of any school clubs related to sports and physical education, the results showed that adolescent boys are most involved in football (22.2%), followed by basketball (16.7%) and handball (15.6%). Adolescent girls are most commonly members of the school volleyball club (12.7%), followed by handball (12%), athletics (11.3%), basketball (13.4%), dance (7.0%), and gymnastics (2.1%).

In their free time, 36.5% of adolescents exercise with their friends, while only 21.1% of adolescent girls exercise in a group. The majority of both adolescents and adolescent girls sometimes exercise with friends (46.7% and 59.2%, respectively). When asked whether they exercise in sports centers during their free time, 24.6% of adolescents reported that they regularly exercise in sports centers, while the percentage of adolescent girls who exercise in sports centers is only 12.7%. A small number of adolescents and adolescent girls have their own exercise programs (26.3% and 10.6%, respectively). The percentage of adolescents who actively and regularly exercise in a sports club is 39.5%, with a higher percentage of girls (21.8%). In response to the statement that they do not exercise in their free time because they do not have a company to exercise with, both adolescents and adolescent girls answered similarly.

$\chi 2$ test for independence (with Yates' correction) was applied to determine the differences in PA between adolescent boys and girls. Based on the obtained results (p), it was found that there are statistically significant differences between adolescent boys and girls in all the statements ($p < .001$; $p < .05$) (Table 1).

Table 1. Descriptive statistics and differences between groups

		Boys n=167	Girl n=142	Total n=309	Boys vs Girl			95% CI
Question/Statement		Frq (%)	Frq (%)	Frq (%)	Cramer's V	$\chi 2$	p	
How much do you engage in sports or recreation during your free time?	never	35 (21,0)	23 (16,2)	58 (18,8)	,269	22,31	< .001**	4,07–4,83
	sometimes	30 (18,0)	37 (26,1)	67 (21,7)				
	1-2/week	33 (19,8)	53 (37,3)	86 (27,8)				
	3-4/week	69 (41,3)	29 (20,4)	98 (31,7)				
Are you a member of any school club?	Track & Field	12 (7,2)	16 (11,3)	28 (9,1)	,474	69,56	< .001**	3,43–3,74
	Handball	26 (15,6)	17 (12,0)	43 (13,9)				
	Gymnastics	3 (1,8)	3 (2,1)	6 (1,9)				
	Karate	5 (3,0)	4 (2,8)	9 (2,9)				
	Basketball	28 (16,7)	19 (13,4)	47 (15,2)				
	Judo	7 (4,2)	6 (4,2)	13 (4,2)				
	Volleyball	7 (4,2)	18 (12,7)	25 (8,1)				
	Dance	16 (9,6)	10 (7,0)	26 (8,4)				
	Football	37 (22,2)	2 (1,4)	39 (12,6)				
	Table tennis	12 (7,2)	1 (,7)	13 (4,2)				
In my free time, I exercise by having my own group of friends.	never	27 (16,2)	27 (19,0)	54 (17,5)	,169	8,81	.032*	2,03–2,18
	sometimes	78 (46,7)	84 (59,2)	162 (52,4)				
	regularly	61 (36,5)	30 (21,1)	91 (29,4)				

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In my free time, I exercise in one of the sports centers.	never	51 (30,5)	77 (54,2)	128 (41,4)	,247	18,82	< .001**	1,68–1,85
	sometimes	74 (44,3)	46 (32,4)	120 (38,8)				
	regularly	41 (24,6)	18 (12,7)	59 (19,1)				
In my free time, I exercise and have my own independent workout program.	never	68 (40,7)	56 (39,4)	124 (40,1)	,224	15,55	.001**	1,69–1,86
	sometimes	54 (32,3)	70 (49,3)	124 (40,1)				
	regularly	44 (26,3)	15 (10,6)	59 (19,1)				
In my free time, I practice sports in a club.	never	70 (41,9)	74 (52,1)	144 (46,6)	,192	11,33	.010**	1,74–1,93
	sometimes	30 (18,0)	36 (25,4)	66 (21,4)				
	regularly	66 (39,5)	31 (21,8)	97 (31,4)				
I don't have a group to exercise with, I don't exercise alone.	never	124 (74,3)	120 (84,5)	244 (79,0)	,165	8,44	.038*	1,19–1,32
	sometimes	26 (15,6)	12 (20,7)	44 (14,2)				
	regularly	16 (9,6)	3 (2,1)	16 (6,1)				

Legend: Frq. - Frequencies - number of subjects; % - percent; χ2 - Chi-square test, ** - significance level p< .01; * - significance level p< .05

Discussion

In the present study, we investigated the level of PA in the adolescent population aged 16 and whether there are differences between genders. It was found that about one-third of adolescents engage in regular PA, which is consistent with other studies (Foster, Moore, Singletary & Skelton, 2018; Rakić et al., 2021). However, a large number of adolescents remain insufficiently physically active. The reason for this may be found in the increased time adolescents spend in front of computers and TVs (Markuš, Neljak & Trstenjak, 2010; Pechtl, Kim & Jacobsen, 2022), and an increasing number of adolescents are not regularly participating in sports in a club. The study by Markuš et al. (2010) demonstrated that an increasing number of adolescents spend three or more hours in front of the TV, with adolescent girls spending more time in front of the TV compared to adolescent boys. In developed countries, the time spent in front of the TV has started to exceed the time spent in school. Song et al. (2019) also state that this population spends more and more time leading a sedentary lifestyle, with fewer and fewer adolescents participating in sports clubs, and the largest portion of their free time is spent doing homework, watching TV, using computers, or mobile phones.

In the study, we also investigated whether there are differences in PA between adolescent boys and girls. Our results showed that there are differences in PA between genders, with adolescent boys being more physically active than adolescent girls. The prevalence of PA among adolescent boys, at 41.3% as found in our study, is slightly lower than in the study by Rakić et al. (2021), while similar values were observed for adolescent girls (Rakić et al., 2021). Other studies also indicate that the level of PA is lower among adolescent girls compared to adolescent boys (Kretschmer et al., 2023; Rakić et al., 2024). These results can also be attributed to the number of adolescents and adolescent girls involved in a sports club.

The results showed that adolescent boys engage more in team sports such as football, basketball, and handball compared to adolescent girls, who prefer athletics, gymnastics, volleyball, and basketball. Similar results were obtained in the study by Fakhouri et al. (2014), which examined the PA levels of american youth. It was found that basketball is the most popular sport among adolescent boys, followed by football, cycling, and walking. In contrast, adolescent girls most frequently engaged in basketball, volleyball, handball, and athletics, and they also practiced dance and cycling. This can be partially explained by the assumption that adolescent boys tend to choose activities that involve more time spent in moderate and high-intensity PA, compared to adolescent girls. Therefore, the choice of activities was influenced by this (Brockman, Jago, & Fox, 2010; Maher & Olds, 2011). Some authors argue that there are also socio-cultural reasons why adolescent girls participate less and are less likely to engage in certain sports and recreational activities, and these differences can be attributed to such factors (Chalabaev, Sarrazin, Fontayne, Boiché, & Clément-Guillotin, 2013; Watson, Eliott, & Mehta, 2015). Additionally, interventions in schools may play a key role in promoting and influencing the PA choices of adolescents (OECD/WHO, 2023), as well as well-developed programs that promote PA (van Sluijs, McMinn, & Griffin, 2007).

In the present study, it was found that both adolescent boys and girls who engage in physical exercise do so in groups with others, but adolescent boys more frequently exercise with friends. According to previously conducted studies, it has also been established that exercising with friends can contribute to increasing the level of PA in adolescents (Sawka, McCormack, Nettel-Aguirre, Hawe, & Doyle-Baker, 2013). Inequality in PA, particularly those of moderate intensity, was observed in the study by Kretschmer et al. (2023), while Sember et al. (2020) found differences in moderate and high-intensity physical activities. Based on the results of the present study, where football, basketball, and handball were the most commonly practiced activities by adolescent boys, the differences obtained can be explained by the choice of PA themselves. Fakhouri and colleagues (2014) state that, in addition to differences in the intensity of physical activities between adolescent boys and girls, there are also differences in the choice of activities, and that this population needs to be included in joint exercise programs in order to generally increase their level of physical activity.

Additionally, this study also investigated whether adolescents who engage in PA do so in sports and recreational facilities. In our study, we found that adolescent boys more frequently exercise in sports centers compared to adolescent girls. The choice of location for PA in free time depends on a large number of factors (Ferreira et al., 2007), and access to programs and facilities where specific types of PA can be performed can significantly influence the choice of place for exercising (Ferreira et al., 2007; Sterdt, Liersch, & Walter, 2014; Davison & Lawson, 2006). It is assumed that adolescent boys had more opportunities to engage in PA in sports and recreational centers, but it is essential to ensure the availability and accessibility of PA programs for all population groups, especially adolescents, in order to increase the overall level of

PA (OECD/WHO, 2023). Furthermore, the choice of exercise location may also be related to adolescents' perception of the safety of the exercise facilities, as evidenced by certain studies (Sterdt, Liersch & Walter, 2014).

In accordance with the previously mentioned findings, the results of our study also showed that there are differences in the ways PA are carried out, with adolescent boys being more likely to have their own independent exercise programs compared to adolescent girls. Since adolescence is a critical period for the development of PA (Sember et al., 2020), and during this period adolescent girls experience a significant decrease in PA, it is assumed that many adolescent girls are not familiar with exercise methods and programs. This, in turn, has contributed to the very low levels of PA observed among them.

This study also has some methodological limitations that need to be highlighted. First, the limitation relates to the sample size and the fact that the participants were from only one country. This limitation may restrict the ability to generalize the results to the entire adolescent population. Second, the instrument (survey) used for data collection is not fully comparable with other surveys, making it another methodological limitation. Future research should involve a larger sample, ideally from different countries, and apply a methodology that allows for direct comparison with other studies.

Conclusion

In the study, we investigated the level of PA, the most common PA, where and with whom 16-year-old adolescents engage in PA, as well as whether there are gender differences. Although there is evidence that regular PA has positive and significant health benefits for this age group, our results showed that adolescents are more physically active than adolescent girls, but both groups predominantly lead a sedentary lifestyle. Furthermore, the choice of sports and recreational activities differs based on gender, indicating the need to develop strategies to increase PA levels and encourage the participation of adolescents, particularly adolescent girls, in various forms of PA. Our results can serve as a potential and practical reference for finding and shaping programs and policies aimed at the implementation of various forms of PA tailored to the adolescent female population, helping them reach the recommended level of PA and thereby improve their overall health.

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UDK 796:796.065(497.13)

Physical activity among croatian judo referees

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Introduction

Physical activity plays a key role in maintaining overall health and physical readiness, especially in professional sports environments that demand a high degree of physical endurance and mental focus (Nowak, 2014). In sports disciplines where fitness requirements are particularly pronounced, physical activity forms the foundation for success and longevity. One such discipline is judo, a sport that requires an exceptional level of physical fitness (Julio et al. 2017). However, unlike competitive sports or officiating in some other sports, refereeing in judo is not physically demanding, as the match occurs in a relatively small area, meaning that referees do not require significant activity to follow the actions of the two competitors. In sports in general, including judo, referees play a crucial role in ensuring fairness, safety, and integrity in competitions. A referee is not only someone who observes and evaluates the fight but also a guardian of the ethical and technical standards of the sport. According to the World Health Organization's definition, physical activity is any bodily movement that increases energy expenditure above resting levels.

The WHO describes health as a state of complete physical, mental, and social well-being, not merely the absence of disease or infirmity (WHO, 2017). On the other hand, physical inactivity is defined as the absence of body movements that consume energy similar to the level of resting (Dietz, 1996). Physical activity, exercise, and physical fitness are often mistakenly used as synonyms, though they denote different concepts. Physical activity refers to any bodily movement caused by skeletal muscles that leads to energy expenditure, which can be measured in kilocalories (Ndahimana et al. 2017). This activity can encompass various aspects of daily life, such as professional duties, sports activities, fitness training, household chores, and other types of movement. Exercise is a specific type of physical activity that is planned, structured, and repetitive, aiming to improve or maintain physical fitness. It includes activities designed specifically to enhance physical fitness. Physical fitness encompasses a set of physical attributes related to health and skills.To the authors' knowledge, no previous studies have investigated the physical activity of judo referees. Therefore, the main objective is to determine the level of physical activity among judo referees and to explore differences in physical activity between younger and older judo referees. The primary hypothesis of the study is that no differences in physical activity will be found between younger and older judo referees.

Methods

The complete sample of participants consisted of 41 judo referees, of whom 23 were men and 18 were women. Among the total number of analyzed referees, four were international referees, while the rest belonged to the category of referees who officiated only at domestic competitions. For the purposes of this research, participants were divided into two groups: those under 30 years old (n =23) and those over 30 years old (n=18).

For this study, a physical activity questionnaire was applied (short version; InterAct Consortium, 2012). The survey consists of 7 questions, allowing for an assessment of the respondents' physical activity levels. Some surveys were completed in person, while others were conducted online via email. Of the total number of distributed surveys, 5 respondents did not fully complete the questionnaire and were therefore excluded from further data analysis.

Basic descriptive statistical measures were used for all observed variables, including the arithmetic mean (M), standard deviation (SD), minimum and maximum values, skewness coefficient (α3), and kurtosis coefficient (α4). Since it was found that the data distribution for all observed variables significantly deviated from normality, the Mann-Whitney U test was used to determine differences between younger and older referees. Data were processed using the SPSS 29.0 statistical software. The significance level for all indicators was set at α = 0.05.

Results

Table 1. Descriptive statistical parameters for all observed variables (n = 41)

Item	mean	(SD)	Min.	Max.	α3	α4
Days of Vigorous-Intensity Activities	3.15	(1.74)	0	7	0.21	-0.36
Minutes of Vigorous-Intensity Activities	68.41	(54.24)	3	300	2.22	7.47
Days of Moderate-Intensity Activities	3.61	(1.92)	0	7	0.12	-0.71
Minutes of Moderate-Intensity Activities	99.02	(106.44)	0	480	2.18	4.88
Days of Walking	5.32	(2.32)	1	7	-0.93	-0.84
Minutes of Walking	83.22	(132.23)	5	648	3.58	13.26
Hours of Sitting	4.76	(4.36)	1	27	3.65	16.97

Table 1 presents the descriptive parameters of the 7 items that are part of the questionnaire. It can be observed that the data distribution for all observed variables significantly deviates from normality. Therefore, nonparametric methods will be used in the further data analysis.

UDK 796:796.065(497.13)

Table 2. Analysis of differences in observed variables between younger (n = 23) and older (n = 18) referees.

Item	younger		older		U	p
	median	(Q1;Q3)	median	(Q1;Q3)		
Days of Vigorous-Intensity Activities	3.00	(3;4)	2.00	(2;5.25)	177.5	0.43
Minutes of Vigorous-Intensity Activities	60.00	(45;90)	42.5	(42.5;92.5)	161.5	0.23
Days of Moderate-Intensity Activities	3.00	(2;5)	4.00	(2;6)	235	0.46
Minutes of Moderate-Intensity Activities	60.00	(30;180)	60.00	(30;97.5)	181	0.49
Days of Walking	7.00	(3;7)	7.00	(3;7)	189.5	0.80
Minutes of Walking	45.00	(22.5;120)	40.00	(19.75;67.5)	195.5	0.76
Hours of Sitting	4.00	(3;6)	3.00	(2;5)	153	0.15

Legenda: Q1;Q3 – interquartile range; U – test statistic value of the Mann-Whitney Test; p – significance Value

The results in Table 2 suggest that no statistically significant differences were found between younger and older referees in any of the questionnaire items.

Discussion

This study was conducted to determine the differences in physical activity between younger and older judo referees. No differences in physical activity were found with respect to age among the observed participants, thus confirming the null hypothesis. In this study, the age of 30 was set as the threshold between younger and older participants, as lifestyle changes for many people around this age, with physical activity gradually decreasing. Although the average physical activity levels of older participants were generally lower across all variables compared to younger participants, these differences were not statistically significant. Examining the mean values of individual responses in the questionnaire suggests that the physical activity of judo referees is considerably higher than that of the general population (Conbaz et al. 2015). This can be attributed to the fact that judo referees are often former judo athletes who maintain physical exercise habits even after their sports careers. When considering the physical activity of referees during a judo match, it can be concluded that refereeing in judo is largely static. The match takes place in a relatively small area, so referees do not require extensive movement, unlike in sports like soccer, where referees may run up to 10.5 km in a single game (Krustrup et al., 2009). Therefore, from the perspective of officiating quality, it can be assumed that physical fitness may not significantly impact performance; however, from a health perspective, it would certainly be beneficial for judo referees to be in good physical condition. Future studies could benefit from analyzing differences between high-quality and less experienced referees to determine whether physical activity impacts officiating quality. This study also has some limitations, including the sample size (a relatively small number of domestic referees at lower levels) and the challenges associated with survey-based research (e.g., subjective assessment of the analyzed parameters by the respondents).

Conclusion

In this study, no significant differences in physical activity were found between younger and older judo referees. Compared to the general population, judo referees exhibit higher levels of physical activity, attributed to their athletic lifestyle. Future research should aim to expand the sample to include high-quality international referees.

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UDK 796:616-001

Standard rehabilitation protocols following Anterior Cruciate Ligament (ACL) injury in Athletes - Advantages and Disadvantages

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Introduction

Anterior cruciate ligament (ACL) injuries are among the most common injuries in high-intensity sports, particularly those involving sudden changes in direction, rotational movements, and high-load forces, such as football, basketball, handball, and tennis. The ACL plays a crucial role in knee stability, preventing excessive anterior displacement of the tibia relative to the femur. Injuries to this ligament often require prolonged recovery periods, which can be achieved by implementing appropriate rehabilitation protocols (Brinlee et al., 2022; Buckthorpe et al., 2024).

Rehabilitation following an ACL injury is vital for restoring functionality, reducing pain, preventing complications and reinjuries, and facilitating the return of athletes to their sport. Although rehabilitation protocols vary depending on the type and severity of the injury and the specific sport, the primary goal across all approaches is to achieve full restoration of knee mobility and stability while minimizing recovery time (Buckthorpe et al., 2024).

There are two primary rehabilitation pathways for ACL injuries: conservative (non-operative) rehabilitation and operative rehabilitation following ligament reconstruction. Each approach has its distinct features, with different stages, exercises, and strategies aimed at maximizing effectiveness (Buckthorpe et al., 2020; Diermeier et al., 2020; Filbay, 2023b). Consequently, well-defined rehabilitation guidelines are essential, along with an understanding of the advantages and limitations of each approach.

A key challenge in rehabilitating athletes with ACL injuries lies in selecting an appropriate rehabilitation protocol that will enable a safe return to the field within an optimal time frame, while also reducing the risk of re-injury. While standardized rehabilitation protocols exist, their success can vary significantly depending on the sport, the severity of the injury, and the specific needs of the athlete (Lynch et al., 2015). The hypotheses to be examined in this study are as follows:

1. Standardized rehabilitation protocols that combine kinesitherapy and surgical interventions result in a higher-quality recovery, particularly concerning the return of athletes to their sport.
2. A personalized approach to rehabilitation, tailored to the specific demands of the sport, can significantly reduce the risk of reinjury and enhance the recovery process qualitatively.

The aim of this study is to highlight the advantages and limitations of standardized rehabilitation protocols following ACL injuries by analyzing how different approaches impact the recovery process and athletic activity return.

Methodology

For the purposes of this research, a systematic review of the available literature was conducted to gather relevant studies analyzing rehabilitation following anterior cruciate ligament (ACL) injuries in athletes. Electronic databases, primarily MEDLINE (PubMed), were utilized to search for relevant studies. The search was limited to the past 10 years (2014–2024) to ensure a focus on the latest rehabilitation methods, as recent data are critical for understanding current approaches to ACL rehabilitation.

Using keywords such as «rehabilitation ACL injury,» «ACL rehabilitation protocols,» «return to sport after ACL injury,» and «postoperative rehabilitation ACL,» a total of 517 papers were identified. These studies were then screened based on the following inclusion criteria:

- Study type: Only studies addressing ACL rehabilitation in athletes, regardless of competition level (professional or amateur), were included.
- Type of rehabilitation: Both conservative and postoperative rehabilitation protocols were considered.
- Clear relevance to return to sport: Only studies on athletes' return to sports activities following rehabilitation were included.
- Recovery period: Studies providing data on recovery timelines and the return to sport after ACL injuries were included.
- Outcomes: Only studies presenting specific results and conclusions regarding the efficacy of rehabilitation and the advantages or disadvantages of different protocols were selected.

After the preliminary analysis, 10 relevant studies were identified as most closely addressing ACL rehabilitation and athletes' return to sports, regardless of their competition level. These studies employed various methodological approaches, including meta-analyses, randomized controlled trials, and longitudinal research. The selected studies were analyzed to identify key rehabilitation strategies, factors influencing rehabilitation effectiveness, and their practical applications. Relevant parameters, such as the duration of rehabilitation, recurrence rates of injury, time to return to sport, and post-rehabilitation test outcomes, were examined.

Results

The literature review identified several rehabilitation protocols to facilitate athletes' return to sport following anterior cruciate ligament (ACL) injuries. These protocols encompass various approaches to rehabilitation, including kinesitherapy, strength training, psychological preparation, and sport-specific training methodologies. According to Brinlee et al. (2022), the success of ACL reconstruction depends on both preoperative and postoperative rehabilitation, with transitions between phases tailored to the individual needs of each athlete (Buckthorpe, 2019; Buckthorpe et al., 2020; Buckthorpe et al., 2024). The early phase of rehabilitation, which focuses on stability and strength exercises, forms the foundation for successful recovery (Buckthorpe et al., 2024). This phase emphasizes regaining joint mobility, reducing inflammation, and gradually increasing load tolerance to prepare for more advanced rehabilitation stages.

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Table 1. Five established ACL rehabilitation protocols, highlighting their key success factors, timelines for return to sport, and outcomes based on relevant studies.

Rehabilitation Protocol	Protocol Description	Key Success Factors	Studies Addressing the Protocol
Delaware Protocol	It focuses on the gradual increase of load with an emphasis on strength and stability.	Gradual load progression, muscle strengthening, and knee stability.	(Brinlee et al., 2022; Grindem et al., 2016; Lynch et al., 2015)
Melbourne Protocol	Gradual return to sports activities with an emphasis on balance and agility.	Balance, agility, pain reduction.	(Filbay, 2023a)
ACL Return to Sport (RTS) Protocol	A protocol based on testing the ability to return to sport based on physical readiness.	Ability to return to sport, functional testing, and mental readiness.	(Gokeler et al., 2022)
Cross Bracing Protocol (non-operative)	It focuses on a faster return to rehabilitation without the need for surgical intervention, using specialized devices (orthoses) for knee stabilization.	Use of orthoses, minimally invasive interventions, and a faster start of rehabilitation.	There is a limited number of long-term studies, but it is widely applied in practice (Filbay, 2023b)
Optimizing the Late-Stage Rehabilitation and Return-to-Sport Training and Testing Process	A protocol for optimizing the later stages of rehabilitation and returning to sports.	Later stages of rehabilitation, specific training and testing.	(Buckthorpe, 2019; Buckthorpe et al., 2020)

Each protocol employs specific rehabilitation methods and adopts various approaches to ensure a successful return of athletes to the field. The studies cited in Table 1 indicate that a combination of physical therapy, strength training, and psychological preparation significantly enhances both the speed and quality of recovery.

The literature emphasizes that, with proper adherence to rehabilitation protocols, most athletes can return to sport within 6 to 12 months, with a reduced risk of reinjury and improved knee stability. These findings highlight the importance of a multidisciplinary approach to optimizing rehabilitation outcomes.

Discussion

Rehabilitation following an anterior cruciate ligament (ACL) injury requires a detailed and precise approach to ensure athletes can successfully return to their previous level of activity. This study analyzed various rehabilitation protocols, each with distinct advantages and limitations (Table 2). Research highlights the importance of timely and tailored interventions, as supported by literature (Brinlee et al., 2022; Buckthorpe et al., 2024).

Standardized protocols provide clearly defined guidelines that facilitate a gradual return to sport, reducing anxiety during recovery and enhancing athletes' mental preparation (Gokeler et al., 2022). However, concerns remain regarding the potential for premature progression, particularly in athletes under the age of 20, which may elevate the risk of reinjury (Gokeler et al., 2022).

The Delevar and Melbourne Protocols analysis demonstrates its high efficacy during the early stages of rehabilitation but highlights the need for individualized approaches in later phases as athletes prepare for sport-specific activities (Brinlee et al., 2022; Filbay, 2023a). Research conducted by Grindem found that 74 out of 83 patients returned to sport within two years, with an average return time of eight months post-ACL reconstruction. Athletes who met return-to-sport (RTS) criteria showed an 84% lower reinjury rate. Strength testing, particularly addressing quadriceps strength deficits, proved crucial, as patients with an average Limb Symmetry Index (LSI) of 84.4% avoided reinjury (Grindem et al., 2016).

ACL Return-to-Sport (RTS) Protocol emphasizes functional and mental readiness testing, critical for athletes aiming to return to competition quickly (Gokeler et al., 2022). However, it risks pressuring athletes to resume play before achieving optimal physical readiness, underlining the importance of valid RTS criteria tailored to age and sport-specific demands.

Cross Bracing Protocol is a nonoperative approach that facilitates an earlier start to rehabilitation and reduces the need for surgical intervention (Filbay, 2023b). While it significantly improves clinical outcomes for athletes seeking rapid returns without surgery, its reliance on specialized orthopedic devices (braces) and potential limitations in mobility during initial stages pose challenges. The limited availability of these devices further restricts its application in everyday rehabilitation practices.

Optimizing Late-Stage Rehabilitation and Return-to-Sport Protocol is vital in later rehabilitation stages, incorporating physical and psychological assessments critical for a safe return to play (Buckthorpe, 2019). However, it presents challenges for athletes recovering quickly, as rapid progression may risk premature advancement to subsequent phases. Comprehensive testing for elite athletes, including neuromuscular function, movement quality, load tolerance, and cardiovascular endurance, is essential.

The analysis concludes that no protocol is universally applicable to all athletes. Individualized rehabilitation should be a cornerstone of planning and implementing these protocols. Beyond the physical aspects of recovery, significant emphasis must be placed on athletes' psychological readiness. Returning to sport depends not only on physical capabilities but also on mental preparation to face the challenges of reinjury and competitive pressure.

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Table 2. Advantages and Disadvantages of Rehabilitation Protocols Following ACL Injury in Athletes

Protocol Rehabilitation	Advantages	Disadvantages
Delaware Protocol	Clearly defined phases of rehabilitation, with precise monitoring of progress.	The possibility of overly rapid progression through phases, depending on the time factor.
Melbourne Protocol	Gradual return to sport, with a focus on balance and agility.	Generalization in application, dependent on the time factor.
ACL Return to Sport (RTS) Protocol	Focus on functional testing and mental readiness.	Some athletes may become overly reliant on tests rather than functional progress.
Cross Bracing Protocol (non-operative)	Less invasive, faster rehabilitation start, reduced need for surgery, and improved clinical outcomes.	Limited mobility, consistent adherence to the protocol, dependence on rehabilitation, exclusivity of patients, lack of specialized devices (orthoses), and insufficient long-term research.
Optimizing the Late Stage Rehabilitation and Return to Sport	Focus on the later stages of rehabilitation, with a high degree of controlled return to sport.	There is insufficient focus on the earlier stages of rehabilitation.

Conclusion

The aim of this study was to analyze standard rehabilitation protocols following anterior cruciate ligament (ACL) injuries in athletes, with a specific focus on their advantages and limitations. Based on the analysis, it was confirmed that while standard protocols are useful for establishing clear guidelines, their applicability is limited, particularly when considering the individuality of each athlete.

The hypotheses proposed in the introduction—that rehabilitation using standard protocols can contribute to a more effective return to competition but may also have inherent weaknesses—were confirmed. Although protocols such as Delevar, Melbourne, ACL Return-to-Sport (RTS), Cross Bracing Protocol, and Optimizing Late-Stage Rehabilitation and Return-to-Sport provide a solid foundation for rehabilitation, the research revealed that premature progression and overgeneralization can increase the risk of reinjury. Furthermore, psychological aspects of rehabilitation are often underrepresented, despite the critical role of mental readiness in a successful return to sport. The findings underscore the necessity of individualized rehabilitation to achieve optimal outcomes. Athletes should be treated in a manner that considers not only their physical readiness but also their specific needs and mental preparation for returning to sport. Additionally, particular attention should be paid to the late stages of recovery, when athletes are preparing to face the challenges of returning to competition. This study highlighted the importance of continuously adapting rehabilitation protocols to mitigate the risks associated with premature progression and excessive reliance on fixed timeframes instead of functional tests. Future research should delve deeper into the psychological dimensions of rehabilitation and explore the role of specific physical readiness tests that can ensure a safer return to competition. From a practical perspective, rehabilitation protocols should not be applied uniformly. Instead, they should be tailored to the specific characteristics of each athlete, their physical capabilities, and their psychological preparation to handle the challenges of reintegrating into competitive sports.

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UDK 796:616-001

Standardni protokoli rehabilitacije nakon povrede prednjeg ukrštenog ligamenta (PUL) kod sportista – prednosti i mane

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Uvod

Povrede prednjeg ukrštenog ligamenta (PUL) su među najčešćim povredama u sportovima visokog intenziteta, posebno onima koji uključuju nagle promene pravca, rotacije i velike sile opterećenja, kao što su fudbal, košarka, rukomet i tenis. Prednji ukršteni ligament (PUL) je ključan za stabilnost kolena i sprečava prekomerno pomeranje tibije u odnosu na femur. Povrede ovog ligamenta obično zahtevaju dugotrajan oporavak, koji se može postići uz primenu odgovarajućih rehabilitacionih protokola (Brinlee et al., 2022; Buckthorpe et al., 2024).

Rehabilitacija nakon povrede PUL-a ima ključnu ulogu u vraćanju funkcionalnosti, smanjenju bola, sprečavanju komplikacija i ponovnih povreda, kao i povratku sportista na teren. Iako se protokoli rehabilitacije razlikuju u zavisnosti od vrste povrede zgloba kolena, opsega povrede i sporta, glavni cilj svih metoda je da se postigne potpuna obnova pokretljivosti i stabilnosti kolena, uz minimalno vreme oporavka (Buckthorpe et al., 2024).

Postoje dva osnovna pravca rehabilitacije nakon povrede PUL-a: konzervativna (neoperativna) rehabilitacija i operativna rehabilitacija nakon rekonstrukcije ligamenta. Svaki od navedenih pristupa ima svoje specifičnosti, sa različitim etapama, vežbama i strategijama za postizanje maksimalne efikasnosti (Buckthorpe et al., 2020; Diermeier et al., 2020; Filbay, 2023b). Zbog toga je izuzetno važno imati dobro definisane smernice za rehabilitaciju, kao i razumeti prednosti i mane različitih pristupa.

Problem koji se javlja u rehabilitaciji sportista sa povredom PUL-a jeste kako odabrati adekvatan rehabilitacioni protokol koji će omogućiti bezbedan povratak na teren u optimalnom vremenskom okviru, ali i smanjiti rizik od ponovnih povreda. Iako postoje standardni protokoli rehabilitacije, njihov uspeh može značajno varirati u zavisnosti od sporta, ozbiljnosti povrede i specifičnih potreba sportista (Lynch et al., 2015). Izdvojene su hipoteze koje će biti ispitane u ovom radu:

1. Standardni protokoli rehabilitacije koji kombinuju kinezi terapiju i operativne zahvate imaju kvalitetniji oporavak u pogledu povratka sportista na teren.
2. Personalizovani pristup rehabilitaciji, prilagođen specifičnostima sporta, može značajno smanjiti rizik od ponovnih povreda i kvalitativno unaprediti proces oporavka.

Cilj ovog rada je da ukaže na prednosti i mane standardnih protokola rehabilitacije nakon povrede PUL-a, analizirajući kako različiti pristupi utiču na oporavak sportista i povratak u sportsku aktivnost.

Metode

Za potrebe ovog istraživanja sprovedena je sistematska pretraga dostupne literature kako bi se prikupili relevantni radovi koji analiziraju rehabilitaciju nakon povrede prednjeg ukrštenog ligamenta (PUL) kod sportista. Elektronske baze podataka, pre svega MEDLINE (PubMed), korišćene su za pretragu relevantnih studija. Pretraga je bila ograničena na period od poslednjih 10 godina (2014–2024) kako bi se obezbedio uvid u najnovije metode rehabilitacije, jer su noviji podaci ključni za razumevanje trenutnih pristupa u rehabilitaciji PUL-a.

Upotrebom ključnih reči kao što su „rehabilitacija nakon povrede PUL", „PUL protokoli rehabilitacije", „povratak u sport nakon povrede PUL" i „postoperativna rehabilitacija PUL", pronađeno je ukupno 517 radova. Ovi radovi su potom analizirani prema sledećim kriterijumima uključivanja:

- Tip studije: Samo studije koje se bave rehabilitacijom PUL-a kod sportista, nezavisno od nivoa takmičenja (profesionalni, amaterski).
- Vrsta rehabilitacije: Uključene su studije koje razmatraju kako konzervativne, tako i postoperativne protokole rehabilitacije.
- Jasna povezanost sa povratkom na sport: Samo studije koje se bave povratkom sportista u sportske aktivnosti nakon rehabilitacije.
- Period oporavka: Studije koje pružaju podatke o vremenskim okvirima oporavka i povratka na sport nakon povrede PUL-a.
- Rezultati: Samo studije koje nude konkretne rezultate i zaključke o efikasnosti rehabilitacije i potencijalnim prednostima ili manama različitih protokola.

Nakon preliminarne analize, izdvojeno je 10 relevantnih studija koje su se najviše bavile rehabilitacijom PUL-a i povratkom sportista na teren, nezavisno od nivoa takmičenja. Ove studije obuhvataju različite metodološke pristupe, uključujući meta-analize, randomizovane kontrolisane studije i longitudinalna istraživanja. Izabrane studije analizirane su kako bi se identifikovale ključne strategije rehabilitacije, faktori koji utiču na efikasnost rehabilitacije i njihova primena u praksi. Analizirani su relevantni parametri kao što su trajanje rehabilitacije, broj ponovnih povreda, vreme povratka u sport i rezultati testova post-rehabilitacije.

Rezultati

U pretrazi literature, identifikovano je nekoliko rehabilitacionih protokola koji se koriste za povratak sportista nakon povrede prednjeg ukrštenog ligamenta (PUL). Ovi protokoli pružaju različite pristupe rehabilitaciji, uključujući kineziterapiju, trening snage, psihološku pripremu i specifičnu metodologiju treninga za povratak sportu.

Prema Brinlee i saradnicima (Brinlee et al., 2022), uspeh rekonstrukcije PUL-a zavisi od preoperativne i postoperativne rehabilitacije, a prelaz između faza je specifičan za svakog sportistu (Buckthorpe, 2019; Buckthorpe et al., 2020; Buckthorpe et al., 2024).

Rana faza rehabilitacije, koja uključuje vežbe stabilnosti i snage, predstavlja temelj uspešne rehabilitacije (Buckthorpe et al., 2024).

U Tabeli 1 je prikazano 5 poznatih protokola rehabilitacije PUL-a, sa ključnim faktorima uspeha, periodima povratka u sport i rezultatima na osnovu relevantnih studija.

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Tabela 1. Pregled poznatih rehabilitacionih protokola nakon povrede PUL kod sportista i ključni faktora uspeha

Naziv protokola rehabilitacije	Opis protokola	Ključni faktori uspeha	Studije koje se bave protokolom
Delaver protokol	Fokusira se na postepeno povećanje opterećenja uz naglasak na snazi i stabilnosti.	Postepeno povećanje opterećenja, jačanje mišića i stabilnost kolena.	(Brinlee et al., 2022; Grindem et al., 2016; Lynch et al., 2015)
Melburn protokol	Postepeni povratak sportskim aktivnostima sa naglaskom na ravnotežu i agilnost.	Ravnoteža, agilnost, smanjenje bola.	(Filbay, 2023a)
PUL Povratak u sport (PUS) protokol	Protokol koji se bazira na testiranju sposobnosti povratka sportu na osnovu fizičke spremnosti.	Sposobnost povratka sportu, testiranje funkcionalnosti i mentalne spremnosti.	(Gokeler et al., 2022)
Kros Brejsing Protokol (neoperativni)	Fokusira se na brži povratak rehabilitaciji bez potrebe za hirurškom intervencijom, korišćenjem specijalizovanih uređaja (ortoza) za stabilizaciju kolena.	Korišćenje ortoza, minimalan broj invazivnih intervencija, brži početak rehabilitacije.	Nema veliki broj dugoročnih studija, ali se koristi u praktičnoj primeni (Filbay, 2023b)
Optimizacija zadnje faze rehabilitacije i Povratak u Sport Proces Treninga i Testiranja	Protokol za optimizaciju kasnijih faza rehabilitacije i povratak sportu.	Kasnije faze rehabilitacije, specifičan trening i testiranje.	(Buckthorpe, 2019; Buckthorpe et al., 2020)

Svaki protokol ima specifične metode rehabilitacije i koristi različite pristupe kako bi se osigurao uspešan povratak sportista na teren. Studije koje se citiraju u tabeli pokazuju da kombinacija fizikalnih terapija, treninga snage i psihološkog pripremanja značajno doprinosi brzini i kvalitetu oporavka.

U literaturi se naglašava da, uz pravilno praćenje protokola, većina sportista može da se vrati na teren u roku od 6 do 12 meseci, sa smanjenim rizikom od ponovnih povreda i poboljšanom stabilnošću kolena.

Diskusija

Rehabilitacija nakon povrede prednjeg ukrštenog ligamenta (PUL) zahteva detaljan i precizan pristup kako bi se sportisti što uspešnije vratili na svoj prethodni nivo aktivnosti. U ovom istraživanju analizirani su različiti rehabilitacioni protokoli, a svaki od njih ima svoje specifične prednosti i mane (Tabela 2). Prema istraživanjima, uspeh rehabilitacije zavisi od pravovremenog i specifičnog pristupa, kako se navodi u literaturi (Brinlee et al., 2022; Buckthorpe et al., 2024).

Standardizovani protokoli pružaju jasno definisane smernice koje sportistima omogućavaju postepeni povratak u sport, što može smanjiti anksioznost tokom oporavka i doprineti njihovoj mentalnoj spremnosti (Gokeler et al., 2022). Međutim, važno je napomenuti da i dalje postoji zabrinutost u vezi sa mogućnošću prebrzog napredovanja kroz rehabilitaciju (posebno kod sportista mlađih od 20 godina), što može povećati rizik od ponovne povrede (Gokeler et al., 2022)

Analizirajući Delaver i Melburn protokol, važno je naglasiti njihovu efikasnost u ranoj fazi rehabilitacije, ali i potrebu za individualnim pristupom u kasnijim fazama kada se sportisti pripremaju za povratak u sport (Brinlee et al., 2022; Filbay, 2023a). U istraživanju Grindem i sar., 74 od 83 pacijenta su se vratila u sport u roku od 2 godine, a prosek vremena povratka u vrhunski sport je 8 meseci nakon operacije PUL-a. Pacijenti koji su prošli RTS (Return To Sport) kriterijume, pokazali su 84% nižu stopu ponovnih povreda. Jedna od bitnijih komponenti u RTS-u je da se proveri deficit snage kvadriceps-a. Kod 51 pacijenta koji su imali, u proseku, jačinu kvadriceps-a na 84,4% (preporučen LSI (Limb Symmetry Index) je od >90%) nisu doživeli ponovnu povredu (Grindem et al., 2016). PUL Povratak u sport (PUS) protokol postavlja visok fokus na testiranje funkcionalne i mentalne spremnosti, što je ključ za sportiste koji žele brzo da se vrate u takmičenja (Gokeler et al., 2022). Ipak, ovaj protokol može izvršiti pritisak na sportiste da se vrate na teren pre nego što postignu optimalnu fizičku spremnost, pa je validnost kriterijuma za PUS izuzetno bitna, kako prema uzrasnoj kategoriji, tako i prema sportu u koji se sportisti vraćaju. Kada se analizira Kros Brejsing Protokol, njegova najveća prednost je u tome što predstavlja neoperativni pristup i na takav način omogućava brži početak rehabilitacije i smanjenje potrebe za operativnim zahvatima (Filbay, 2023b).

Ovaj protokol nudi i mogućnost značajnog poboljšanja kliničkih ishoda, posebno kod sportista koji žele da se što pre vrate u aktivnost, bez operacije. Međutim, jedan od glavnih izazova ovog protokola je njegova zavisnost od posebnih ortopedskih uređaja (ortoza), kao i to što može doći do ograničenja pokretljivosti tokom početnih faza rehabilitacije. Zbog nedostatka specijalizovanih uređaja u mnogim slučajevima, ovaj pristup nije široko primenljiv u svakodnevnoj rehabilitaciji, što dodatno komplikuje njegovu implementaciju u praksi. Optimizacija zadnje faze rehabilitacije i povratak u sport, proces treninga i testiranja je od posebne važnosti u kasnijim fazama rehabilitacije, jer uključuje testiranje fizičkih i psiholoških sposobnosti koje su ključne za siguran povratak na teren (Buckthorpe, 2019). Međutim, i ovaj protokol pokazuje određene izazove kada se primenjuje na sportiste koji se brzo oporavljaju, jer postoji rizik da prebrzo napreduju prema sledećoj fazi. Testiranje za povratak na sportski teren/borilište, naročito kod elitnih sportsita, zahteva sveobuhvatnost - procenu neuromišićne funkcije, kvalitet pokreta, procenu opterećenja i kardiovaskularnu izdržljivost. Prema analiziranim podacima, zaključak je da nijedan protokol nije univerzalno primenljiv na sve sportiste. Individualizacija rehabilitacije treba da bude ključni faktor u planiranju i primeni ovih protokola. Pored fizičkih aspekata rehabilitacije, veliki značaj treba dati i psihološkoj spremnosti sportista, jer povratak u sport ne zavisi samo od telesne sposobnosti, već i od mentalne pripremljenosti da se suoče sa izazovima ponovnih povreda i pritiska takmičenja.

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Tabela 2: Prednosti i mane rehabilitacionih protokola nakon povrede PUL kod sportista

Protokol rehabilitacije	Prednosti	Mane
Delaver protokol	Jasno definisane faze rehabilitacije, precizno praćenje napretka.	Mogućnost prebrzog napredovanja kroz faze, zavisnost od vremena.
Melburn protokol	Postepeni povratak u sport, fokus na ravnotežu i agilnost.	Generalizacija u primeni, zavisnost od vremena.
PUL Povratak U Sport (PUS) protokol	Fokus na testiranju funkcionalnosti i mentalne spremnosti.	Neki sportisti mogu biti previše zavisni od testova, a ne funkcionalnog napretka.
Kros Brejsing Prtokol (neoperativni)	Manje invazivan, brži početak rehabilitacije, smanjena potreba za hirurgijom, poboljšanje kliničkih ishoda.	Ograničenje u pokretljivosti, dosledno pridržavanje protokola, zavisnost od rehabilitacije, isključivost pacijenata, nedostatak specijalizovanih uređaja (ortoze), nedovoljno istraživanja na duže staze.
Optimizacija Zadnje Faze Rehabilitacije i Povratak U Sport Proces Treninga i Testiranja	Fokus na kasniji deo rehabilitacije, visok stepen kontrolisanog povratka sportu.	Nema dovoljno fokusiranja na ranije faze rehabilitacije.

Zaključak

Cilj ovog istraživanja bio je da se analiziraju standardni protokoli rehabilitacije nakon povrede prednjeg ukrštenog ligamenta (PUL) kod sportista, sa posebnim fokusom na njihove prednosti i mane. Na osnovu analize, potvrđeno je da standardni protokoli, iako korisni u postavljanju jasnih smernica, imaju određene ograničene primene, naročito kada se uzme u obzir individualnost svakog sportiste.

Hipoteze postavljene u uvodu, prema kojima se očekivalo da rehabilitacija uz primenu standardnih protokola može doprineti kvalitetnijem povratku sportista u takmičenja, ali i da imaju svoje slabosti, potvrđene su. Iako standardni protokoli kao što su Delaver, Melburn, PUL Povratak u sport (PUS), Kros Brejsing Protokol i Optimizacija zadnje faze rehabilitacije i povratak u sport proces treninga i testiranja nude solidne temelje za rehabilitaciju, istraživanje je pokazalo da prebrzo napredovanje i generalizacija mogu povećati rizik od ponovnih povreda. Pored toga, psihološki aspekti rehabilitacije često nisu dovoljno zastupljeni, a mentalna spremnost sportista je ključna za uspešan povratak u sport.

Prema svemu navedenom, može se zaključiti da je individualizacija rehabilitacije neophodna za postizanje optimalnih rezultata. Sportisti bi trebalo da budu tretirani na način koji uzima u obzir ne samo fizičku spremnost, već i njihove specifične potrebe i mentalnu pripremu za povratak u sport. Takođe, ključno je da se u rehabilitaciji pridaje poseban značaj kasnim fazama oporavka, kada su sportisti spremni da se suoče sa izazovima povratka na teren i ponovnih takmičenja.

Ovo istraživanje je ukazalo na to da bi se protokoli rehabilitacije trebali stalno prilagođavati, kako bi se izbegli potencijalni problemi povezani sa prebrzim napredovanjem i prekomernim oslanjanjem na vremenske okvire, umesto na funkcionalne testove.

Za buduća istraživanja, potrebno je dublje proučiti psihološke aspekte rehabilitacije, kao i ulogu specifičnih testova fizičke pripremljenosti koji mogu osigurati sigurniji povratak sportista na teren. Preporuka za praktičnu primenu ovog istraživanja je da se protokoli ne primenjuju uniformno, već da se uzmu u obzir specifične karakteristike svakog sportiste, njegove fizičke sposobnosti, kao i psihološka spremnost da se suoči sa izazovima povratka u takmičarski ritam.

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UDK 796:612

Heart rate response to increase in „G FORCE“ during flight

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Introduction

Gliding (soaring) is the process of taking advantage of favourable wind conditions to extend flight duration (Lawrance and Sukkarieh, 2011). It's not all about the wind, there are also so-called thermal columns (or just thermal) that glider pilots use to increase their altitude. The flight inside the thermal column is almost completely circular.

Gliding is one of the few sports in which the entire body of the competitor is exposed to higher amounts of acceleration than standard 9.81 m/s2 (1g or just g) for (quite) a long period of time. The reason for this is that in circular motions, due to the change in the direction of the velocity vector (and possibly the change in the amount of velocity), the object is constantly exposed to the influence of centripetal acceleration. In the general population, the term «g force» is often heard, although it is actually about acceleration (as a result of the action of a force) and not force. Circlings are an integral part of every glider flight when covering longer distances. The cause of every circular motion is the influence of the centripetal force, so every particle of the rotating object is exposed to the influence of this force and it can be said that the weight of each particle is increased. It definitely affects some physiological functions of the organism, and thus training needs to be adapted to those conditions (Andersen at al., 2017).

During one flight, pilots find themselves in such situations as many times as the situation requires of them, so the number, duration and intensity cannot be predicted. Preparing for situations whose number, duration and intensity cannot be predicted are the nightmare of every fitness trainer. Since the weight of each particle is increased (up to several times, depending on the applied force), the heart's work is more difficult and the body must somehow respond to such newly created conditions. Searching the previous literature, we saw that there is a lack of studies on the physiology of the human body during glider flight, so we thought that this is a good start, especially considering the fact that we had the opportunity to measure and analyse real competitive flight. The chronic effects of regular exposure to high acceleration levels (g force) on the neuro-cardiovascular system are unclear (Rangel at al., 2023). Convertino (2001) tested the hypothesis that repeated exposure to high acceleration (g) would be associated with enhanced functions of specific mechanisms of blood pressure regulation.

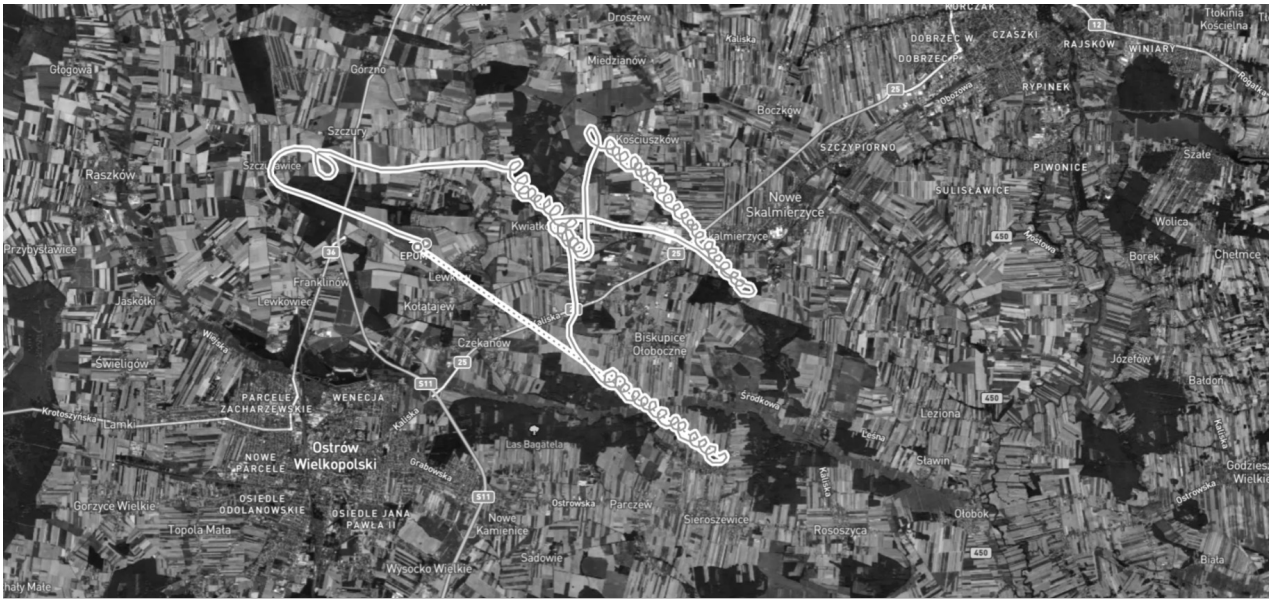

Figure 1. Observed flight trajectory with visible circling during which the pilot (theoretically) experiences an increased amount of acceleration

As the increase in heart rate is one of the logical responses to new conditions, we decided to monitor heart rates (HR) during the flight. It is at the same time the simplest and most effective solution in a situation such as the world championship, because hardly any pilot will agree that in such a situation (where the stake is high) you burden him with measuring devices, increase the mass of his glider, reduce the space in the cockpit, distract him from the flying task, reduce the safety of the glider, We hypothesized that pilot's heart rate should be increased every time he makes a circular motion no matter how. It is precisely this «how» that is important, because the amount of centripetal force and, consequently, centripetal acceleration depends on some parameters such as flight speed, circling radius, roll around longitudinal axis of the sailplane, «controllability» of the turn... Figure 1 shows that in the analyzed flight the pilot had quite a number of circlings. The aim of this paper was to determine if there are statistically significant differences in heart rate values during periods when the pilot is circling (>1g) and periods when he is flying (relatively) straight (approximately 1g).

Methods

Data collection was conducted in Poland during an official glider flight at the 35th FAI World Aeronautical Gliding Championship (2018) in the standard class. The pilot was a Croatian representative, 1.79 m tall, weight 85 kg, smoker. The model of the glider used during the entire competition was the ASW24. A Polar H7 device was used to record HR data. Heart

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rate data was recorded during the entire flight and later divided into groups with the help of flight information recorded with a flight data logger. The first group (HR1) consisted of heart rates recorded during a circle flight (>1g), and the second (HR2), heart rates recorded during a straight flight (approximately 1g). The duration of the observed flight was 5 hours and 5 minutes. The data were analyzed with statistical data processing program Statistica, version 14. The t-test for independent samples was used to determine whether there are significant differences in average HR values between the period when the pilot is affected by approximately 1g and the period when he is affected by more than 1g, with the assumption that the pilot's body will respond to an increase above 1g by increasing HR.

Results

Table 1 shows the results of descriptive statistics for the HR variable, as well as two variables obtained by grouping the HR variable into group 1 (group of heart rates during circling) and group 2 (group of heart rates during straight flight).

What is immediately noticeable is that the arithmetic mean values for the two observed groups of heart rates differ by barely more than one heart beat. Likewise, we observe that the value of the arithmetic mean for the variable HR1 is higher than the value of the arithmetic mean for the variable HR2.

Table 1. Descriptive statistics for observed variables

	Group	Valid N	Mean	Min.	Max.	Std. Dev.	Skew.	Kurt.
HR (bpm)	All	18383	99.51	80.00	133.00	8.07	1.42	2.30
HR 1 (bpm)	1	5507	98.39	86.00	124.00	6.24	0.86	0.84
HR 2 (bpm)	2	12876	99.98	80.00	133.00	8.69	1.41	2.33

Legend: HR- heart rate, HR1 – heart rate of group 1 (during increased g), HR2 - heart rate of group 2 (during standard g), bpm – beats per minute, Valid N – number of samples, Min. – minimal result, Max. – maximal result, Std. Dev. – standard deviation, Skew. – Skewness measure of asymmetry of distribution, Kurt. – Kurtosis measure of the tailedness of a distribution

The histograms shown in Figure 2, Figure 3 and Figure 4 show that the distributions of the variable scores, although they appear so at first glance, are not normal:

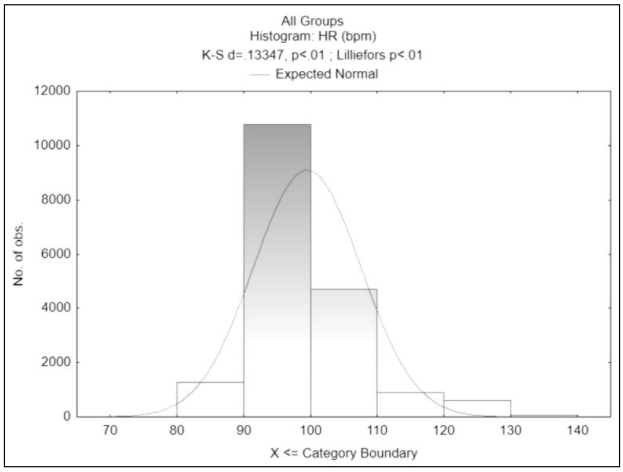

Figure 2. Distribution of all heart rate data

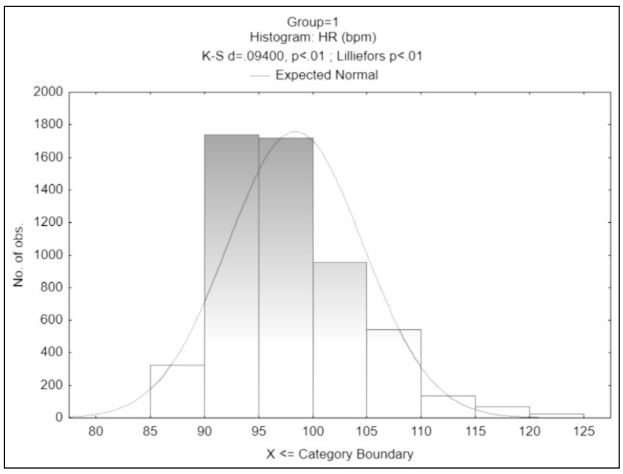

Figure 3. Distribution of heart rate data for group 1 (heart rate during increased g)

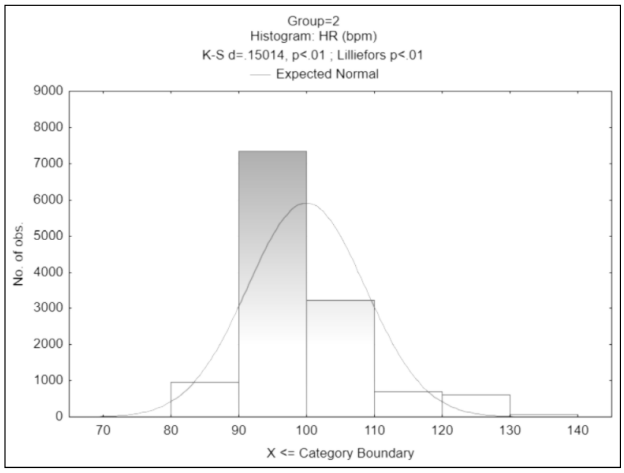

Figure 4. Distribution of heart rate data for group 2 (heart rate during standard g)

Since the normality of the distribution is not such an important factor in the t-test that it would fundamentally affect the calculation of the p level (robust method in relation to impaired normality), the significance of the differences between groups 1 and 2 was tested with the help of the parametric t-test for independent samples.

As with the t-test for independent samples, the test value does not integrate the correlation coefficient, in this structure the possibility of the first type error is increased, so we reduced the error to the p=0.01 level as a limit for statistical inference. Table 2 shows the results of the t-test between groups HR1 and HR2 obtained by grouping the variable HR.

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Table 2. t-test between two groups of observed variables

	Mean 1	Mean 2	t-value	df	p	Valid N 1	Valid N 2
HR (bmp)	98.39	99.98	-12.29	18381.00	0.000*	5507.00	12876.00

Legend: HR – heart rate, bpm – beats per minute, Mean 1 – mean for group 1 (during increased g), Mean 2 - mean for group 2 (during standard g), * - statistically significant, Valid N 1 – number of samples in group 1 (during increased g), Valid N 2 – number of samples in group 2 (during standard g)

Discussion

Although the values of the arithmetic means show a small difference in the average values (barely more than one heart beat), the results of the t-test for independent samples still show a significant difference in HR between the observed flight periods ($p<0.00000...$). We can attribute this statistically significant difference, between the heart rate groups that we compared, to the sample size, i.e. the large number of heart rate data collected during the flight (5507 for group 1 and 12876 data for group 2). With such a large number of samples, even the smallest differences will turn out to be statistically significant, although in reality, in this case, we see that the difference in the arithmetic means of the groups is small (in any case, smaller than expected). Although the mentioned difference is small, it is interesting that a lower value of the arithmetic mean was recorded for the group of heart frequencies recorded during circling in flight, which is even contrary to the assumed and set hypothesis. Such an outcome is not surprising, although it is interesting. It is not surprising for several reasons and the first is that we had no information about the actual value of the accelerations during the flight. We considered situations with increased g to be any situation in which the pilot was circling because it is so according to the laws of physics (pure theory). Group 1 includes all heart rate data when the pilot was in circular motion with the glider, regardless of whether the acceleration value was significantly increased compared to the standard one (1g). This would specifically mean that the pilot was in situations where he was exposed to negligibly higher values than 1g, and thus the organism should not have reacted with any changes in physiological parameters such as heart rate. This problem could be solved by using a so-called «g meter» that can record acceleration values during the entire flight. In this way, the acceleration values could even be sorted into certain groups with regard to their values and then compared with the corresponding values of the heart rates. Reason two, since this is an experienced pilot, a member of the national team, it was to be expected that the organism would not react to small changes. Convertino (2001) states that the results of his research support the hypothesis that exposure to repeated high g is associated with increased capacities of mechanisms that underlie blood pressure regulation. We should not ignore the fact that the observed flight lasted 5 hours and 5 minutes, during which the lowest recorded value of the heart rate was 80 beats per minute (Table 1). Flights can last longer and be more physiologically and psychologically demanding than the flight observed in this research. The average value of the heart rate during the entire observed flight was 99.51 bpm (Table 1), which indicates the need for good aerobic abilities of the pilot, because rarely any sporting activity can last so long and take place for several days (weeks) in a row. Like any study, this one has some limitations. One of them is the fact that no other parameters that could influence the change in heart rate were observed. There are many reasons why a pilot could be exposed to stress during a flight and Shah, Kumari and Jain (2024) state that one of the physiological biomarkers associated with stress is change in heart rate. Spasić (2024) published a study in which he concluded that there is a connection between the height at which the pilot is currently with the glider and the pilot's heart rate. In this research, we did not take height into account, so in some future research it would be good to combine it together with the values of acceleration and heart rate. Onwards, no actual acceleration values corresponding to a specific heart rate value were recorded for the entire flight time. In future research, it would be good to measure the actual acceleration values at a certain heart rate in order to get a clearer picture of the correlation between these two variables. Then the testing of statistical significance between the two groups of heart rates with the t-test would have a greater value. Additionally, if there is a correlation, one could see what kind of connection it is, or what the heart rate response looks like (linear or not).

For future research, we can recommend that it would be good (in addition to the things listed as limitations of this study) to monitor spirometric parameters also, considering that small and portable spirometers are available today.

Conclusion

The research revealed significant HR differences between the observed flight periods (1g vs >1g). Nevertheless, the significance of the differences should be attributed to the large number of recorded and processed HR data. It seems that the conditions during the observed flight periods did not present a challenge to the pilot enough to cause a noticeable change in heart rate. This information is important for planning the physical preparation of pilots and shows how aerobic training, along with the others, should be an indispensable part of their physical preparation.

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UDK 796: 659.3

The role of mass media in promoting physical activity: a review

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Introduction

Everything that happens in our country and at the global level is transmitted through the media. The media occupy a very important place in providing information from the world of sports, science, politics, art and life. Thanks to media channels (television, radio, newspapers and magazines, internet), all important information of importance for society reaches every person quickly and efficiently. The technological revolution has enabled this kind of efficient transfer of the most important information between media companies and ordinary people. For example, modern mobile phones allow a person on the move to keep up with all the happenings, which was not possible before. Furthermore, the Internet has brought us the era known as "internetization", without which it would not be possible to function in business and ordinary, personal life. That "internetization" works flawlessly, without interruptions, which means that the communication between previously published and the latest information flows perfectly. Television enables the transmission of the most important information from the scene by professional journalists and reporters. Such transmission is the communication between the reporting professionals and the viewers who accept the auditory and visual information served to them through television. Therefore, it is a very complex communication that combines the ability of television to show reality, as well as the ability to process information in the central nervous system (CNS), which enables the correct interpretation of the presented facts. It is clear that communication with the public is the foundation of successful media functioning, which means that it must be at an extremely high and professional level. It is worth noting the role of radio in informing the public about all relevant events related to all aspects of life. Unlike television, which visually shows events from the scene, radio as a special medium allows listeners to be informed in a timely manner anywhere and at any place. Also, the special charm of this medium is reflected in the fact that it allows listeners to be imaginative in understanding the events themselves, i.e. in creating images of them in their minds. Newspapers and magazines represent, in a way, a "conversation" between the authors of the texts themselves and the readers who analyze the information translated into written journalistic words. Some newspapers have a high circulation, while others have a low circulation, which indicates the quality of the editorial policy and employees in the newsrooms. Thanks to the mass distribution of newspapers and subscriptions to digital editions, it is now easier to get information about important aspects for a better understanding of the situation in the country and the world. Newspapers and magazines, without any doubt, represent one of the most important pillars of the mass media.

When it comes to sports and sports culture, mass media contribute to a better understanding of sports results achieved at international and national competitions or matches. A distinction should be made between media of public and sports interest, because sports media are specialized in following sports events, while media of public interest are focused on important social events from the economy, politics, health, etc. Regardless of the differences between public interest and sports media, both media use the same media channels. For a better understanding, it is worth citing an interesting example that illustrates the power that mass and social media have in shaping our thinking and behavior. During the most difficult days of the pandemic caused by the SARS-CoV-2 virus, known as COVID-19, the media machinery significantly contributed to better informing the public about the harmfulness of the virus to the human body.

In support of this, Anwar, Malik, Raees & Anwar (2020) in their review highlighted the significant contribution of the media to quality public information about the virus, its transmission and the epidemiological measures introduced to reduce the number of patients. Research by Al-Dmour, Masa'deh, Salman, Abuhashesh & Al-Dmour (2020), confirms the positive effect of using one of the social media platforms on the protection of public health during the COVID-19 pandemic. Source information, which is timely and accurate, can help society better understand the challenges it faces and successfully deal with them, as was the case during the pandemic. This example illustrates the positive impact of mass and social media on the behavior of individuals and society as a whole at a time when the virus was rampant and claimed millions of lives. The pandemic will no doubt be the subject of scientific debate for the next hundred years.

Numerous scientific studies support greater frequency in different forms and levels of recreational physical activity, because it consists of a set of different movement patterns that vary in biomechanical and physiological load. Levels of exercise, such as low, moderate, medium and intense, help the body to adapt and withstand different efforts without harming the heart. From a biomechanical point of view, the correct execution of movements leads to positive changes in muscle and bone tissue. A variety of movements improve muscle and bone function, which is essential for a healthy life. The modern era, marked by technological achievements that help people function in work and life, has also brought hypokinetic syndrome. Hypokinetic syndrome is a health hazard because it deprives a person of movement, metabolic and physiological changes that occur as a result of constant body movement due to flexor muscle contractions or agonists with a greater physiological response. A person is motorically active to some degree in certain situations both at work and at home. However, the constant motor activity of the entire kinetic chain causes significant metabolic-physiological changes in the body because it lasts for a longer period of time and involves a certain intensity. When there is insufficient metabolic emptying of fat depots through adequate movement, the body's activity slows down, which leads to a constant increase in the number of excessively obese people.

Promotion of physical activity through the media is necessary, if one considers the negative impact of hypokinetic syndrome on human health and well-being. For normal health functioning in life, it is necessary to be physically active at least three times a week for at least half an hour. This means that promotion through media channels should be focused on physical activity, because it is available to everyone, regardless of age and gender. From a health perspective, it has been proven that regular physical activity contributes to better physical and mental health (Gualdi-Russo & Zaccagni, 2021; Stamenković, Pantelić, Bubanj, Petković, Aksović, Preljević et al., 2024). Simply, the higher the level of physical activity, the better the health status of people. On the other hand, the lower the level of physical activity, the higher the probability of cardiovascular and other diseases (Ruiz, Ortega, Gutierrez, Meusel, Sjöström & Castillo, 2006).

In general, more frequent and better quality media information about the positive aspects of physical activity is an important step in combating hypokinetic syndrome. This syn-

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drome leads to sedentarism, which reduces motor actions that require higher values of metabolic equivalent (MET) compared to the resting state. The aim of this paper is to present research that determined the role of mass media in the promotion of physical activity in order to raise awareness of their role in increasing the overall level of physical activity.

Methods

In this paper, a descriptive analysis of previous research related to the role of mass media in the promotion of physical activity was applied. Google Scholar, Kobson and PubMed were used to search for previous research. Works published in the period from 2014 to 2024 were analyzed. Since television, radio, internet and newspapers are considered mass media, the papers will be grouped in this order. In order to find relevant works, the following keywords were used: television, impact, promotion, physical activity, exercise, health, radio, internet, magazines, recreational activities, media.

Results with discussion

The role of television in promoting physical activity and healthy lifestyles

It is known that the information we get through visual analysis of reality is more easily processed in an extremely powerful central unit called the CNS. Television has media power, thanks to which it can awaken viewers' interest in preserving and improving health through quality shows. This is crucial in the fight against health problems in modern society. In order to further investigate this phenomenon, sociologist Ljiljana Milošević (2011) analyzed the influence of television on the promotion of mental health. Her research showed that most respondents pay special attention to health-related messages in the media. Television, as the most widespread and popular medium, attracts a significant amount of viewers' attention; more than 87,7% of respondents get information about health through television. Also, 42,0% regularly follow the content, occasionally 36,4%, and rarely 9,3% of the survey participants. The author came to the conclusion that television, in addition to being an important source of information, also has a significant influence on health-related behavior and attitudes.

Television as a powerful media tool is a "technological miracle" that can improve the understanding of healthy aspects of recreational physical activity (Ahmad, Tahat, Safori, Al-Zpubi, Ahmad & Ananza, 2023). Ahmad et al. (2023a) conducted research with the aim of determining the impact of broadcasting a healthy way of physical exercise through television on better understanding and greater engagement of students. The research showed that men watched shows related to sports activities more than women. Furthermore, physically active students had the habit of watching programs about physical exercise on television, while this was not the case with physically inactive students. In contrast to physically inactive students, students who watched shows about physical exercise were far better informed about its health effects on the body. Thanks to the extensive show, it was shown that students coming from the University of Yarmouk had a better understanding of the positive effects of physical exercise compared to students whose residence is in the city of Zarqa. It has been proven that the duration of the show and program on exercise contributes statistically significantly to greater engagement of students in various forms and levels of recreational exercise. The conclusion of the mentioned study is expected, because it is known that a longer period of time is needed for a better understanding, regardless of whether it is about health or scientific shows and programs. On the other hand, the time duration of the show and program in itself does not lead to greater engagement of people in recreational forms of physical exercise, which means that in addition to the time duration, the frequency of broadcasting of such shows and programs should also be kept in mind. These results highlight the importance of media content in education about recreational physical exercise and health.

The study by the aforementioned authors (Ahmad et al., 2023b) clearly indicates the importance of developing awareness of the positive effects of physical activity through television. However, developing awareness about the positive effects of physical activity through television is a big challenge, especially because of the level of prior knowledge of viewers about the healthy benefits of recreation, as well as because of those who speak from a professional aspect about movement. This especially applies to children, whose cognitive abilities are developing, as well as to older people who may not be sufficiently familiar with the health benefits of physical activity. In this regard, mutual cooperation between television editorial policy and experts who talk about physical activity must be at a high level in order to achieve better information to the public. This means that information should be adapted so that it is understandable to both the youngest and the oldest. In order for the presentation to be successful, it is necessary for the expert to adhere to the concept of excellent expression with short and precise sentences.

Internet and physical activity

Modern times have brought a number of conveniences that make it easier for people to get the desired information in a fast and efficient way. Television, the Internet, mobile applications, social networks and specialized sports programs represent the basis of establishing communication between the world of sports and fans of sports and recreation. The Internet allows all of us to be continuously informed about all happenings at all times of the day and night. Through social networks, we can follow live events from sporting events, while mobile applications allow quick download of the latest news. While shows and programs have clearly defined start and duration times, the Internet is constantly active, without any time limit. For example, it is enough to type keywords related to sports on Google at any time of the day or night, which automatically leads to the desired data and portals from the world of sports. In addition, Internet users are given the opportunity to return countless times to the same page of content from the world of sports. When it comes to physical activity, the Internet is a friend to everyone who wants to get important information about physical activity in the fastest way. Thanks to the Internet, information about physical activity is becoming available to everyone, regardless of where they are. Research shows that proper use of the Internet can contribute to a higher level of physical activity in people (Zach & Lissitsa, 2016). Zach & Lissitsa (2016a) conducted a study to determine whether respondents who receive information about physical activity online will be more physically active compared to respondents who do not use the Internet. The data is based on a general social survey conducted by the Israel Central Bureau of Statistics in 2010. In the research of the mentioned authors, the total number of respondents was 6,305, aged from 20 to 65 years. The results of the logistic regression analysis showed that respondents who used the Internet more often were more active than respondents who did not use the Internet. Regarding the level of physical activity, the research confirmed that re-

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spondents who used the Internet were more active in physical activities of high and moderate intensity, while this was not the case with respondents who did not use the Internet. As can be seen, the Internet not only facilitates access to information about sports, but also plays a key role in promoting physical activity. Therefore, proper use of the Internet can significantly contribute to a healthier lifestyle and greater engagement in physical activities.

Radio and physical activity

Radio occupies an important place in informing the public about all aspects of social and political life, including physical activity. Unlike television, radio allows listeners to make an imaginative analysis of events from spoken words. This transformational process, in which words become imaginative images, represents the special value of radio as a medium. For example, during physical activity shows, radio often invites health and fitness experts to share exercise tips. In this way, experts motivate listeners to engage in physical activities and take care of their health. The content offered by radio helps listeners form their own opinions and images about the situation, which is especially important when visual information is only available through television or online media. Previous research has confirmed that radio messages can contribute to the promotion of healthy lifestyles (Diddi, Kumble & Shen, 2021; Smith, Menn & McKyer, 2011). In the context of physical activity, research has shown that radio can serve as a marketing promoter of physical activity (Balamurugan, Oakleaf & Rath, 2005).

Newspapers and physical activity

Newspapers have always been a key part of mass media. In this sense, the author Svjetlana Mokriš confirms the importance of newspapers in her work with the following explanation: "Newspapers, as one of the mass media in the modern information society, perform four basic roles: information, entertainment, persuasion and cultural transmission" (Mokriš, 2011). Thus, newspapers perform multiple functions, which makes them more complex to understand from the aspect of media science. Newspapers offer information on current topics, both in paper and electronic form. Thanks to the electronic format, the newspaper is available to everyone who subscribes to the digital editions.

A good newspaper text depends on the journalist's ability to describe events from different fields in an interesting and simple way. A well-written beginning of the text forms the basis of its further development, because a good beginning is followed by the rest of the text.

This means that if the beginning of the writing was successful, the completion of the writing will result in the text as a whole being well received by the readers. In this sense, the journalistic profession is extremely demanding, given that high productivity is expected from journalists continuously. From a reporting perspective, it is never simple, because quality texts depend on several factors that together form the basis of quality journalism, including the skill of constructing sentences, motivation, creativity, ability to react quickly and the emotional state of the journalist. For example, when covering a sports event, a sports journalist finds himself under stress because he is competing not only with competitors from other newsrooms, but also with deadlines. Timely reporting of news is crucial to ensure success and reputation in the journalism profession.

It is important to understand the mutual connection between journalists, the editorial policy of the newsroom, cooperation and the reputation that their newspaper has in society. Unlike other media, news media represent a complex functioning system, which means that there is no greater circulation and sales of printed newspapers if there is a lack of good, creative and interesting texts, as well as cooperation between journalists, editors and photojournalists. Photographs also make the complex system within the news media even more complex because newspapers cannot survive without good quality photographs. Photography is more than just a picture, it is an art that aims to unite reality with written text. If it is about sports, a sports photo must contain important elements that determine whether it will be published in the planned publication or not. In a research that dealt with the theoretical analysis of the artistic dimensionality of sports photography, the author Miloš Stamenković (2021) stated the four most important elements that should be in balance in order for the photo to fulfill its purpose: composition, angle, ratio of light-dark tones and captured moment. If any of the mentioned elements fall out of balance, the photo loses its quality. The photojournalist profession, like the journalistic profession, is extremely stressful due to the possibility of successfully or unsuccessfully completing tasks on the field, in terms of immortalizing the most important sports moments with a camera. It is clear that for a larger circulation of daily newspapers there must be a very strong connection between journalistic texts and quality photographic details from the world of sports and recreation. Journalists and photo-reporters represent the key pillars of the successful functioning of a media company, contributing to the realization of profits and strengthening of reputation on the international media scene.

Photography is proving to be an extremely powerful marketing tool that can help popularize movement as a source of health, well-being, enjoyment and entertainment. Psychologically speaking, photography has the power to stimulate people's inner motivation, which is key to successful functioning in all spheres of life, including sports and recreation. Along with quality newspaper text about physical activity and sports, a good and interesting photo can motivate readers to think about how to improve their health through physical activity.

Mass media and physical activity

Research shows that mass media can increase people's interest in physical activity and recreation (2020; Gulam, 2016; Rogala, 2017; Perdana, Sumaryanto, Saputra, Subekti & Abrori 2024; Günther, Schleberger, & Pischke 2021).

Sahu (2020a) in his paper entitled "Role of Mass Media in Sports Promotion", concludes that mass media significantly contribute to a better understanding of sports and increase the frequency of sports activities among respondents.

Gulam (2016a) in his research titled "Role of Mass Media in Sports Communication" explains the complexity of communication between sports media and the public. He points out that television, radio and the Internet contribute in different ways to a better understanding of sports. A significant difference was found between the transmission of sports information via radio and television. Radio satisfies the sensory aspects of listeners, while television allows viewers to witness the most important sporting events. The Internet also transmits sports information flexibly, allowing people to easily find the information they want.

An systematic review by the author Rogal (2017a) showed positive results in the promotion of healthy lifestyles through mass media. Research indicates that mass media

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act as one of the tools in the promotion of healthy lifestyles of adults through activities related to HP40P (Health Promotion for Older People). The results confirm the significant role of the mass media in acquiring knowledge and developing attitudes about health.

Research by Perdana et al. (2024a) focuses on the role of media from conventional to digital in sports and health. The descriptive-qualitative method was applied in the research, which included the study of literature and the analysis of the media in society. The sample of respondents was selected using the purposive sampling method in order to obtain data that reflect the characteristics of Indonesian society regarding the use of information obtained through the media. This research confirms the power of mass media in shaping opinions and behaviors related to healthy habits. People are armed with knowledge that helps in understanding the importance of activating the locomotor apparatus in various physical activities. The researchers concluded that the media increases the level of physical activity, which is crucial for maintaining and improving health fitness.

In a review by Günther et al. (2021a), papers investigating the effects of social media on the promotion of physical activity were analyzed. The results show that Facebook is the best social platform for promoting physical activity. More than a third of the analyzed research confirms the important role of social media in the promotion of physical activity. The main conclusion of the authors is that social media can stimulate people to be more physically active in various forms of recreational exercise.

Conclusion

Thanks to the mass media, people can easily access the most important information at any time of the day and in any place. Properly presented physical activity through the mass media can lead to the activation of passive and active parts of the locomotor apparatus, thereby reducing the negative impact of sedentarism on health. The paper theoretically explained that television, radio, internet and newspapers can "awaken" interest in planning physical activity, regardless of the differences between them. This role of mass media is crucial for promoting healthy lifestyles and improving general health.

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Uloga masovnih medija u promociji fizičke aktivnosti: pregledno istraživanje

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Uvod

Sve što se dešava u našoj zemlji i na globalnom nivou prenosi se putem medija. Mediji zauzimaju vrlo važno mesto u obezbeđivanju informacija iz sveta sporta, nauke, politike, umetnosti i života. Zahvaljujući medijskim kanalima (televizija, radio, novine i časopisi, internet), sve važne informacije od značaja za društvo, brzo i efikasno dolaze do svakog čoveka. Tehnološka revolucija je upravo omogućila ovakav efikasan transfer najvažnijih informacija između medijskih kuća i običnih ljudi. Na primer, savremeni mobilni telefoni omogućavaju čoveku koji je u pokretu da bude u toku sa svim događanjima, što ranije nije bilo moguće. Dalje, internet nam je doveo doba koje je poznato kao ,,internetizacija'' bez kojeg se ne bi moglo funkcionisati u poslovnom i običnom, ličnom životu. Ta ,,internetizacija'' funkcioniše besprekorno, bez prekida i zastoja, što znači da komunikacija između ranije objavljenih i najnovijih informacija teče savršeno. Televizija omogućava prenos najvažnijih informacija sa lica mesta od strane profesionalnih novinara i izveštača. Takav prenos predstavlja komunikaciju između profesionalaca koji izveštavaju i gledalaca koji prihvataju auditivne i vizuelne informacije koje im se serviraju preko televizije. Dakle, u pitanju je vrlo kompleksna komunikacija koja objedinjuje sposobnost televizije da prikaže stvarnost, kao i sposobnost obrade informacija u centralnom nervnom sistemu (CNS), što omogućava pravilnu interpretaciju iznetih činjenica. Jasno je da komunikacija sa javnošću predstavlja fundament uspešnog medijskog funkcionisanja, što znači da ona mora biti na izuzetno visokom i profesionalnom nivou. Vredi napomenuti i ulogu radija u informisanju javnosti o svim relevantnim događajima vezanim za sve aspekte života. Za razliku od televizije, koja prikazuje vizuelno događaje sa lica mesta, radio kao poseban medij omogućava slušaocima da budu pravovremeno informisani bilo gde i na bilo kom mestu. Takođe, posebna draž ovog medija ogleda se u tome što omogućava slušaocima da budu maštoviti u razumevanju samih događaja, tj. u stvaranju slika o njima u njihovim glavama. Novine i časopisi predstavljaju, na neki način, ,,konverzaciju'' između autora samih tekstova i čitalaca koji analiziraju informacije pretočene u pisane novinarske reči. Neke novine imaju visok tiraž, dok druge imaju nizak tiraž, što ukazuje na kvalitet uređivačke politike i zaposlenih u redakcijama. Zahvaljujući masovnoj distribuciji novina i pretplatama na digitalna izdanja, sada je lakše informisati se o važnim aspektima za bolje razumevanje situacije u zemlji i svetu. Novine i časopisi, bez ikakve sumnje, predstavljaju jedan od najvažnijih stubova masovnih medija.

Kada je reč o sportu i sportskoj kulturi, masovni mediji doprinose boljem sagledavanju sportskih rezultata ostvarenih na međunarodnim i nacionalnim takmičenjima ili utakmicama. Treba napraviti razliku između medija od javnog i sportskog interesa, jer sportski mediji specijalizovani su za praćenje sportskih dešavanja, dok su mediji od javnog interesa fokusirani na važna društvena dešavanja iz ekonomije, politike, zdravstva, itd. Bez obzira na razlike između medija od javnog i sportskog interesa, oba medija koriste iste medijske kanale. Za bolje razumevanje, vredi navesti jedan zanimljiv primer koji ilustruje moć koju masovni i društveni mediji imaju u oblikovanju našeg razmišljanja i ponašanja. Tokom najtežih dana pandemije izazvane virusom SARS-CoV-2, poznatim kao COVID-19, medijska mašinerija je značajno doprinela boljem informisanju javnosti o štetnosti virusa za ljudski organizam. U prilog tome, Anwar, Malik, Raees & Anwar (2020) su u svom preglednom radu istakli značajan doprinos medija kvalitetnom informisanju javnosti o virusu, njegovom prenošenju i epidemiološkim merama uvedenim za smanjenje broja obolelih.

Istraživanje Al-Dmour, Masa'deh, Salman, Abuhashesh & Al-Dmour (2020), potvrđuje pozitivan efekat korišćenja jedne od platformi društvenih medija na zaštitu javnog zdravlja tokom pandemije COVID-19. Izvorne informacije, koje su pravovremene i tačne, mogu pomoći društvu da bolje razume izazove sa kojima se suočava i da se uspešno izbori sa njima, kao što je to bio slučaj tokom pandemije. Ovaj primer ilustruje pozitivan uticaj masovnih i društvenih medija na ponašanje pojedinaca i društva u celini u vreme kada je virus harao i odneo milione života. Pandemija će, bez sumnje, biti predmet naučnih rasprava u narednih sto godina.

Brojne naučne studije podržavaju veću učestalost u različitim oblicima i nivoima rekreativne fizičke aktivnosti, jer se ona sastoji od skupa različitih kretnih obrazaca koji variraju u biomehaničkom i fiziološkom opterećenju. Nivoi opterećenja, kao što su nizak, umereni, srednji i intenzivni, pomažu telu da se prilagodi i izdrži različite napore bez štete za srce. Sa biomehaničkog aspekta, pravilno izvođenje pokreta dovodi do pozitivnih promena u mišićnom i koštanom tkivu. Različiti pokreti poboljšavaju funkciju mišića i kostiju, što je ključno za zdrav život. Savremeno doba, obeleženo tehnološkim dostignućima koja pomažu ljudima da funkcionišu u poslu i životu, donelo je i hipokinetički sindrom. Hipokinetički sindrom predstavlja opasnost po zdravlje zato što lišava čoveka kretnih, metaboličkih i fizioloških promena koje nastaju kao posledica konstantnog pomeranja tela zahvaljujući kontrakcijama mišića fleksora iliti agonista sa većim fiziološkim odgovorom. Osoba je do nekog nivoa motorički aktivna u određenim situacijama kako na poslu, tako i kod kuće. Međutim, konstantna motorička aktivnost celog kinetičkog lanca izaziva značajne metaboličko-fiziološke promene u organizmu jer traje duži vremenski period i uključuje određeni intenzitet. Kada nema u dovoljnoj meri metaboličkog pražnjenja masnih depoa kroz adekvatne pokretne radnje, aktivnost organizma se usporava, što dovodi do stalnog porasta broja prekomerno gojaznih osoba.

Promocija fizičke aktivnosti putem medija je potrebna, ako se uzme u obzir negativan uticaj hipokinetičkog sindroma na ljudsko zdravlje i blagostanje. Za normalno zdravstveno funkcionisanje u životu, potrebno je biti fizički aktivan najmanje tri puta nedeljno u trajanju od najmanje pola sata. To znači da bi promocija medijskim kanalima trebalo da bude usmerena na fizičku aktivnost, jer je ona dostupna svima, bez obzira na uzrast i pol. Iz zdravstvenog ugla, dokazano je da redovno bavljenje fizičkom aktivnošću doprinosi boljem fizičkom i mentalnom zdravlju (Gualdi-Russo & Zaccagni, 2021; Stamenković, Pantelić, Bubanj, Petković, Aksović, Preljević et al., 2024). Jednostavno, što je veći nivo fizičke aktivnosti bolji je zdravstveni status ljudi. S druge strane, što je niži nivo fizičke aktivnosti veća je verovatnoća za kardiovaskularna i druga oboljenja (Ruiz, Ortega, Gutierrez, Meusel, Sjöström & Castillo, 2006).

Generalno, češće i kvalitetnije medijsko informisanje o pozitivnim stranama fizičke aktivnosti predstavlja važan korak u suzbijanju hipokinetičkog sindroma. Ovaj sindrom dovodi do sedentarizma koji smanjuje kretne radnje koje zahtevaju veće vrednosti metaboličkog ekvivalenta (MET) u odnosu na stanje mirovanja. Cilj ovog rada je prikazati istraživanja koja su utvrdila ulogu masovnih medija u promociji fizičke aktivnosti radi podizanja svesti o njihovoj ulozi u povećanju ukupnog nivoa fizičke aktivnosti.

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Metod rada

U ovom radu, bila je primenjena deskriptivna analiza dosadašnjih istraživanja vezanih za ulogu masovnih medija u promociji fizičke aktivnosti. Za pretragu dosadašnjih istraživanja, koristili su se Google Scholar, Kobson i PubMed. Analizirani su radovi koji su objavljeni u periodu od 2014. do 2024. godine. Uzevši u obzir da se televizija, radio, internet i novine ubrajaju u masovne medije, radovi će biti grupisani po ovom redosledu. U cilju pronalaženja relevantnih radova, korišćene su sledeće ključne reči: television, impact, promotion, physical activity, excercise, health, radio, internet, magazines, recreational activities, media.

Rezultati sa diskusijom

Uloga televizije u promociji fizičke aktivnosti i zdravih stilova života

Poznato je da se informacije koje dobijamo vizuelnom analizom stvarnosti lakše obrađuju u izuzetno moćnoj centrali zvanoj CNS. Televizija poseduje medijsku moć zahvaljujući kojoj može probuditi interesovanje gledalaca za očuvanje i unapređenje zdravlja putem kvalitetnih emisija. Ovo je ključno u borbi protiv zdravstvenih problema u savremenom društvu. Kako bi se dodatno istražio ovaj fenomen, sociološkinja Ljiljana Milošević (2011) analizirala je uticaj televizije na promociju mentalnog zdravlja. Njeno istraživanje je pokazalo da većina ispitanika obraća posebnu pažnju na poruke koje se odnose na zdravlje u medijima. Televizija kao najrasprostranjeniji i najpopularniji medij privlači u značajnoj meri pažnju gledalaca; više od 87.7% anketiranih informiše se o zdravlju putem televizije. Takođe, sadržaje redovno prati 42.0%, povremeno 36.4%, a retko 9.3% učesnika ankete. Autorka je došla do zaključka da televizija, pored toga što predstavlja važan izvor informacija, ima i značajan uticaj na ponašanje i stavove koji su povezani sa zdravljem. Ovi nalazi naglašavaju važnost kvalitetnih medijskih sadržaja u obrazovanju o mentalnom zdravlju.

Televizija kao snažno medijsko sredstvo predstavlja ,,tehnološko čudo'' koje može poboljšati razumevanje zdravih aspekata rekreativne fizičke aktivnosti (Ahmad, Tahat, Safori, Al-Zpubi, Ahmad & Ananza, 2023). Ahmad et al. (2023a) realizovali su istraživanje sa ciljem utvrđivanja uticaja emitovanja zdravog načina fizičkog vežbanja putem televizije na bolje razumevanje i veće angažovanje studenata. Istraživanje je pokazalo da su muškarci više pratili emisije vezane za sportske aktivnosti u odnosu na žene. Dalje, fizički aktivni studenti imali su naviku da putem televizije prate emisije o fizičkom vežbanju, dok to nije bio slučaj sa fizički neaktivnim studentima. Za razliku od fizički neaktivnih studenata, studenti koji su pratili emisije o fizičkom vežbanju bili su daleko bolje informisani o njenim zdravstvenim efektima na organizam. Zahvaljujući obimnoj emisiji, pokazalo se da su studenti koji dolaze sa Univerziteta u Jarmuku bolje razumeli pozitivne efekte fizičkog vežbanja u poređenju sa studentima čije je prebivalište u gradu Zarka. Dokazano je da vreme trajanja emisije i programa o vežbanju statistički značajno doprinosi većem angažovanju studenata u različitim oblicima i nivoima rekreativnog vežbanja. Zaključak navedene studije je očekivan, jer je poznato da je za bolje razumevanje potrebno duže vremensko trajanje, nevezano da li je reč o zdravstvenim ili naučnim emisijama i programima. S druge strane, vremensko trajanje emisije i programa samo po sebi ne dovodi do većeg angažovanja ljudi u rekreativnim oblicima fizičkog vežbanja, što znači da pored vremenskog trajanja treba imati na umu i učestalost emitovanja takvih emisija i programa. Ovakvi rezultati ističu značaj medijskog sadržaja u obrazovanju o rekreativnom fizičkom vežbanju i zdravlju.

Studija navedenih autora (Ahmad et al., 2023b) jasno ukazuje na važnost razvijanja svesti o pozitivnim efektima fizičke aktivnosti putem televizije. Međutim, razvijanje svesti o pozitivnim efektima fizičke aktivnosti putem televizije predstavlja veliki izazov, posebno zbog nivoa predznanja gledalaca o zdravim benefitima rekreacije, kao i zbog onih koji govore sa stručnog aspekta o kretanju. Ovo se posebno odnosi na decu, čije se kognitivne sposobnosti razvijaju, kao i na starije osobe koje možda nisu dovoljno upoznate sa zdravstvenim benefitima fizičke aktivnosti. U tom pogledu, uzajamna saradnja između televizijske uređivačke politike i stručnjaka koji govore o fizičkoj aktivnosti mora da bude na visokom nivou kako bi se postigla bolja informisanost javnosti. To znači da informisanje treba prilagoditi tako da bude razumljivo i najmlađima i najstarijima. Kako bi izlaganje bilo uspešno, neophodno je da se stručnjak pridržava koncepta kog prati izvanredno izražavanje sa kratkim i preciznim rečenicama.

Internet i fizička aktivnost

Savremeno doba donelo je niz pogodnosti koje olakšavaju ljudima da na brz i efikasan način dođu do željenih informacija. Televizija, internet, mobilne aplikacije, društvene mreže i specijalizovani sportski programi predstavljaju osnovu uspostavljanja komunikacije između sveta sporta i obožavatelja sporta i rekreacije.

Internet omogućava svima nama da budemo neprekidno obavešteni o svim dešavanjima u svako doba dana i noći. Putem društvenih mreža, možemo pratiti uživo dešavanja sa sportskih događaja, dok mobilne aplikacije omogućavaju brzo preuzimanje najnovijih vesti. Dok emisije i programi imaju jasno definisano vreme početka i trajanja, internet je konstantno aktivan, bez bilo kakvog vremenskog ograničenja. Na primer, dovoljno je da u bilo koje doba dana i noći ukucamo ključne reči vezane za sport na Google-u, čime automatski dolazimo do željenih podataka i portala iz sveta sporta. Pored toga, korisnicima interneta pruža se mogućnost da se bezbroj puta vrate na istu stranicu sadržaja iz sveta sporta. Kada je u pitanju fizička aktivnost, internet predstavlja prijatelja svima koji žele da na najbrži način dođu do značajnih informacija o fizičkoj aktivnosti. Zahvaljujući internetu, informacije o fizičkoj aktivnosti postaju dostupne svima, bez obzira na to gde se nalaze. Istraživanja pokazuju da pravilna upotreba interneta može doprineti većem nivou fizičke aktivnosti ljudi (Zach & Lissitsa, 2016). Zach & Lissitsa (2016a) sproveli su istraživanje kako bi utvrdili da li će ispitanici koji se informišu putem interneta o fizičkoj aktivnosti biti fizički aktivniji u odnosu na ispitanike koji ne koriste internet. Podaci se oslanjaju na opštu društvenu anketu koju je sproveo Centralni izraelski biro za statistiku 2010. godine. U istraživanju navedenih autora, ukupan broj ispitanika bio je 6.305, uzrasta od 20. do 65. godine. Rezultati logističke regresione analize pokazali su da su ispitanici koji su češće koristili internet bili aktivniji u odnosu na ispitanike koji nisu koristili internet. Što se tiče nivoa fizičke aktivnosti, istraživanje je potvrdilo da su ispitanici koji su koristili internet bili aktivniji u fizičkim aktivnostima visokog i umerenog intenziteta, dok to nije bio slučaj sa ispitanicima koji nisu koristili internet. Kao što se može videti, internet ne samo da olakšava pristup informacijama o sportu, već igra ključnu ulogu i u promovisanju fizičke aktivnosti. Stoga, pravilna upotreba interneta može značajno doprineti zdravijem načinu života i većem angažovanju u fizičkim aktivnostima.

Radio i fizička aktivnost

Radio zauzima važno mesto u obaveštavanju javnosti o svim aspektima društvenog i političkog života, uključujući i fizičku

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aktivnost. Za razliku od televizije, radio omogućava slušaocima da od izgovorenih reči naprave imaginativnu analizu događaja. Ovaj transformacioni proces, u kojem reči postaju maštovite slike, predstavlja posebnu vrednost radija kao medija. Na primer, tokom emisija o fizičkoj aktivnosti, radio često poziva stručnjake za zdravlje i kondiciju da dele savete o vežbanju. Na taj način, stručnjaci motivišu slušaoce da se uključe u fizičke aktivnosti i brinu o svom zdravlju. Sadržaji koje radio nudi pomažu slušaocima da formiraju sopstvena mišljenja i slike o situaciji, što je posebno važno kada su vizuelni podaci dostupni samo putem televizije ili online medija. Ranija istraživanja potvrdila su da poruke koje se šalju putem radija mogu doprineti promociji zdravih stilova života (Diddi, Kumble & Shen, 2021; Smith, Menn & McKyer, 2011). U kontekstu fizičke aktivnosti, istraživanja su pokazala da radio može poslužiti kao marketinški promoter fizičke aktivnosti (Balamurugan, Oakleaf & Rath, 2005).

Novine i fizička aktivnost

Novine su oduvek bile ključni deo masovnih medija. U tom smislu, autorka Svjetlana Mokriš u svom radu potvrđuje značaj novina sledećim objašnjenjem: ,,Novine, kao jedan od masovnih medija u suvremenom informacijskom društvu, obavljaju četiri temeljne uloge: informiranje, zabavu, uvjeravanje i transmisiju kulture'' (Mokriš, 2011). Dakle, novine obavljaju više funkcija, što ih čini kompleksnijim za razumevanje sa aspekta nauke o medijima. Novine nude informacije o aktuelnim temama, kako u papirnom, tako i u elektronskom obliku. Zahvaljujući elektronskom formatu, novine su dostupne svima koji su pretplaćeni na digitalna izdanja.

Dobar novinski tekst zavisi od sposobnosti novinara da na zanimljiv i jednostavan način opiše dešavanja iz različitih oblasti. Kvalitetno napisan početak teksta čini osnovu njegovog daljeg razvijanja, jer se sa dobrim početkom nadovezuje i ostatak teksta. To znači da, ako je početak pisanja bio uspešan, završetak pisanja će dovesti do toga da tekst u celini bude odlično prihvaćen od čitalaca. Novinarska profesija je u tom smislu izuzetno zahtevna, s obzirom na to da se od novinara neprekidno očekuje visoka produktivnost.

Iz perspektive izveštavanja, to nikada nije jednostavno, jer kvalitetni tekstovi zavise od više faktora koji zajedno čine osnovu kvalitetnog novinarstva, uključujući veštinu konstruisanja rečenica, motivaciju, kreativnost, sposobnost brzog reagovanja i emocionalno stanje novinara. Na primer, prilikom praćenja sportskog događaja, sportski novinar se nalazi pod stresom jer se takmiči ne samo sa konkurentima iz drugih redakcija, već i sa vremenskim rokovima. Pravovremeno objavljivanje vesti ključno je kako bi se osigurao uspeh i ugled u novinarskoj profesiji.

Važno je razumeti uzajamnu povezanost između novinara, uređivačke politike redakcije, saradnje i ugleda koji njihove novine imaju u društvu. Za razliku od ostalih medija, novinski mediji predstavljaju složen sistem funkcionisanja, što znači da nema većeg tiraža i prodaje štampanih novina ukoliko nedostaju dobri, kreativni i zanimljivi tekstovi, kao i saradnja među novinarima, urednicima i foto-reporterima. Fotografije, takođe, čine složen sistem unutar novinskih medija još složenijim zato što novine ne mogu opstati ako ne sadrže dobre i kvalitetne fotografije. Fotografija je više od pukog prikaza, ona je umetnost koja ima za cilj da objedini realnost sa napisanim tekstom. Ako je u pitanju sport, sportska fotografija mora da sadrži važne elemente od kojih zavisi da li će biti objavljena u planiranom izdanju ili neće. U jednom istraživanju koje se bavilo teorijskom analizom umetničke dimenzionalnosti sportske fotografije, autor Miloš Stamenković (2021) naveo je četiri najvažnija elementa koja treba da budu u ravnoteži kako bi fotografija ispunila svoju svrhu: kompozicija, ugao, odnos svetlo-tamnih tonova i uhvaćeni trenutak. Ako neki od navedenih elemenata ispadne iz ravnoteže, fotografija gubi na kvalitetu. Foto-reporterska profesija je, poput novinarske, izuzetno stresna zbog mogućnosti uspešnog ili neuspešnog ispunjavanja zadataka na terenu, u smislu ovekovečenja najvažnijih sportskih trenutaka foto-aparatom. Jasno je da za veći tiraž dnevnih novina mora postojati vrlo jaka veza između novinarskih tekstova i kvalitetnih fotografskih detalja iz sveta sporta i rekreacije. Novinari i foto-reporteri predstavljaju ključne stubove uspešnog funkcionisanja medijske kuće, doprinoseći ostvarivanju profita i jačanju ugleda na međunarodnoj medijskoj sceni.

Fotografija se pokazuje kao izuzetno moćno marketinško sredstvo koje može pomoći u popularizaciji pokreta kao izvora zdravlja, blagostanja, uživanja i zabave. Psihološki gledano, fotografija poseduje moć koja može stimulisati unutrašnju motivaciju ljudi, koja je ključna za uspešno funkcionisanje u svim sferama života, uključujući sport i rekreaciju. Uz kvalitetan novinski tekst o fizičkoj aktivnosti i sportu, dobra i zanimljiva fotografija može motivisati čitaoce da razmišljaju o tome kako da poboljšaju svoje zdravlje kroz fizičku aktivnost.

Masovni mediji i fizička aktivnost

Istraživanja pokazuju da masovni mediji mogu povećati interesovanje ljudi za fizičku aktivnost i rekreaciju (Sahu, 2020; Gulam, 2016; Rogala, 2017; Perdana, Sumaryanto, Saputra, Subekti & Abrori 2024; Günther, Schleberger, & Pischke 2021).

Sahu (2020a) u svom radu pod naslovom ,,Role of Mass Media in Sports Promotion'', zaključuje da masovni mediji značajno doprinose boljem razumevanju sporta i povećanju učestalosti sportskih aktivnosti kod ispitanika.

Gulam (2016a) u svom istraživanju pod naslovom ,,Role of Mass Media in Sports Communication'' objašnjava kompleksnost komunikacije između sportskih medija i javnosti. Ističe da televizija, radio i internet na različite načine doprinose boljem razumevanju sporta. Utvrđena je značajna razlika između prenosa sportskih informacija putem radija i televizije. Radio zadovoljava čulne aspekte slušalaca, dok televizija omogućava gledaocima da budu svedoci najvažnijih sportskih događaja. Internet, takođe, prenosi sportske informacije fleksibilno, omogućavajući ljudima da lako dođu do željenih podataka.

Pregledno istraživanje autora Rogala (2017a) pokazalo je pozitivne rezultate u promociji zdravih stilova života putem masovnih medija. Istraživanje ukazuje da masovni mediji deluju kao jedan od alata u promociji zdravih stilova života odraslih kroz aktivnosti vezane za HP40P (engl. Health Promotion for Older People). Rezultati potvrđuju značajnu ulogu masovnih medija u sticanju znanja i razvijanju stavova o zdravlju.

Istraživanje autora Perdana et al. (2024a) fokusira se na ulogu medija od konvencionalnih do digitalnih u sportu i zdravlju. U istraživanju je primenjena deskriptivno-kvalitativna metoda koja je uključivala proučavanje literature i analizu medija u društvu. Uzorak ispitanika odabran je metodom namernog uzorka kako bi se dobili podaci koji odražavaju karakteristike indonežanskog društva u vezi sa korišćenjem informacija dobijenih putem medija. Ovo istraživanje potvrđuje moć masovnih medija u oblikovanju mišljenja i ponašanja povezanih sa zdravim navikama.

Osobe su naoružane znanjima koja pomažu u razumevanju značaja aktiviranja lokomotornog aparata u različitim fizičkim aktivnostima. Istraživači su zaključili da mediji podižu nivo fizičke aktivnosti, što je ključno za očuvanje i unapređenje zdravstvenog fitnesa.

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U preglednom istraživanju Günther et al. (2021a), analizirani su radovi koji istražuju efekte društvenih medija na promociju fizičke aktivnosti. Rezultati pokazuju da je Fejsbuk najbolja društvena platforma za promociju fizičke aktivnosti. Više od trećine analiziranih istraživanja potvrđuje važnu ulogu društvenih medija u promociji fizičke aktivnosti. Glavni zaključak autora je da društveni mediji mogu stimulisati ljude da budu fizički aktivniji u različitim oblicima rekreativnog vežbanja.

Zaključak

Zahvaljujući masovnim medijima, ljudi vrlo lako dolaze do najvažnijih informacija u bilo koje doba dana i na bilo kom mestu. Pravilno prezentovana fizička aktivnost putem masovnih medija može dovesti do aktiviranja pasivnih i aktivnih delova lokomotornog aparata, čime se smanjuje negativan uticaj sedentarizma na zdravlje. Rad je teorijski objasnio da televizija, radio, internet i novine mogu "probuditi" interesovanje za planiranje fizičke aktivnosti, bez obzira na razlike među njima. Ova uloga masovnih medija je ključna za promociju zdravih stilova života i unapređenje opšteg zdravlja.

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UDK 796.853.23-056.36-053.2

The impact of inclusive judo on the biopsychosocial aspects of children with intellectual disabilities

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Introduction

Judo for people with disabilities has a long tradition in practice (Dadič, 2001), but a rare one in science (Mosler et al., 2017). Judo ethics are based on values such as respect, fairness, trust, order, discipline, reciprocity, modesty, patience and require the practitioner to be calm, focused and persistent. Judo principles such as mutual prosperity and the use of minimum force for maximum effect (Brousse et al., 2002; Kano et al., 2013) are not only woven into judo practice, but into all areas of life, formal (study, work) and informal (family, friends, etc.). As such, judo represents a particularly favorable environment for equal treatment of athletes.The term "diverse ability" is a modern expression encompassing all types of disabilities, differences, illnesses, and conditions in which individuals require certain adaptations, equipment, or assistance for equal societal inclusion. Similar terms include "different ability" or "additional needs."

Diverse ability - is a modern term for all types of disabilities, differences, diseases and conditions of a person who needs some adjustments, devices or other assistance for equal inclusion in society. Similar expressions are, for example, "different ability" or "additional need".

Autism is a lifelong developmental disorder that affects the brain in the process of processing information. Autism spectrum disorder is a developmental disorder that occurs in the first three years of life and is characterized by communication problems, social interaction deficits, and repetitive/restricted interests and behaviors (Bocioaca & Selikowitz, 2001). Down syndrome, also known as trisomy 21, is a genetic disorder caused by the presence of all or part of the third copy of chromosome 21. ADHD - attention deficit hyperactivity disorder, the most common neurodevelopmental disorder in children (Booker et al., 2020; Volkow et al., 2001; Wolraich et al., 1996), is characterized by 2 different sets of behavioral symptoms (Clarke et al., 2001), which can occur together:

1. Inattention, lack of concentration and learning difficulties,
2. Hyperactivity-impulsivity with an increased tendency to take risks.

The definition of people with intellectual disabilities, according to the American Association on Intellectual and Developmental Disabilities (Schalock et al., 2019), is a disability characterized by significant limitations in both intellectual functioning and adaptive behavior, which covers many everyday social and practical skills, and the disability occurs before age. from the age of 18.

At the 1st and 2nd ID-Judo European Judo Championships in 2017 and 2019 in Cologne, Germany, all judokas with intellectual disabilities who passed the requirements of the International Sports Federation for Persons with Intellectual Disabilities (INAS) could compete (Takahiro, 2020). INAS - (International Sports Federation for People with Intellectual Disabilities; originally called INAS-FMH, later INAS-FID, and now as VIRTUS) was founded in 1986 by professionals in the Netherlands who were involved in sports and wanted to promote the participation of athletes with mental handicaps in elite sports. The name of the organization is the International Federation for Sports for athletes with Intellectual Disabilities, which promotes sports around the world for athletes with intellectual disabilities, autism and Down syndrome.

The social model supports terminology that maintains the dignity of persons with disabilities and avoids medical terms such as retarded (Gleser et al., 1992; Boguszewski et al., 2013) or degenerate, handicap (beggar with cap in hand), disabled (invalid), as well as feeble-minded (Zavirsek, 2014; Cacinovic et al., 2008; Greene, 1987). Words like impairment, special need, additional need, differently abled, special condition began to replace the old medical diagnostic terms. The terminology in judo that is in use today is G-judo, judo for athletes with special needs, adaptive judo (BJA, 2020), judo for all or inclusive judo (Dadič, 2001; Pecnikar et al., 2018; Kuncic, 2019; Zakirov & Naborshikova, 2010; Maslesa et al., 2012). Gan - this word comes from Japanese and means "inclusive". The term "G-judo" has been used for the last 25 years. G-judo refers to inclusive judo and judo for all concepts.

Methods

For the purposes of this paper, Google Scholar and PubMed search databases were used using the following keywords: Judo, inclusion, autism, Down's syndrome, ADHD. Priority was given to works published in the last 10 years.

Discussion

A review of the literature on inclusion in judo, the inclusion of people with intellectual disabilities and others with various psycho-physical conditions, illnesses or disorders points to different aspects of the description of this field. They can be roughly divided into 3 subgroups, namely:

The social perspective includes the importance of equal integration of judokas of different abilities into regular sports clubs (Dadič, 2001; Pecnikar et al., 2018) and the possibility of using the results of research projects in the educational system specific for children with developmental disabilities, as well as the popularization of judo for all, integration and socialization (Krga, 2019; Ion-Ene et al., 2014; Burnik & Brod, 2006). with intellectual disabilities. Judo significantly improves the lives of people with disabilities, challenging social taboos and promoting social integration (Dadič, 2001; Šomen & Pečnikar, 2017; Mihorko et al., 2014). It provides opportunities for participation and decision-making, addressing basic human needs (Pečnikar et al., 2018; Krga, 2019). Observations show that judo improves the mental and physical well-being, socialization and integration of children with intellectual disabilities (Burnik & Brod, 2006). Although it may not lead to immediate physical changes, involvement in sports clubs, including judo, helps integration (Ion-Ene et al., 2014). Collective efforts are needed for ethical inclusion, recognizing that individuals with disabilities are already part of society (Rutar et al., 2010). Overall, engaging judokas of various abilities in regular judo

UDK 796.853.23-056.36-053.2

clubs offers positive experiences for all members. The results of previous research (Bocioaca & Marin, 2023) suggest that the practice of judo can have a positive effect on individuals with Down syndrome and autism spectrum disorder, with over 50% of specialists working with children stating that it contributes to their social integration.

The medical and psychological aspect points to the impact of judo on certain psychophysical characteristics of people with autistic disorder and ADHD and exposes the promotion of health in people with special needs through judo (Tomey, 2017). A previous study (Booker et al., 2020) found marked relative impairment in dynamic balance ability in unmedicated children with ADHD compared to typically developing children. This relative difficulty can lead to children with ADHD participating less than their peers in everyday social and sports activities that require dynamic balance skills, and considering that judo as a sport is based on the ability to maintain it, special attention should be paid in the work. Next, we find benefits in a range of effects of judo on young people with behavioral disorders who are minimally intellectually impaired for various reasons, on young people with cerebral palsy and the positive progress of modified practice and effects of professional judo supervision on young people and adults with Down syndrome, judo as a therapeutic method and judo for public health prophylaxis (Mosler & Kalina, 2017; Gleser et al., 1992; Boguszewski et al. 2013; Greene, 1987; Gleser & Lison, 2011; Aguiar et al., 2008). Authors often cite small sample sizes as a limitation in judo studies. Greene found judo to be effective in improving behavior among mentally retarded adolescents (Greene, 1987). Gleser & Leeson noted various benefits for emotionally disturbed boys, but highlighted limitations such as judo as a sole intervention (Gleser & Leeson, 2011). Tomey noted positive results, but noted the need for longer programs (Tomey, 2017). Rivera and Renziehausen found potential benefits for children with ASD, despite sample size limitations (Rivera, 2019; Renziehausen, 2019). Garcia et al. suggest acceptance of a judo program among ASD participants (Garcia et al., 2020). Gleser et al. observed improvements in children with visual impairment and intellectual disability (Gleser et al., 1992), while Aguiar et al. reported motor improvement in individuals with Down syndrome (Aguiar et al., 2008). Boguszevski et al. believes that judo is useful for children with intellectual disabilities (Boguszewski et al., 2013). Mosler and Kalina support the therapeutic potential of judo for mental disorders and public health (Mosler and Kalina, 2017). In addition, respondents emphasized the importance of adapted judo in the fight against obesity, cardiovascular diseases and osteoporosis in this population, emphasizing the need for specialized training and methodology for trainers in working with children with autism and Down syndrome (Bocioaca and Marin, 2023).

The physical and sports aspect reveals the research of the motor abilities of judokas with intellectual disabilities, the analysis of inclusive judo matches (Kunčić, 2019; Pečnikar et al., 2016; Masleša et al., 2009) and further balance among judokas with intellectual disabilities and reports on the disability sports festival in California. Masleša et al. observed positive changes in motor abilities and skills in judokas with intellectual disabilities (Masleša et al., 2009). Differences in grip strength were observed between dominant and non-dominant hands (Pečnikar et al., 2016). Tatalović observed an improvement in balance in judokas with intellectual disabilities (Tatalović, 2014). Kuncic analyzed inclusive judo matches, highlighting the use of technique and differences in time structure (Kuncic, 2019). Reports from disability sports festivals in the US and Japan show inclusive judo events (Peck, 2020; Takahiro, 2020). Hamana provides valuable insights into the organization and rules of precedence in judo for individuals with intellectual disabilities (Hamana, 2018).

Conclusion

In conclusion, the field of judo for individuals with intellectual disabilities has experienced significant growth in recent years, with an increase in research publications from 2016-2019. Earlier studies, dating back to the 1970s and 1980s, laid the groundwork by focusing on children and youth with various disabilities. These studies highlight the positive impact of judo practice, not only on people with intellectual disabilities, but also on those with specific disorders such as ADHD, Down syndrome and autism. However, due to the limited number of subjects and variations in research methods, generalizing the findings to the wider population is challenging. Nonetheless, judo for individuals with intellectual disabilities is increasingly recognized as a therapeutic tool, a recreational activity that emphasizes inclusion, and a competitive sport with events reaching the World Championship level. As research continues to develop, it is essential to explore the various benefits and opportunities judo offers this population as they address the unique challenges and needs they may face.

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UDK 796.853.23-056.36-053.2

Uticaj inkluzivnog džudoa na biopsihosocijalne aspekte dece sa intelektualnim teškoćama u razvoju

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Uvod

Džudo za osobe sa invaliditetom ima dugu tradiciju u praksi (Dadič, 2001), ali retku u nauci (Mosler i sar., 2017). Džudo etika se zasniva na vrednostima kao što su poštovanje, pravičnost, poverenje, red, disciplina, reciprocitet, skromnost, strpljenje i zahteva od vežbača smirenost, fokusiranost i istrajnost. Principi džudoa kao što su uzajamni prosperitet i upotreba minimalne snage za maksimalni efekat (Brousse i sar., 2002; Kano i sar., 2013), nisu utkani samo u džudo praksu, već u sve oblasti života, formalne (učenje, rad) i neformalne (porodica, prijatelji, itd.). Džudo kao takav predstavlja posebno povoljan ambijent za ravnopravan tretman sportista.

Raznovrsna sposobnost – savremeni je izraz za sve vrste invaliditeta, različitosti, bolesti i stanja osobe kojoj su za ravnopravno uključivanje u društvo potrebna neka prilagođavanja, sprave ili druga pomoć. Slični izrazi su, na primer, „različite sposobnosti" ili „dodatne potrebe".

Autizam je doživotni razvojni poremećaj koji utiče na mozak u procesu obrade informacija. Poremećaj autističnog spektra je razvojni poremećaj koji se javlja u prve tri godine života i karakterišu ga problemi u komunikaciji, deficiti socijalne interakcije i repetitivni/ograničeni interesi i ponašanja (Bocioaca & Selikowitz, 2001). Daunov sindrom, takođe poznat kao trisomija 21, je genetski poremećaj uzrokovan prisustvom cele ili dela treće kopije hromozoma 21. ADHD – poremećaj pažnje sa hiperaktivnošću, najčešći neurorazvojni poremećaj kod dece (Buker i sar., 2020; Volkow i sar., 2001; Wolraich i sar., 1996), karakterišu 2 različita skupa simptoma ponašanja (Clarke i sar., 2001), koji se mogu javiti zajedno:

1. *Nepažnja, nedostatak koncentracije i teškoće u učenju i*
2. *Hiperaktivnost-impulzivnost sa povećanom sklonošću preuzimanju rizika.*

Definicija ljudi sa intelektualnim invaliditetom, prema Američkom udruženju za intelektualne i razvojne smetnje (Schalock i sar., 2019), je invaliditet koji se karakteriše značajnim ograničenjima kako u intelektualnom funkcionisanju tako i u adaptivnom ponašanju, koje pokriva mnoge svakodnevne društvene i praktične veštine, a invalidnost nastaje pre uzrasta. od 18. godina.

Na 1. i 2. Evropskom prvenstvu u džudou ID-džudo 2017. i 2019. u Kelnu, Nemačka, mogli su da se takmiče svi džudisti sa intelektualnim teškoćama, koji su prošli uslove Međunarodne sportske federacije za osobe sa intelektualnim invaliditetom (INAS) (Takahiro, 2020). INAS – (Međunarodna sportska federacija za osobe sa intelektualnim invaliditetom; prvobitno nazvana INAS-FMH, kasnije INAS-FID, a sada kao INAS) osnovana je 1986. godine od strane profesionalaca u Holandiji koji su se bavili sportom i želeli da promovišu učešće sportista sa mentalnim hendikepom u elitnom sportu. Ime organizacije je Međunarodna federacija za sport sa intelektualnim oštećenjima, koja promoviše sport širom sveta za sportiste sa intelektualnim invaliditetom, autizmom i Daunovim sindromom.

Socijalni model podržava terminologiju koja održava dostojanstvo osoba sa invaliditetom i izbegava medicinske izraze kao što su retardiran (Gleser i sar., 1992; Boguszewski i sar., 2013) ili degenerisan, hendikep (prosjak sa kapom u ruci), invalid (nevažeći), kao i slaboumni (Zavirsek, 2014; Cacinovic i sar., 2008; Greene, 1987). Reči kao oštećenje, posebne potrebe, dodatne potrebe, posebno stanje počele su da zamenjuju stare medicinske dijagnostičke izraze. Terminologija u džudou koja je danas u upotrebi je G-džudo, džudo osoba sa posebnim potrebama, adaptivni džudo (BJA, 2020), džudo za sve ili inkluzivni džudo (Dadič, 2001; Pecnikar i sar., 2018; Kuncic, 2019; Zakirov & Naborshikova, 2010; Maslesa i sar., 2012). Gan – ova reč dolazi iz japanskog i znači „inkluzivno". Termin „G-džudo" se koristi poslednjih 25 godina. G-džudo se odnosi na inkluzivni džudo i džudo za sve koncepte.

Metode

Za potrebe ovog rada, koristile su se pretraživačke baze Google Scholar i PubMed uz upotrebu sledećih ključnih reči: Džudo, inkluzija, autizam, Daunov sindrom, ADHD. Prioritet su dobijali radovi objavljeni u poslednjih 10 godina.

Diskusija

Pregled literature o inkluziji u džudou, inkluziji osoba sa intelektualnim teškoćama i drugih sa različitim psiho-fizičkim stanjima, bolestima ili poremećajima ukazuje na različite aspekte opisa ove oblasti. Oni se mogu grubo podeliti u 3 podgrupe, i to:

Društvena perspektiva obuhvata značaj ravnopravne integracije džudista različitih sposobnosti u redovne sportske klubove (Dadič, 2001; Pecnikar i sar., 2018) i mogućnost korišćenja rezultata istraživačkih projekata u obrazovnom sistemu specifičnog za decu sa smetnjama u razvoju, kao i popularizaciju džudoa za sve, integracija i socijalizacija (Krga, 2019; Ion-Ene i sar., 2014; Burnik & Brod, 2006) osoba sa intelektualnim teškoćama. Džudo značajno poboljšava živote osoba sa invaliditetom, izazivajući društvene tabue i promovišući društvenu integraciju (Dadič, 2001; Šomen & Pečnikar, 2017; Mihorko i sar., 2014). Pruža mogućnosti za učešće i donošenje odluka, adresirajući osnovne ljudske potrebe (Pečnikar i sar., 2018; Krga, 2019). Zapažanja pokazuju da džudo poboljšava mentalno i fizičko blagostanje, socijalizaciju i integraciju dece sa intelektualnim teškoćama (Burnik & Brod, 2006). Iako možda neće dovesti do trenutnih fizičkih promena, uključivanje u sportske klubove, uključujući džudo, pomaže integraciji (Ion-Ene i sar., 2014). Kolektivni napori su potrebni za etičku inkluziju, priznajući da su pojedinci sa invaliditetom već deo društva (Rutar i sar., 2010). Sve u svemu, angažovanje džudista sa različitim sposobnostima u redovnim džudo klubovima nudi pozitivna iskustva za sve članove. Rezultati prethodnog istraživanja (Bocioaca & Marin, 2023), sugerišu da praksa džudoa može pozitivno uticati na pojedince sa Daunovim sindromom i poremećajem autističnog spektra, pri čemu je preko 50% specijalista u radu sa decom navelo da to doprinosi njihovoj društvenoj integraciji.

Medicinski i psihološki aspekt ukazuje na uticaj džudoa na određene psihofizičke karakteristike osoba sa autističnim poremećajem i ADHD-om i promoviše zdravlje kod osoba sa posebnim potrebama kroz džudo (Tomey, 2017). Prethodna studija (Buker i sar., 2020) je otkrila izraženo rela-

UDK 796.853.23-056.36-053.2

tivno oštećenje sposobnosti dinamičke ravnoteže kod dece sa ADHD-om koja nisu uzimala lekove u poređenju sa decom tipičnog razvoja. Ova relativna poteškoća može dovesti do toga da deca sa ADHD-om učestvuju manje od svojih vršnjaka u svakodnevnim društvenim i sportskim aktivnostima koje zahtevaju veštine dinamičke ravnoteže, a uzevši u obzir da se džudo kao sport bazira na sposobnosti održavanja iste, treba posebno obratiti pažnju u radu. Zatim, nalazimo koristi u nizu uticaja džudoa na mlade ljude sa poremećajima u ponašanju koji su minimalno intelektualno oštećeni iz različitih razloga, na mlade sa cerebralnom paralizom i pozitivan napredak modifikovane prakse i efekata stručnog nadgledanja džudoa na mladim i odraslim osobama sa Daunovim sindromom, džudo kao terapijski metod i džudo za profilaksu javnog zdravlja (Mosler & Kalina, 2017; Gleser i sar., 1992; Boguszewski i sar. 2013; Greene, 1987; Gleser i Lison, 2011; Aguiar i sar., 2008). Autori često navode male veličine uzoraka kao ograničenje u studijama džudoa. Grin je otkrio da je džudo efikasan u poboljšanju ponašanja među mentalno retardiranim adolescentima (Greene, 1987). Gleser & Lison su primetili različite prednosti za emocionalno poremećene dečake, ali su istakli ograničenja kao što je džudo kao jedinu intervenciju (Gleser & Lison, 2011). Tomei je primetio pozitivne rezultate, ali je primetio potrebu za dužim programima (Tomey, 2017). Rivera i Renziehausen su otkrili potencijalne koristi za decu sa ASD, uprkos ograničenjima veličine uzorka (Rivera, 2019; Renziehausen, 2019). Garcia i sar. sugerišu prihvatanje džudo programa među učesnicima ASD (Garcia i sar., 2020). Gleser i sar. primetili su poboljšanja kod dece sa oštećenjem vida i intelektualnim invaliditetom (Gleser i sar., 1992), dok su Aguiar i sar. prijavili motoričko poboljšanje kod osoba sa Daunovim sindromom (Aguiar i sar., 2008). Boguszevski i sar. smatraju da je džudo koristan za decu sa intelektualnim teškoćama (Boguszewski i sar., 2013). Mosler i Kalina podržavaju terapeutski potencijal džudoa za mentalne poremećaje i javno zdravlje (Mosler i Kalina, 2017). Pored toga, ispitanici su istakli značaj prilagođenog džudoa u borbi protiv gojaznosti, kardiovaskularnih bolesti i osteoporoze u ovoj populaciji, ističući potrebu za specijalizovanom obukom i metodologijom za trenere u radu sa decom sa autizmom i Daunovim sindromom (Bocioaca i Marin, 2023).

Fizički i sportski aspekt otkriva istraživanje motoričkih sposobnosti džudista sa intelektualnim teškoćama, analizu inkluzivnih džudo mečeva (Kunčić, 2019; Pečnikar i sar., 2016; Masleša i sar., 2009) i dalji balans među džudistima sa intelektualnim teškoćama i izveštaje o invalidskom sportskom festivalu u Kaliforniji. Masleša i sar. su primetili pozitivne promene u motoričkim sposobnostima i veštinama kod džudista sa intelektualnim invaliditetom (Masleša i sar., 2009). Uočene su razlike u snazi hvata između dominantne i nedominantne ruke (Pečnikar i sar., 2016). Tatalovič je primetio poboljšanje ravnoteže kod džudista sa intelektualnim invaliditetom (Tatalović, 2014). Kunčič je analizirao inkluzivne džudo mečeve, ističući upotrebu tehnike i razlike u vremenskoj strukturi (Kunčič, 2019). Izveštaji sa sportskih festivala osoba sa invaliditetom u SAD i Japanu prikazuju inkluzivne džudo događaje (Peck, 2020; Takahiro, 2020). Hamana pruža dragocene uvide u organizaciju i pravila prvenstva u džudou za pojedince sa intelektualnim invaliditetom (Hamana, 2018).

Zaključak

Da zaključimo, oblast džudoa za pojedince sa intelektualnim invaliditetom doživela je značajan rast poslednjih godina, sa porastom istraživačkih publikacija od 2016-2019. Ranije studije, koje datiraju iz 1970-ih i 1980-ih, postavile su temelje fokusirajući se na decu i mlade sa različitim smetnjama u razvoju. Ove studije naglašavaju pozitivan uticaj džudo prakse, ne samo na osobe sa intelektualnim invaliditetom, već i na one sa specifičnim poremećajima kao što su ADHD, Daunov sindrom i autizam. Međutim, zbog ograničenog broja subjekata i varijacija u metodama istraživanja, generalizacija nalaza na širu populaciju predstavlja izazov. Bez obzira na to, džudo za pojedince sa intelektualnim teškoćama je sve više prepoznat kao terapeutsko sredstvo, rekreativna aktivnost koja naglašava inkluziju i takmičarski sport sa događajima koji dostižu nivo Svetskog prvenstva. Kako istraživanja nastavljaju da se razvijaju, od suštinske je važnosti istražiti različite prednosti i mogućnosti koje džudo nudi ovoj populaciji dok se suočavaju sa jedinstvenim izazovima i potrebama sa kojima se mogu suočiti.

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UDK 796.853.23-056.36-053.2

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UDK 796.386-056.26

Table tennis as one of the carriers of paralympic and inclusive sports in Serbia

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Introduction

Although traces of the precursors of table tennis can be found in some older times, it began to be played in the second half of the 19th century in Great Britain, where it was played on dining tables, using books as a net, box lids as rackets, and shamans as a ball, played by representatives of the upper classes of society (Para Table Tennis, 12.7.2024). The World Table Tennis Federation was formed in 1926, the same year the First World Championship was held, and it appeared on the program of the Olympic Games for the first time in 1988 in Seoul. Today it has great popularity and viewership, so that in 2023 it was the sixth most watched sport with a total of 875 million viewers, behind football, cricket, hockey, tennis and volleyball, and more watched than basketball, baseball, rugby and golf (Most Popular Sports in the World 2023).

People with disabilities started playing table tennis in the British hospital for the wounded from the Second World War, which was established in Stoke Mandeville in 1944 by a doctor of Jewish origin, Ludwig Gutmann. Table tennis is one of the sports that has been on the program of the Paralympic Games since their first edition in 1960 in Rome, and it was reserved only for players in wheelchairs. Since 1976, it has been available to standing players, since 1980, players with cerebral palsy have been competing, and in 2000, players with intellectual disabilities participated for the first time. Today, para table tennis is played by more than 40 million players from more than 100 countries around the world, as well as millions of recreational players (Paralympic History, 12.7.2024), and this sport is managed by the World Table Tennis Federation through the International Para Table Tennis Committee. It is very interesting and accessible, because it does not require a lot of space or expensive equipment, and it provides actors with a whole series of significant benefits (Tsou, Chen, Shih, & Lin, 2024). Table tennis provides an opportunity for people with disabilities to compete, develop their skills and achieve outstanding sports results, and it is the third para sport in the world in terms of the number of athletes (Kong, & Sze Ma, 2024). Competitions like the Paralympic Games allow athletes to improve their mindset and calmness in frustrating situations, as well as demonstrate their talent and perseverance (Lin, Tsai, Kao, & Liu, 2019). Through participation in competitions, athletes in a great way promote themselves and their families, their club, the Federation, the Paralympic Committee, the Ministry of Sports, the city and the state... At the same time, they very successfully raise awareness of the presence and needs of people with disabilities in society, and promote inclusion.

In the territory of the former common state of SFRY, para table tennis did not immediately follow the success and popularity that table tennis had. Yugoslavian table tennis players won their first medals at the world championships in 1939, and after the Second World War they became one of the most successful table tennis countries in the world. Competitors from Yugoslavia regularly won medals at the biggest competitions, and by the breakup of the common state they had won over 80 medals (Myth about YU-sport: table tennis, 2021). Para table tennis did not have its representatives on the international scene for a long time, and only in the seventies of the last century did they start appearing in some international competitions. However, our para table tennis players received the full attention of the sports public only at the Paralympic Games in 1980, when the first medals were won. From then until today, the continuity of winning medals has been maintained, so that our competitors have never gone to a major competition without winning at least one medal. That streak of winning medals has been going on continuously for 44 years, and we all hope and expect that it will continue in the future. In the meantime, the country changed its borders and name, but the competitors from Serbia always had a lot of success and were a kind of flagship of our Paralympics, but also of sports as a whole. The subject of this paper is the origin and development of table tennis pairs in Serbia, as well as an overview of the most significant results that the table tennis players from Serbia have achieved to date.

Method

Historical method was dominantly used in the work. By reviewing the available electronic and written sources, an overview of all medals won by our athletes at the biggest para table tennis competitions was made. Only medals from the first category competitions in which our para table tennis players participated were taken into account, namely: Paralympic Games, World and European Championships. The overview of the medals won was made exclusively on the basis of official websites and records, and the medals won by competitors from Serbia were taken into account, while the medals of competitors from Croatia and Slovenia were only mentioned and not included in the analysis. The medals are classified according to the type of competition in which they were achieved, chronologically according to the years when they were won, according to the gender of the competitors who won them, as well as individually for each athlete who won at least one medal in these biggest competitions. The overview of medals is given in absolute and relative values. In the part of the paper that illustrates the inclusive approach in table tennis, in addition to the historical method, a descriptive method was also used.

Results

Table 1: Medals at the Paralympic Games won by competitors from Serbia (Medals at the Games, 2020)

Sport	Gold	Silver	Bronze	Total
Atletics	8 (4m+4w)	10 (1w+9m)	9 m	27 (5w+22m)
Table Tennis	4 (1w+3m)	9 (5w+4m)	9 (2w+7m)	22 (8w+14m)
Archery	7 (2w+5m)	5 (2w+3m)	1 m	13 (4w+9m)
Swimming	2 m	2 m	-	4 m

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Goalball*	1 m	-	1 m	2 m
Sitting volleyball*	-	-	1	1 m
Total	**22 (7w+15m)**	**26 (8w+18m)**	**21 (2w+19m)**	**69 (17w+52m)**

*Team sports in which athletes from Serbia were part of the team

Table 2: Medals of table tennis players from Serbia at the Paralympic Games (Tournaments - Paralympic Games, 2024)

Year	Gold	Silver	Bronze	Total
1980	2 Dimitrijević; Dimitrijević/Šimunić**	Šimunić**		2
1984	Šimunić**	1 Dimitrijević/Šimunić**	3 Gajić 2; Đurašinović	4
1988		1 Dimitrijević		1
1992			1 Kesler	1
1996	1 Kesler			1
2000		1 Kesler		1
2004			1 Kesler	1
2008		1 Ranković Borislava		1
2012		2 Ranković; Kesler		2
2016	1 Ranković B.	1 Ranković B/Matić Nada	2 Matić Nada, Palikuća	4
2021			1 Ranković B.	1
2024		2 Ranković; Ranković/Matić	1 Palikuća	3
Total	**4**	**9**	**9**	**22**

**Medal winners for the SFRY national team who are not from Serbia

Table 3: Medals of Serbian table tennis pairs at the World Championships (Tournaments - World Championships, 2022)

Year	Gold	Silver	Bronze	Total
1990			2 Dimitrijević; Rakić**; Dimitrijević/Rakić**,	2
1998			2 Kesler; Kesler/Đurašinović	2
2002		1 Kesler		1
2006	1 Kesler			1
2010		1 Ranković/Matić/Popadić	2 Ranković; Kesler	3
2014	1 Ranković/Matić/Popadić		3 Ranković; Matić Nada; Palikuća	4
2017	1 Ranković/Matić/Arančić		1 Palikuća/Malešić/Babić	2
2018	1 Ranković Borislava			1
2022	1 Ranković/Matić Nada		3 Ranković/Ćirić; Matić/Palikuća; Matić N.	4
Total	**5**	**2**	**13**	**20**

Table 4: Medals of Serbian table tennis pairs at the European Championships (Tournaments-European Championships, 2023)

Year	Gold	Silver	Bronze	T.
1985			2 Dimitrijević/Šimunić**; Gajić/Gubica**/Berti**	2
1987		1 Dimitrijević		1
1989		1 Kesler/Đurašinović	2 Gajić; Dimitrijević	3
1991		1 Kesler	(Rakić**)	1
1995		1 Kesler		1
1997		1 Kesler		1

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1999	1 Kesler			1
2001	1 Kesler/Đurašinović	1 Kesler		2
2003			2 Kesler	2
2005	1 Kesler/Đurašinović			1
2007	1 Ranković	1 Ranković/Matić/Popadić	1 Kesler/Đurašinović/Matić Z	3
2009	2 Kesler/Đurašinović; Ranković Borislava	1 Kesler	2 Ranković Borislava; Ranković/Mitrović/Popadić	5
2011	3 Kesler; Ranković/Matić/Popadić; Kesler/Palikuća/Đurašinović	1 Ranković Borislava	1 Palikuća	5
2013	1 Ranković Borislava	1 Kesler/Palikuća/ Đurašinović/ Homa	2 Palikuća; Perlić/Radišić/Petković	4
2015	1 Ranković Borislava	2 Matić Nada; Ranković/Matić/ Popadić	1 Palikuća	4
2017	2 Ranković Borislava; Ranković/Matić/Ubović		4 Palikuća; Matić Nada; Perlić/Stojiljković; Palikuća/Homa/Zelen Milan	6
2019	2 Ranković Borislava; Ranković/Matić/Mijatović	4 Palikuća; Zelen A; Matić; Perlić/Stojiljković/Petković		6
2023	2 Ranković Borislava; Palikuća/Matić Nada	3 Ranković/Matić; Zelen A; Ćirić/Ranković	3 Palikuća/Ćirić; Palikuća; Perlić/Zelen A.	8
Total	**17**	**19**	**20**	**56**

Table 5: Medal winners at the biggest competitions in para table tennis from Serbia

No	**Name**	**Paralympic Games**			**World Championships**			**European Championships**			**Total**			**All**
1	Ranković Borisl.	1	5	1	4	1	3	10	5	2	15	11	6	32
2	Kesler Zlatko	1	2	2	1	1	3	6	7	3	8	10	8	26
3	Matić Nada		2	2	3	1	3	4	5	1	7	8	6	21
4	Palikuća Mitar			2			3	2	2	7	2	2	12	16
5	Dimitrijević Sv.	2	2				2		1	2	2	3	4	9
6	Đurašinović Ilija			1			1	4	2	1	4	2	3	9
7	Gajić Zoran			2			2			2			6	6
8	Popadić Zorica				1	1		1	2	1	2	3	1	6
9	Perlić Goran								1	3		1	3	4
10	Zelen Ana								2	1		2	1	3
11	Ćirić Mladen						1		1	1		1	2	3
12	Stojiljković Boris								1	1		1	1	2
13	Petković Vladan								1	1		1	1	2
14	Homa Miroslav								1	1		1	1	2
15	Arančić Kristina				1						1			1
16	Mijatović Sanja							1			1			1
17	Ubović Biljana							1			1			1
18	Babić Darko						1						1	1
19	Malešić Budimir						1						1	1
20	Matić Zoran									1			1	1
21	Radišić Aleksan.									1			1	1
22	Mitrović Sanja									1			1	1
23	Zelen Milan									1			1	1

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Table 6: Distribution of medals won by Serbian table tennis pairs by gender

Competition	Men				Women				Mixed				All
	1	2	3	Uk	1	2	3	Uk	1	2	3	Uk	
Paralympic Games	3	4	7	14	1	5	2	8					**22**
World Champion.	1	1	7	9	4	1	4	9			2	2	**20**
European Champ.	6	10	16	32	10	8	3	21	1	1	1	3	**56**
Total	10	15	30	**55**	15	14	9	**38**	1	1	3	5	**98**
Total %	10.2	15.3	30.6	**56.1**	15.3	14.3	9.2	**38.8**	1	1	3.1	5.1	100

Discussion

From the review of the results that have been achieved in the past, it is very noticeable that our table tennis players with disabilities have achieved fantastic success. In the list of medals won at the Paralympic Games, table tennis is in second place, right after athletics (Table 1), and the fact that they have never returned from a major competition without winning a medal is particularly impressive. Only at the Paralympic Games, starting in 1980, competitors from Serbia won 22 out of a total of 24 medals, the number won by all representatives of the SFRY, FRY, SCG and Serbia in table tennis, and those two medals were won by the Slovenian Simonič (Table 2), while at the world championships, starting from the premiere edition in 1990 until today, our table tennis players have won as many as 20 medals, of which 5 gold (Table 3). During the time of the joint state, only one more medal at the world championships was won by Rakić from Croatia. As many as 56 medals were won at the European championships, of which 17 were gold (Table 4), and at these competitions only one more medal was "added" by the already mentioned competitor from Croatia. It sounds simply incredible that in the previous 44 years, the competitors of our national team (SFRJ, independent competitors, FRY, SCG, Serbia) won a total of 102 medals in para table tennis, and that 98 of them were won by competitors from Serbia. It should be clarified that out of those 98 medals, 5 were won in the combined team, where in addition to competitors from Serbia, there were also competitors from Croatia or Slovenia (Tables 2, 3 and 4). This information gains special weight when you take into account the fact that during the joint state, competitors from Croatia and Slovenia achieved very impressive results in table tennis. For the sake of a realistic representation of this issue, it should be clarified that after the separation from the joint state, the table tennis players from Croatia achieved great results, so that table tennis, with 4 medals, of which two are gold, is the second most successful sport in Croatia at the Paralympic Games after athletics. (Croatia won 30 medals at the summer POI, September 8, 2024). In Slovenia, after gaining independence, para-table tennis players won two medals at the Paralympic Games, a gold and a bronze, so that para-table tennis is the third most successful sport, after athletics and archery (Slovenian Paralympic medals, 2024). It can be seen that table tennis is very popular and of high quality in the entire region of the former joint state, but athletics dominates in terms of the number of medals won in all countries. For the sake of a more realistic picture, we also mention the fact that at the POI in Paris, out of a total of 549 disciplines, only 164 competitions were held in athletics, while in table tennis the competition was held in 31 disciplines. In the past, that number of competitive disciplines favored athletics even more, so it is also logical that the most medals are won in athletics, in the countries of the region but also in the world.

A total of 23 athletes completed the great collection of 98 medals at the biggest competitions of players from Serbia, of which 8 were female competitors and 15 were male competitors (Table 5). It is noticeable that out of the total number of medal winners, more than a third are female athletes, which is of particular importance when considering the fact that women with disabilities in Serbia are significantly less involved in sports activities than men and that women make up only 26% of the total number of athletes with disabilities in Serbia (Ivanović, Eminović, Potić and Medenica, 2010). If the number of medals won is taken as a criterion, then the performance of female competitors is even more pronounced, because 38 medals were won by female table tennis players and 55 by male table tennis players, while 5 medals were won in the mixed competition. Expressed as a percentage, 44% of medals in para table tennis at the biggest competitions were won by sportswomen, mostly in women's competition (38.8%), but also as part of mixed doubles (5.1%). Such success of women has not been recorded in any other Paralympic sport in Serbia. The fact that women have become more involved in pair table tennis only since the independence of Serbia in 2006 gives additional weight to such a significant performance of pair table tennis players. All the medals for Serbia until then were won by men, while the female competitors achieved all the great successes after 2006. This means that since the independence of Serbia, our female competitors have won 38 medals, and male competitors 24 medals, while 5 medals were won in mixed competition. In this period, female competitors were more successful than their male colleagues, as they won 56.7% of medals and participated in winning another 7.5% of medals in the mixed competition, while men in this period won 35.8% of the total number of medals won. Para table tennis in Serbia achieves fantastic successes, and the fact that women play an extremely large role in these successes is of particular importance, so this sport can be considered one of the main carriers of Paralympic sports, but also the locomotive of women's Paralympism in Serbia.

The medals and successes of our para-tennis players represent a great example and incentive for work in other sports as well. The way in which the training and competition process is organized gives extraordinary results, so it also represents a kind of model for those who have not been so successful so far. And that model implies that the existing resources from non-Paralympic sports, in the form of space, equipment, sports experts, administration, are used to the maximum extent... The first para table tennis clubs were formed only at the end of the last century, and the Table Tennis Association of Persons with Disabilities of Serbia was formed only in 2006. , with only three clubs in Novi Sad, Belgrade and Smederevo, while today this Association consists of 12 clubs. However, great successes on the international stage have been achieved before. Although inclusion was not mentioned in our country at that time, neither in education nor in sports, our most successful competitors were a forerunner and a kind

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of model for an inclusive approach, which was officially accepted in Serbia only 15 years ago. It was our celebrated para table tennis players who showed the general public how it can and should work.

Zoran Gajić was born in Belgrade (February 15, 1942 - September 15, 2022) and since 1956, regardless of knee problems, he started training table tennis. He achieved great success, such as the title of junior team champion of the SFRY in 1961 (STK Mladost from Zemun) and senior team champion of the SFRY in 1966 (STK Partitzan from Belgrade), and in para table tennis he won two bronze medals at the Paralympic Games, World and European championships (Table 5). Even as an active player, he started coaching, and as a coach he made a deep mark in our table tennis. He was the coach of Milivoj Karakašević and Zoran Kosanović, of the Greek national team, and of clubs in Sweden and the Netherlands (Uzorinac, 1978).

Dimitrijević Svetislav (August 2, 1949) had his left hand amputated at the age of twelve, but he started training table tennis very early. He was the champion of Kosovo three times, the junior vice-champion of the SFRY and played in the second federal league, and in the seventies of the last century he started competing in the competition for people with disabilities, where he achieved fantastic success. Already in 1974, he won a gold medal at the Games of the International Federation for Sports of Persons with Disabilities ISOD, and from 1980 to 1992 he won 9 medals at the biggest competitions, including two gold and one silver medals each at the Paralympic Games. After the end of his competitive career, he worked as a coach and was the president of the Table Tennis Association of Persons with Disabilities of Serbia, as well as a long-term member of the Board of Directors of the Table Tennis Association of Serbia.

The example of these two giants shows that sport is not only possible to connect people with and without disabilities, but that such a thing is a completely logical need and interest. The hall for training and competitions can be shared, club rooms and offices can be shared, sports experts and experts from other fields who are engaged in sports do not always have to be separate, and even the training and competition process itself can often be connected. This kind of connection between table tennis and pairs of table tennis also exists in other countries. The famous Polish table tennis player Natalija Partuka was born in 1989 without a right forearm, and at the Paralympic Games from 2004 to 2024, she won as many as 10 medals, of which 6 were gold, at the world championships 14 medals, of which 8 were gold, but as member of the Polish national team played at the Olympic Games in 2008, 2012 and in 2016, and won silver and bronze medals at the European Championships and bronze at the European Games in 2019. Bruna Alexandra from Brazil, whose right arm was amputated six months after her birth in 1995, has won a total of 7 medals at the Paralympic Games since 2016 and was twice the world champion, and in Paris in 2024 she played at both the Olympic and Paralympic Games. As a member of the Brazilian national team, she won all three medals at the Pan American Games and Championships, which is another great example of the complete inclusion of athletes with disabilities. A similar example is Melissa Tapper from Australia, who won a silver medal at the Paralympic Games in Tokyo and two bronze medals at the Para Table Tennis World Championships in 2014 and 2018, as well as a bronze medal at the Commonwealth Games in 2014, as well as more medal at the Oceania championships for younger age categories in the competition of the general population. In Rio 2016, she became the first Australian athlete to compete at the Olympic and Paralympic Games. There are many similar examples, but these few are enough to illustrate the potential of table tennis to ensure full inclusion for athletes with disabilities. In Serbia, this potential was noticed more than fifty years ago, so the training of para-tennis players is often realized through joint work and sparring with players of the general population, while in recent times their participation in competitions of the general population is somewhat rarer. In the training activities of the players.

Conclusion

Along with athletics and shooting, table tennis is certainly the most successful Paralympic sport in Serbia. Medals at major international competitions were won continuously, and significant successes were achieved in both men's and women's competitions. The successes achieved by our para-tennis players are truly numerous and it is almost impossible to list them all, but in this paper all the medals of Serbian para-tennis players are listed and systematized only from the most important competitions, namely the Paralympic Games, the World Championships and the European Championships. The reasons for the success of our para-tennis players lie, first of all, in the motivation and enthusiasm of the competitors themselves, then in the professional and well-organized work in the clubs, but also in the strong and continuous support from the Paralympic Committee of Serbia. The support of the Paralympic Committee has been continuous since the establishment of the Paralympic Committee of Yugoslavia in 1999, and before that also by the Association for Disabled Sports of Yugoslavia and Serbia. The fact that our female players achieved great success is especially pleasing, which is not the case in some other para sports in Serbia, so that para table tennis is one of the main carriers of the promotion of women's para sports in Serbia. A large number of players who play standing compete and train with players without disabilities, while players who play in wheelchairs very often train with players without disabilities who sit on chairs. This approach is a great example of inclusion in sports, which can and should serve as a good model for work in other sports as well. At the recently concluded Paralympic Games in Paris, three medals were won, with which our para table tennis players once again confirmed that we work well and with quality, and that we can expect good results in the future as well.

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UDK 796.386-056.26

Stoni tenis kao jedan od nosilaca paraolimpijskog i inkluzivnog sporta u Srbiji

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Uvod

Mada se tragovi preteče stonog tenisa mogu naći i u nekim starijim vremenima, on počinje da se igra u drugoj polovini 19. veka u Velikoj Britaniji, gde su ga na trpezarijskim stolovima, koristeći knjige kao mrežicu, poklopce od kutija kao rekete, a pampure od šamanjca kao lopticu, igrali predstavnici viših slojeva društva (Para Table Tennis, 12.7.2024.). Svetska stonoteniska federacija formirana je 1926. godine, iste godine održano je i Prvo svetsko prvenstvo, a na programu olimpijskih igara prvi put se našao 1988. godine u Seulu. Danas ima veliku poularnost i gledanost, tako da je 2023. godine bio šesti sport po gledanosti sa ukupno 875 miliona gledalaca, iza fudbala, kriketa, hokeja, tenisa i odbojke, a gledaniji od košarke, bezbola, ragbija i golfa (Most Popular Sports in the World 2023).

Osobe sa invaliditetom su stoni tenis počele da igraju u britanskoj bolnici za ranjenike iz Drugog svetskog rata, koju je u Stok Mendevilu 1944. godine formirao lekar jevrejskog porekla Ludvig Gutman. Stoni tenis je jedan od sportova koji je na programu paraolimpijskih igara još od njihovog premijernog izdanja 1960. godine u Rimu, a bio je rezervisan samo za igrače u kolicima. Od 1976. godine postaje dostupan i stojećim igračima, od 1980. takmiče se i igrači sa cerebralnom paralizom, a 2000. godine prvi put su učestvovali i igrači sa intelektualnom ometenošću. Danas se para stonim tenisom bavi više od 40 milona igrača iz više od 100 zemalja širom sveta, kao i milioni rekreativaca (Paralympic History, 12.7.2024.), a ovim sportom rukovodi Svetska stonoteniska federacija preko Međunarodnog parastonoteniskog komiteta. Veoma je interesantan i pristupačan, jer ne zahteva mnogo prostora ni skupu opremu, a akterima pruža čitav niz značajnih benefita (Tsou, Chen, Shih,& Lin, 2024). Stoni tenis pruža priliku osobama sa invaliditetom da se takmiče, razvijaju svoje veštine i postižu izvanredne sportske rezultate, a po broju sportista je treći para sport u svetu (Kong, & Sze Ma, 2024). Takmičenja poput paraolimpijskih igara omogućavaju sportistima da unaprede svoj način razmišljanja i smirenost u frustrirajućim situacijama, kao i da pokažu svoj talenat i istrajnost (Lin, Tsai, Kao, & Liu, 2019). Kroz učešće na takmičenjima, sportisti na sjajan način promovišu sebe i svoju porodicu, svoj klub, Savez, Paraolimpijski komitet, Ministarstvo sporta, grad i državu… Istovremeno, oni vrlo uspešno podižu svest o prisutnosti i potrebama osoba sa invaliditetom u društvu, te promovišu inkluziju.

Na prostorima nekadašnje zajedničke države SFRJ, para stoni tenis nije odmah pratio uspehe i popularnost koju je imao stoni tenis. Stonoteniseri Jugoslavije su prve medalje na svetskim prvenstvima osvojili još 1939. godine, da bi nakon Drugog svetskog rata postali jedna od veoma uspešnih svetskih stonoteniskih zemalja. Takmičari iz Jugoslavije su redovno osvajali medalje na najvećim takmičenjima, a do raspada zajedničke države osvojili su preko 80 medalja (Mit o YU-sportu: stoni tenis, 2021). Para stoni tenis dugo nije imao svoje predstavnike na međunarodnoj sceni, da bi tek sedamdesetih godina prošlog veka počeli da se pojavljuju na nekim međunarodnim takmičenjima. Ipak, naši para stonoteniseri su punu pažnju sportske javnosti dobili tek na Paraolimpijskim igrama 1980. godine, kada su i osvojene prve medalje. Od tada do danas kontinuitet osvajanja medalja se zadržao, tako da naši takmičari nikada nisu otišli na neko veliko takmičenje a da nisu osvojili barem jednu medalju. Taj niz osvajanja medalja neprekidno traje već 44 godine, a svi se nadamo i očekujemo da će se nastaviti i u budućnosti. U međuvremenu, država je menjala svoje granice i naziv, ali su takmičari iz Srbije uvek imali puno uspeha i bili neka vrsta perjanice našeg paraolimpizma, ali i sporta u celini. Predmet ovog rada je nastanak i razvoj para stonog tenisa u Srbiji, kao i pregled najznačajnijih rezultata koje su parastonoteniseri iz Srbije ostvarili do danas.

Metode

U radu je dominantno korištena istorijska metoda. Uvidom u dostupne elektronske i pisane izvore, napravljen je pregled svih medalja koje su naši sportisti ostvarili na najvećim takmičenjima u para stonom tenisu. U obzir su uzete samo medalje sa takmičenja prve kategorije na kojima su učestvovali naši para stonoteniseri, a to su: paraolimpijske igre, svetska i evropska prvenstava. Pregled osvojenih medalja sačinjen je isključivo na osnovu zvaničnih sajtova i zapisnika, a u obzir su uzete medalje koje su osvojili takmičari iz Srbije, dok su medalje takmičara iz Hrvatske i Slovenije samo pomenute i nisu uzimane u analizu. Medalje su klasifikovane prema vrsti takmičenja na kojem su ostvarene, hronološki po godinama kada su osvojene, prema polu takmičara koji su ih ostvojili, kao i pojedinačno za svakog sportistu koji je osvojio barem jednu medalju na ovim najvećim takmičenjima. Pregled medalja dat je u apsolutnim i relativnim vrednostima. U delu rada koji ilustruje inkluzivni pristup u stonom tenisu, pored istorijske, korištena je i deskriptivna metoda.

Rezultati

Tabela 1: Medalje na Paraolimpijskim igrama koje su osvojili takmičari iz Srbije (Medalje na igrama, 2020)

Sport	Zlatne	Srebrne	Bronzane	Ukupno
Atletika	8 (4m+4ž)	10 (1ž+9m)	9 m	27 (5ž+22m)
Stoni tenis	4 (1ž+3m)	9 (5ž+4m)	9 (2ž+7m)	22 (8ž+14m)
Streljaštvo	7 (2ž+5m)	5 (2ž+3m)	1 m	13 (4ž+9m)
Plivanje	2 m	2 m	-	4 m

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Golbal*	1 m	-	1 m	2 m
Sedeća odbojka*	-	-	1	1 m
Ukupno	**22 (7ž+15m)**	**26 (8ž+18m)**	**21 (2ž+19m)**	**69 (17ž+52m)**

*Ekipni sportovi u kojima su deo tima činili i sportisti iz Srbije

Tabela 2: Medalje stonotenisera iz Srbije na Paraolimpijskim igrama (Tournaments – Paralympic Games, 2024)

Godina	Zlatne	Srebrne	Bronzane	Ukupno
1980	2 Dimitrijević; Dimitrijević/Šimunić**	Šimunić**		2
1984	Šimunić**	1 Dimitrijević/Šimunić**	3 Gajić 2; Đurašinović	4
1988		1 Dimitrijević		1
1992			1 Kesler	1
1996	1 Kesler			1
2000		1 Kesler		1
2004			1 Kesler	1
2008		1 Ranković Borislava		1
2012		2 Ranković; Kesler		2
2016	1 Ranković B.	1 Ranković B/Matić Nada	2 Matić Nada, Palikuća	4
2021			1 Ranković B.	1
2024		2 Ranković; Ranković/Matić	1 Palikuća	3
Ukupno	**4**	**9**	**9**	**22**

**Osvajači medalja za reprezentaciju SFRJ koji nisu iz Srbije

Tabela 3: Medalje srpskih para stonotenisera na Prvenstvima sveta (Tournaments - World Championships, 2022)

Godina	Zlatna	Srebrna	Bronzana	Ukupno
1990			2 Dimitrijević; Rakić**; Dimitrijević/Rakić**,	2
1998			2 Kesler; Kesler/Đurašinović	2
2002		1 Kesler		1
2006	1 Kesler			1
2010		1 Ranković/Matić/Popadić	2 Ranković; Kesler	3
2014	1 Ranković/Matić/Popadić		3 Ranković; Matić Nada; Palikuća	4
2017	1 Ranković/Matić/Arančić		1 Palikuća/Malešić/Babić	2
2018	1 Ranković Borislava			1
2022	1 Ranković/Matić Nada		3 Ranković/Ćirić; Matić/Palikuća; Matić N.	4
Ukupno	**5**	**2**	**13**	**20**

Tabela 4: Medalje srpskih para stonotenisera na Prvenstvima Evrope (Tournaments-European Championships, 2023)

Godina	Zlatne	Srebrne	Bronzane	
1985			2 Dimitrijević/Šimunić**; Gajić/Gubica**/Berti**	2
1987		1 Dimitrijević		1
1989		1 Kesler/Đurašinović	2 Gajić; Dimitrijević	3
1991		1 Kesler	(Rakić**)	1
1995		1 Kesler		1
1997		1 Kesler		1

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1999	1 Kesler			1
2001	1 Kesler/Đurašinović	1 Kesler		2
2003			2 Kesler	2
2005	1 Kesler/Đurašinović			1
2007	1 Ranković	1 Ranković/Matić/Popadić	1 Kesler/Đurašinović/Matić Z	3
2009	2 Kesler/Đurašinović; Ranković Borislava	1 Kesler	2 Ranković Borislava; Ranković/Mitrović/Popadić	5
2011	3 Kesler; Ranković/Matić/Popadić; Kesler/Palikuća/Đurašinović	1 Ranković Borislava	1 Palikuća	5
2013	1 Ranković Borislava	1 Kesler/Palikuća/ Đurašinović/ Homa	2 Palikuća; Perlić/Radišić/Petković	4
2015	1 Ranković Borislava	2 Matić Nada; Ranković/Matić/ Popadić	1 Palikuća	4
2017	2 Ranković Borislava; Ranković/Matić/Ubović		4 Palikuća; Matić Nada; Perlić/Stojiljković; Palikuća/Homa/Zelen Milan	6
2019	2 Ranković Borislava; Ranković/Matić/Mijatović	4 Palikuća; Zelen A; Matić; Perlić/Stojiljković/Petković		6
2023	2 Ranković Borislava; Palikuća/Matić Nada	3 Ranković/Matić; Zelen A; Ćirić/Ranković	3 Palikuća/Ćirić; Palikuća; Perlić/Zelen A.	8
Ukupno	**17**	**19**	**20**	**56**

Tabela 5: Osvajači medalja na najvećim takmičenjima u para stonom tenisu iz Srbije

Rb.	**Ime**	**Paraolimpijske igre**			**Prvenstva sveta**			**Prvenstva Evrope**			**Zbirno medalja**			**Uk.**
1	Ranković Borislav	1	5	1	4	1	3	10	5	2	15	11	6	32
2	Kesler Zlatko	1	2	2	1	1	3	6	7	3	8	10	8	26
3	Matić Nada		2	2	3	1	3	4	5	1	7	8	6	21
4	Palikuća Mitar			2			3	2	2	7	2	2	12	16
5	Dimitrijević Sv.	2	2				2		1	2	2	3	4	9
6	Đurašinović Ilija			1			1	4	2	1	4	2	3	9
7	Gajić Zoran			2			2			2			6	6
8	Popadić Zorica				1	1		1	2	1	2	3	1	6
9	Perlić Goran								1	3		1	3	4
10	Zelen Ana								2	1		2	1	3
11	Ćirić Mladen						1		1	1		1	2	3
12	Stojiljković Boris								1	1		1	1	2
13	Petković Vladan								1	1		1	1	2
14	Homa Miroslav								1	1		1	1	2
15	Arančić Kristina				1						1			1
16	Mijatović Sanja							1			1			1
17	Ubović Biljana							1			1			1
18	Babić Darko						1						1	1
19	Malešić Budimir						1						1	1
20	Matić Zoran									1			1	1
21	Radišić Aleksan.									1			1	1
22	Mitrović Sanja									1			1	1
23	Zelen Milan									1			1	1

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Tabela 6: Distribucija osvojenih medalja srpskih para stononotenisera prema polu

Takmičenje	Muškarci				Žene				Miks				All
	1	2	3	Uk	1	2	3	Uk	1	2	3	Uk	
POI	3	4	7	14	1	5	2	8					**22**
Prvenstva sveta	1	1	7	9	4	1	4	9			2	2	**20**
Prvenstva Evrope	6	10	16	32	10	8	3	21	1	1	1	3	**56**
Ukupno	10	15	30	**55**	15	14	9	**38**	1	1	3	5	**98**
Ukupno %	10.2	15.3	30.6	**56.1**	15.3	14.3	9.2	**38.8**	1	1	3.1	5.1	100

Diskusija

Iz pregleda rezultata koji su ostvareni u prošlosti, veoma je uočljivo da su naši stonoteniseri sa invaliditetom ostvarili fantastične uspehe. Na popisu medalja koje su osvojene na paraolimpijskim igrama, stoni tenis je na drugom mestu, odmah iza atletike (Tabela 1), a posebno je inpresivna činjenica da se nikada, od kada nastupaju na najvećim takmičenjima, nisu sa nekog velikog takmičenja vratili bez osvojene medalje. Samo na paraolimpijskim igrama, počev od 1980. godine, takmičari iz Srbije osvojili su 22 od ukupno 24 medalje, koliko su osvojili svi reprezentativci SFRJ, SRJ, SCG i Srbije u stonom tenisu, a te dve medalje osvojio je Slovenac Simonič (Tabela 2), dok su na svetskim prvenstvima, počev od premijernog izdanja 1990. godine do danas, naši stonoteniseri osvojili čak 20 medalja, od čega 5 zlatnih (Tabela 3). U vreme zajedničke države samo još jednu medalju na svetskim prvenstvima osvojio je Rakić iz Hrvatske. Na prvenstvima Evrope osvojeno je čak 56 medalja, od čega je čak 17 zlatnih (Tabela 4), a i na ovim takmičenjima samo je još jednu medalju "dodao" već pomenuti takmičar iz Hrvatske. Prosto neverovatno zvuči da su u prethodne 44 godine takmičari naše reprezentacije (SFRJ, nezavisni takmičari, SRJ, SCG, Srbija) u para stonom tenisu osvojili ukupno 102 medalje, a da je su od toga čak 98 osvojili takmičari iz Srbije. Treba pojasniti da su od tih 98 medalja 5 osvojeno u kombinovanom sastavu, gde su pored takmičara iz Srbije bili i takmičari iz Hrvatske ili Slovenije (Tabele 2, 3 i 4). Ovaj podatak posebnu težinu dobija kada se ima u vidu činjenica da su za vreme zajedničke države takmičari iz Hrvatske i Slovenije u stonom tenisu ostvarivali veoma inpozantne sportke rezultate. Radi realne predstave o ovoj problematici, treba pojasniti da su nakon odvajanja od zajedničke države, para stonoteniseri iz Hrvatske ostvarili sjajne rezultate, tako da je stoni tenis sa 4 medalje, od čega dve zlatne, posle atletike drugi sport u Hrvatskoj po uspešnosti na paraolimpijskim igrama (Hrvatska osvojila 30 medalja na ljetnim POI, 8.9.2024.). U Sloveniji su parastonoteniseri nakon sticanja nezavisnosti na paraolimpijskim igrama osvojili dve medalje, zlatnu i bronzanu, tako da je para stoni tenis treći sport po uspešnosti, posle atletike i streljaštva (Slovenske paraolimpijske medalje, 2024). Uočava se da je stoni tenis veoma popularan i kvalitetan u celom regionu bivše zajedničke države, ali atletika dominira po broju osvojenih medalja u svim zemljama. Radi realnije slike, navodimo i podatak da je na POI u Parizu, od ukupno 549 disciplina, samo u atletici takmičenje održano u 164, dok je u stonom tenisu takmičenje održano u 31 disciplini. U prošlosti je broj takmičarskih disciplina još više favorizovao atletiku, tako da je i logično to da se u atletici osvaja najviše medalja, u zemljama regiona ali i u svetu.

Sjajnu kolekciju od 98 medalja na najvećim takmičenjima igrača iz Srbije kompletiralo je ukupno 23 sportista, od čega su 8 takmičarke a 15 takmičari (Tabela 5). Uočljivo je da su od ukupnog broja osvajača medalja više od trećine sportiskinje, što ima poseban značaj kada se ima u vidu činjenica da su žene sa invaliditetom u Srbiji značajno slabije uključene u sportske aktivnost nego muškarci i da žene čine svega 26% od ukupnog broja sportista sa invaliditetom u Srbiji (Ivanović, Eminović, Potić i Medenica, 2010). Ako se kao kriterijum uzme broj osvojenih medalja, onda je taj učinak takmičarki još izraženiji, jer su 38 medalja osvojile stonoteniserke a 55 stonoteniseri, dok je 5 medalja osvojeno u mešovitoj konkurenciji. Izraženo u procentima, 44% medalja u para stonom tenisu na najvećim takmičenjima osvojile su sportskinje, većim delom u konkurenciji žena (38.8%), ali i kao deo mešovitih dublova (5.1%). Ovakva uspešnost žena nije zabeležena ni u jednom drugom paraolimpijskom sportu u Srbiji. Dodatnu težinu ovako značajnom učinku para stonoteniserki daje i činjenica da se žene u para stoni tenis značajnije uključuju tek od osamostaljenja Srbije 2006. godine. Sve medalje za Srbiju do tada osvajali su muškarci, dok su takmičarke sve velike uspehe ostvarile nakon 2006. godine. To znači da su od osamostaljenja Srbije naše takmičarke osvojile 38, a takmičari 24 medalje, dok je 5 madalja osvojeno u mešovitoj konkurenciji. Takmičarke su u ovom periodu bile uspešnije od svojih muških kolega, jer su osvojile 56.7% medalja i učestvovale u osvajanju još 7.5% medalja u mešovitoj konkurenciji, dok su muškarci u ovom periodu osvojili 35.8% od ukupnog broja svih osvojenih medalja. Para stoni tenis u Srbiji ostvaruje fantastične uspehe, a poseban značaj ima činjenica da u tim uspesima izuzetno veliki učinak imaju žene, tako da se ovaj sport može smatrati za jedan od glavnih nosilaca paraolimpijskog sporta, ali i lokomotivu ženskog paraolimpizma u Srbiji.

Medalje i uspesi naših parastonotenisera i para stonoteniserki predstavljaju sjajan primer i podsticaj za rad i u drugim sportovima. Način na koji je organizovan trenažni i takmičarski proces daje izvanredne rezultate, tako da predstavlja i svojevrstan model za one koji do sada nisu bili tako uspešni. A taj model podrazumeva da su maksimalno korišteni već postojeći resursi iz neparaolimpijskog sporta, u vidu prostora, opreme, sportskih stručnjaka, administracije… Prvi para stonoteniski klubovi formirani su tek krajem prošlog veka, a Stonoteniski savez osoba sa invaliditetom Srbije formiran je tek 2006. godine, sa svega tri kluba u Novom Sadu, Beogradu i Smederevu, dok danas ovaj Savez čini 12 klubova. Ipak, veliki uspesi na međunarodnoj pozornici ostvarivani su i ranije. Iako tada u našoj zemlji inkluzija nije pominjana, ni u obrazovanju niti u sportu, naši najuspešniji takmičari su bili preteče i svojevrsni model za inkluzivni pristup, koji će zvanično u Srbiji biti prihvaćen tek pre 15 godina. Upravo su naši proslavljeni para stonoteniseri pokazali široj javnosti kako to može i treba da funkcioniše.

Zoran Gajić (15.2.1942. – 15.9.2022.) je rođen u Beogradu i od 1956. godine, bez obzira na probleme sa kolenom, počeo da trenira stoni tenis. Ostvario sjajne uspehe, poput titula juniorskog ekipnog prvaka SFRJ 1961. godine (STK Mladost iz Zemuna) i seniorskog ekipnog prvaka SFRJ 1966. godine (STK Partitzan iz Beograda), a u para stonom tenisu osvojio je po dve bronzane medalje na paraolimpijskim

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igrama, svetskim i evropskim prvenstvima (Tabela 5). Još kao aktivan igrač počeo je da se bavi trenerskim poslom, pa je i kao trener ostvario dubok trag u našem stonom tenisu. Bio je trener Milivoja Karakaševića i Zorana Kosanovića, reprezentacije Grčke, te klubova u Švedskoj i Holandiji (Uzorinac, 1978).

Dimitrijević Svetislavu (2.8.1949.) je sa dvanest godina amputirana leva šaka, ali on vrlo rano počinje da trenira stoni tenis. Tri puta bio je prvak Kosova, juniorski vicešampion SFRJ i igrao drugu saveznu ligu, a sedamdesetih godina prošlog veka počinje da se takmiči i u konkurenciji osoba sa invaliditetom, gde ostvaruje fantastične uspehe. Već 1974. godine, osvaja zlatnu medalju na Igrama Međunarodne federacije za sport osoba sa invaliditetom ISOD, a od 1980. do 1992. godine osvaja 9 medalja na najvećim takmičenjima, među kojima su i po dve zlatne i srebrne medalje na paraolimpijskim igrama. Nakon završetka takmičarske karijere radio je kao trener i bio predsednik Stonoteniskog saveza osoba sa invaliditetom Srbije, kao i dugogodišnji član UO Stonoteniskog saveza Srbije. Upravo primer ove dvojica velikana pokazuje da je sport osoba sa i bez invaliditeta ne samo moguće povezati, već da je tako nešto sasvim logična potreba i interes. Sala za treninge i takmičenja može biti zajednička, prostorije kluba i kancelarije mogu biti i zajedničke, sportski stručnjaci i stručnjaci iz drugih oblasti koji su angažovani u sportu ne moraju uvek biti zasebni, a čak i sam trenažni i takmičarski proces često može biti povezan. Ovakva povezanost stonog i para stonog tenisa postoji i u drugim zemljama. Proslavljena poljska para stonoteniserka Natalija Partuka rođena je 1989. godine bez desne podlaktice, a na paraolimpijskim igrama od 2004. do 2024. godine, osvojila je čak 10 medalja od čega 6 zlatnih, na svetskim prvenstvima 14 medalja od čega 8 zlatnih, ali je kao član poljske reprezentacije igrala i na Olimpijskim igrama 2008., 2012. i 2016. godine, te osvojila srebnu i bronzanu medalju na Prvenstvima Evrope i bronzanu na Evropskim igrama 2019. godine. Bruna Aleksandre iz Brazila, kojoj je šest meseci nakon rođenja 1995. godine amputirana desna ruka, od 2016. godine na paraolimpijskim igrama osvojila je ukupno 7 medalja i dva puta bila prvak sveta, a u Parizu 2024. godine igrala je i na Olimpijskim i na Paraolimpijskim igrama. Kao član reprezentacije Brazila je osvojila sve tri medalje na Panamerićkim igrama i prvenstvima, što je još jedan sjajan primer potpune inkluzije sportista sa invaliditetom. Sličan primer je i Melise Taper iz Australije, koja je osvojila srebnu medalju na Paraolimpijskim igrama u Tokiju i dve bronzane medalje Svetskim prvenstvima u para stonom tenisu 2014. i 2018. godine, ali i bronzanu medalju na Igrama Komonvelta 2014. godine, kao i više medalja na prvenstvima Okeanije za mlađe uzrasne kategorije u konkurenciji opšte populacije. U Riju 2016. godine postala je prvi austarlijski sportista sa nastupom na Olimpijskim i na Paraolimpijskim igrama. Sličnih primera ima dosta, ali je i ovih nekoliko sasvim dovoljno da ilustruje potencijal stonog tenisa da obezbedi punu inkluziju za sportiste sa invaliditetom. U Srbiji je taj potencijal uočen pre više od pedeset godina, tako da se treninzi parastonotenisera često realizuju kroz zajednički rad i sparing sa igračima opšte populacije, dok je u novije vreme njihovo učešće na takmičenjima opšte populacije ipak nešto ređa pojava. Kod trenažnih aktivnosti igrača koji igraju stojeći gotovo da nema nikakvih ograničenja, dok se na takmičenju prilagođavanja mogu odnositi pre svega na način izvođenja servisa. Kod treninga sa igračima u kolicima, poželjno je da i sparing partner sedne na stolicu kako bi loptica dolazila na sličan načim kao kada igra igrač u kolicima. Kada se igraju mečevi glavna modifikacija je da stojeći igrač mora da servira u širini stola, tako da ona nakon odskoka ne izlazi sa stola preko bočnih linija stola. Nije dozvoljen ni servis sa jakom donjom rotacijom, koja bi lopticu nakon prvog odskoka vraćala ka mrežici ili je zaustavila na stolu. Sve ostalo je dozvoljeno, tako da uvek ima lepih i atraktivnih poena koji pružaju veliko zadovoljstvo igračima i publici. Izveštaj Evropske komisije (European Commission, 2018) navodi podatak da u Evropi živi oko 80 miliona osoba sa invaliditetom, koje se sportom bave puno ređe nego osobe bez invaliditeta, a upravo stoni tenis (uz fudbal, odbojku, rukomet, tenis, mini golf, aerobik i fitnes) naveden je kao izuzetno pogodan za inkluzivnu primenu sportskih aktivnosti. Činjenica da je stoni tenis atraktivan paraolimpijski sport, a da je veoma jednostavno obezbediti minimalne uslove za njegovo upražnjavanje, na najbolji mogući način objašnjava zašto je ovaj sport toliko popularan u opštoj populaciji, ali i među osobama sa invaliditetom.

Zaključak

Stoni tenis je, uz atletiku i streljaštvo, svakako najuspešniji paraolimpijski sport u Srbiji. Medalje na velikim međunarodnim takmičenjima osvajane se u kontinuitetu, a značajni uspesi ostvareni su i u muškoj i u ženskoj konkurenciji. Uspesi koje su naši parastonoteniseri ostvarili su zaista mnogobrojni i gotovo da je nemoguće sve ih nabrojati, ali su u ovom radu nabrojane i sistematizovane sve medalje srpskih parastonotenisera samo sa najznačajnjih takmičenja, a to su Paraolimpijske igre, Prvenstva sveta i Prvenstva Evrope. Razlozi ovakve uspešnosti naših parastonotenisera leže, pre svega, u motivisanosti I entuzijazmu samih takmičara, zatim stručnom i kvalitetno organizovanom radu u klubovima, ali i u snažnoj i kontinuiranoj podršci od strane Paraolimpiskog komiteta Srbije. Podrška Paraolimpijskog komiteta kontinuirano se odvija još od osnivanja Paraolimpijskog komiteta Jugoslavije 1999. godine, a pre toga i od strane Saveza za sport invalida Jugoslavije i Srbije. Posebno raduje činjenica da su sjajne uspehe ostvarile i naše igračice, što nije slučaj u nekim drugim para sportovima u Srbiji, tako da je para stoni tenis jedan od glavnih nosilaca promocije ženskog para sporta u Srbiji. Veliki broj igrača koji igraju stojeći takmiče i treniraju i sa igračima bez invaliditeta, dok igrači koji igraju u kolicima vrlo često treniraju sa igračima bez invaditeta koji sede na stolici. Ovakav pristup predstavlja sjajan primer inkluzije u sportu, koji može i treba da posluži kao dobar model za rad i u drugim sportovima. Na nedavno završenim Paraolimpijskim igrama u Parizu osvojene su tri medalje, čime su naši para stonoteniseri ponovo potvrdili da se kod nas dobro i kvalitetno radi, te da i u budućnosti možemo očekivati dobre rezultate.

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UDK 796.02(497.11)

Sports Culture and Infrastructure - Opinions of students of the Faculty of Sports and Physical Education University of Belgrade about the importance of the building of a national stadium

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Introduction

From a sociological point of view, the culture of a certain society in the broadest sense includes both non-material and material aspects. Non-material aspects refer to beliefs, ideas, values, norms, etc. which make up the content of a particular culture, while the material aspects refer to objects, symbols, architecture and technology, etc. through which the content of a certain culture is expressed. Just as no culture can exist without society, so no society can exist without culture (Giddens, 2005; Marković, Radenović, Bokan, 2016). Let us recall a comprehensive sociological understanding of the concept of culture, which highlights the ambiguity of the concept. Culture is a storehouse of information and accumulated knowledge, ways of thinking, feeling and acting that dominate a certain social community and that a certain social group transmits to its descendants (Golubović, 2007).
The aforementioned definition of culture can be transposed to the broad field of sports culture of a society, but also to the field of global sports culture. Thus, sports culture can be defined as a storehouse of information and accumulated knowledge, ways of thinking, feelings, beliefs and actions related to sports and different forms of sports behavior.

Both the global sports culture and the sports culture of a particular society contain non-material and material aspects at the same time. The non-material aspects of sports culture refer to the values on which the sports system is based in the broadest sense, such as respect for the rules of sports and the principles of sports ethics: respect and appreciation of the opponent, fair play, non-use of doping and the principle of a strict responsibility of the athlete – the athlete is always responsible for what gets into his/her organism. The values that sport implies also refer to the promotion of the hard work and effort, to the unity and strengthening of solidarity, cohesiveness and patriotism of a community (team, club, people, nation), to the unity of humanity in the fight against various forms of violence in sports, against hooliganism and vandalism, nationalism, chauvinism, racism, sexism in sports, and the fight against the mentioned 'isms' outside the sports field in terms of preserving the universal values of humanity, etc.

Regarding the material aspects of sports culture, let us recall the monuments, statues and busts as an expression of the material global sports culture, which are dedicated to famous athletes. First of all, monuments as an expression of the material culture of a certain people and nation carry not only a national element, which makes them part of the national identity (Giddens, 2005) and the cultural heritage of a people and/or nation, but can also have the characteristics of world cultural heritage. The building of monuments represents a very old institution of preserving memory and the culture of remembrance, both at the national and global level (Bulatović, 2019). In this context, there are significant monuments around the world that have been raised in honor of numerous athletes, both from individual and team sports (Stride, Thomas and Wilson, 2012). The special attention of researchers is attracted by statues of football players who died in the middle of their sports career (Stride, Thomas and Chamorro, 2019), but also statues and busts established around the world in honor of still-living celebrated athletes, such as Zlatan Ibrahimović and Cristiano Ronaldo (Stride, Thomas and Wilson, 2012).

In addition to monuments as an unavoidable expression of the material global sports culture, we must not leave out the importance of sports infrastructure consisting of sports facilities such as numerous sports halls, sports centers, and especially stadiums which are necessary for organization of the sports events. Stadiums can quite justifiably be considered a very resilient and permanent infrastructure if we keep in mind the purpose of a particular stadium. For example, the JNA stadium in Belgrade overcame the socialist ideology in the context in which it was built and continued its work in the 21st century because it was built for the needs of modern sports, which had and still have a prominent role in society (Mijatov, 2023). In this sense, „the ideology of modern sports makes stadiums resistant" (Mijatov, 2023: 267).

The connection between the non-material and material expression of sports culture can be distinguished by examples of contemporary, modern stadiums where hooliganism and vandalism by extreme fan groups are almost eradicated. Namely, let us recall the most modern European stadiums, such as the FC Olympique Lyon stadium in Lyon, France, whose construction was completed in January 2016 and which has 270 cameras inside the stadium and in a 1000-meter zone around the stadium, so that every person in every moment of the match can be recorded with at least three cameras (one camera is on the goal post, the others are on the roof and in the stands), which means that in case of any problem, in the shortest possible time the person can be identified. The management of the stadium has a list of 20 persons who are prohibited from approaching the stadium, but if it were to happen that these persons do come, the police and the legal service intervene and immediately take those persons to a prison cell within the stadium, and judgments can be made within only several hours (Knežević, 2016). Monitoring of all 270 cameras is carried out from the direction of the FC Olympique Lyon club television program, which is also located inside the stadium (Knežević, 2016), so it can be concluded that hooliganism and vandalism are almost impossible in the conditions of the mentioned state-of-the-art infrastructure. The prevention of hooliganism and vandalism in the context of the aforementioned security measures and the entire infrastructure of this stadium built in 2016 was very important because of the European Football Championship that took place in France that same year. Therefore, the mentioned example shows the importance of modern sports infrastructure in preventing hooliganism and vandalism at sports events, and in order to improve the entire sports culture.

In this paper, the opinions of the students of the Faculty of Sport and Physical Education of the University of Belgrade on the importance of the building of a national stadium in the context of the development of sports infrastructure were discussed.

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Method

The method of theoretical analysis and the survey questionnaire method are applied in the paper.

The survey of the opinions of students of the Faculty of Sport and Physical Education of the University of Belgrade on the importance of the building of a national stadium was conducted at the end of May 2024 on the occasion of the panel entitled «Heart of millions: Football between profit and humanitarian values.» Towards the European Football Championship (Germany, 2024)» which took place at the Faculty of Sports and Physical Education of the University of Belgrade on 05/31/2024. organized by the Friedrich Ebert Stiftung, the Faculty of Sports and Physical Education and the Football Friends organization.

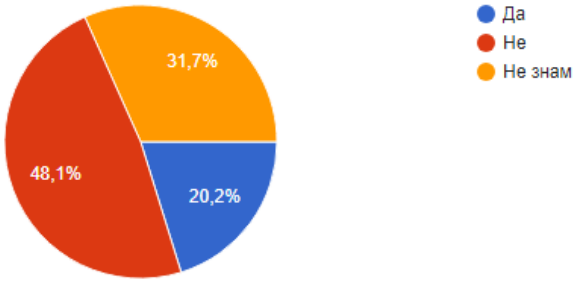
For the purposes of the research, a non-standardized questionnaire was constructed, and the data was collected through the online platform Google Forms. One hundred and four (104) students were surveyed: 45,2% female students and 54,8% male students. A total of 98,1% of those surveyed are students of the final year of the basic academic studies.

Results

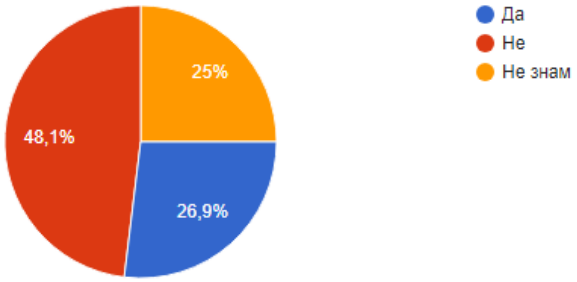
The surveyed students expressed a positive opinion towards the construction of the national stadium: they believe that improving the sports infrastructure can affect the change within the demographic structure of stadium visitors (family visits to matches), can initiate the organization of mega sports events in the future and can generally improve the entire sports culture. Let us consider the respondents' answers to the questions.

To the question 'Do you think that domestic football is invested enough?', all respondents answered as follows: 48,1% think that not enough is invested, 20,2% think that enough is invested, while a significant percentage of respondents 31,7% do not know the answer to the question (Graph 1).

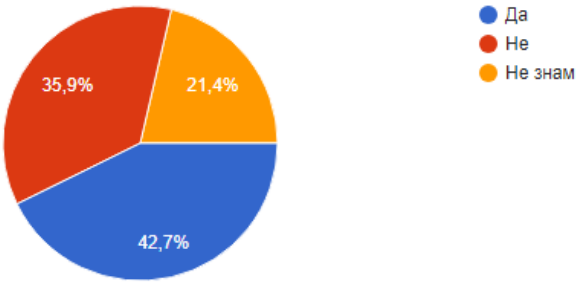
All surveyed students answered the question 'Do you think football should be seen as an investment and not just as a sport?', 48,1% of respondents answered negatively, 26,9% gave a positive answer, while as many as 25% of respondents stated that they did not know the answer to the question (Graph 2). One houndred and three (103) respondents answered the question 'Do you think the construction of the national stadium is justified?': 42,7% think that the building of the national stadium is justified, 35,9% of respondents think that the building of the national stadium is not justified, and 21,4% of respondents do not know the answer to the question (Graph 3). One houndred and three (103) respondents gave the following answers to the question 'Do you think that the construction of a national stadium is necessary for the improvement of the entire sports culture?': 47,6% of the respondents answered the question positively, 37,9% of the respondents gave a negative answer, while 14,6% of the respondents indicated that they did not know (Graph 4). One houndred and two (102) respondents answered the question 'Do you think that the construction of a national stadium can initiate the organization of mega sports events such as the European and/or World Championships or the Olympic Games in the Republic of Serbia in the future?': 54,9% of the respondents gave a positive answer, 26,5% of the respondents gave a negative answer, while 18,6% of the respondents answered that they «don't know» (Graph 5). The question 'Do you think that the construction of a national stadium with planned facilities (shopping center, restaurants, parks, water sports center, football academy, golf courses, etc.) can contribute to the changing of the demographic structure of visitors of the sports events (for example, family visits stadium)?' was answered by 102 respondents as follows: 56,9% of respondents gave a positive answer, 25,5% of respondents gave a negative answer, while 17,6% state that they 'don't know' (Graph 6). One houndred and three (103) respondents answered the question 'Do you think that the construction of a national stadium with the mentioned planned contents can contribute to reducing the disturbances in the stands caused by fan groups?': 54,4% of the respondents gave a negative answer, 22,3% of the respondents gave a positive answer, while a similar percentage of respondents (23,3%) declare that they 'don't know' (Graph 7). Finally, to the question 'Are you in principle FOR the construction of a national stadium?', 100 respondents answered as follows: 60% of respondents are in principle 'FOR' the construction of a national stadium, while 40% of respondents are against (Graph 8).



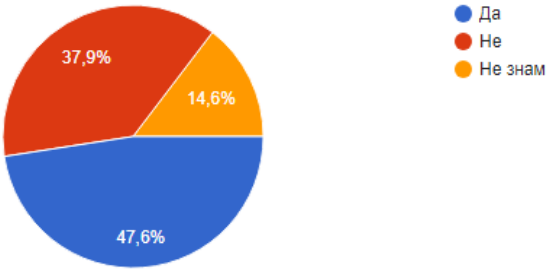
Graph 1. Question: Do you think that domestic football is invested enough?



Graph 2. Question: Do you think football should be seen as an investment and not just as a sport?



Graph 3. Question: Do you think the construction of the national stadium is justified?



Graph 4. Question: Do you think that the construction of a national stadium is necessary for the improvement of the entire sports culture?

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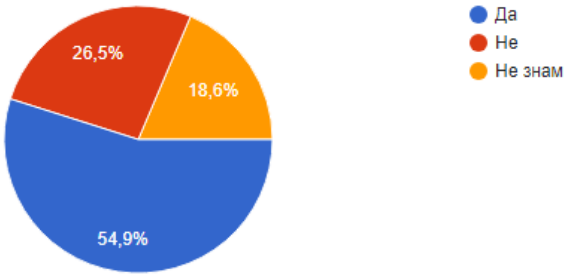
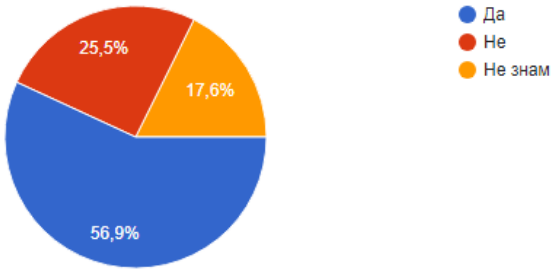
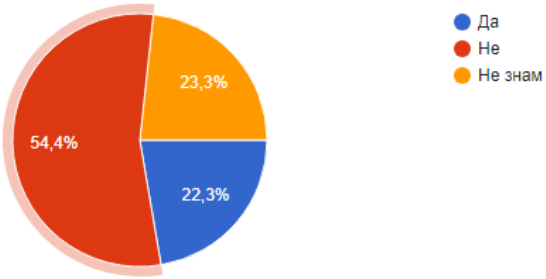


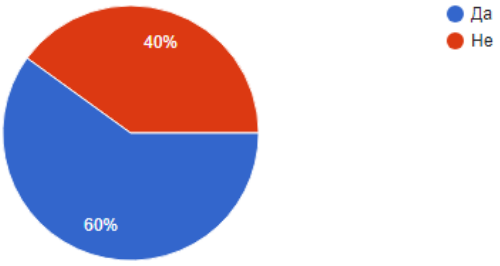
Graph 5. Question: Do you think that the construction of a national stadium can initiate the organization of mega sports events such as the European and/or World Championships or the Olympic Games in the Republic of Serbia in the future?



Graph 6. Question: Do you think that the construction of a national stadium with planned facilities (shopping center, restaurants, parks, water sports center, football academy, golf courses, etc.) can contribute to the changing of the demographic structure of visitors of the sports events (for example, family visits stadium)?



Graph 7. Question: Do you think that the construction of a national stadium with the mentioned planned contents can contribute to reducing the disturbances in the stands caused by fan groups?



Graph 8. Question: Are you in principle FOR the construction of a national stadium?

Discussion

As it is mentioned, the survey of the opinions of students of the Faculty of Sports and Physical Education of the University of Belgrade on the importance of the building of a national stadium was conducted on May 31, 2024, on the occasion of the panel entitled "Heart of millions: Football between profit and humanitarian values." Towards the European Football Championship (Germany, 2024)" which took place at the Faculty of Sports and Physical Education of the University of Belgrade on the same day organized by the Friedrich Ebert Stiftung Foundation, the Faculty of Sports and Physical Education and the Football Friends organization. Considering the topic of the panel dedicated to, among the other things, the possibility of considering football as an investment in the broadest sense, the basic idea guiding the research was the fact that students of the Faculty of Sports and Physical Education of the University of Belgrade are future professionals in sports – coaches and teachers of physical education, and that considering the educational profile, they have certain knowledge about the characteristics and importance of modern sports infrastructure and about the importance of investing in the development of sports infrastructure in the context of improving the entire sports culture.

In general, it can be noted that the surveyed student population has a positive opinion about the importance of the building of a national stadium and, in general, about the importance of the investing in the development of sports infrastructure. On the other hand, a significant percentage of surveyed students did not know the answers to the questions, or rather, did not have an opinion on a certain topic. Thus, even 31,7% do not know the answer to the question 'Do you think that domestic football is invested enough?'; furthermore, 25% of those surveyed state that they do not know the answer to the question 'Do you think that football should be seen as an investment, and not just as a sport?'; similarly, 21,4% of respondents do not know the answer to the question 'Do you think that the construction of the national stadium is justified?'; then 14,6% of respondents state that they do not know the answer to the question 'Do you think that the construction of a national stadium is necessary for the improvement of the entire sports culture?'; similarly, 18,6% of respondents state that they do not know the answer to the question 'Do you think that the construction of a national stadium can initiate the organization of mega sports events such as the European and/or world championships or the Olympic Games in the Republic of Serbia in the future?'; further, 17,6% state that they do not know the answer to the question 'Do you think that the construction of a national stadium with planned facilities (shopping center, restaurants, parks, water sports center, football academy, golf courses, etc.) can contribute to change demographic structure of visitors of sports events (for example, family visits to the stadium)?'; and finally, 23,3% declare that they do not know the answer to the question 'Do you think that the construction of a national stadium with the mentioned planned contents can contribute to reducing the disorder in the stands caused by fan groups?'. A significant percentage of surveyed students who state that they do not know the answer to the mentioned questions can point researchers of this and similar phenomena to the presence, importance and need of processing thematic units related to sports infrastructure, organization of sports events, management of sports events, etc. in the complex field of sociology of sport, but also other disciplines that are studied as part of the curriculum provided by the program of basic, integrated and master academic studies of the Faculty of Sport and Physical Education of the University of Belgrade.

Finally, it would be relevant to compare the opinions of students of the Faculty of Sports and Physical Education of the University of Belgrade and other related sports faculties with the opinions of students of other faculties on a larger sample of the student population about the importance of the building of a national stadium, which can be a potential research endeavor for future researchers of this and similar phenomena.

Conclusion

Considering the large investments in infrastructure, the insufficient utilization of the capacities of the existing sports

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centers, as well as the still insufficient physical exercise of the population in the Republic of Serbia (Radenović, 2021), the importance of the construction of the national stadium, and the opinions of the students of the Faculty of Sports and Physical Education of the University in Belgrade on the importance of building a national stadium are relevant topics within the complex and current field of sociology of sport.

The connection between the non-material and material expression of sports culture can be seen through the examples of contemporary, modern stadiums where hooliganism and vandalism by extreme fan groups have almost been eradicated. Nevertheless, more than 50% of the surveyed students, despite their positive opinion about the construction of the national stadium, believe that the national stadium with the planned facilities (shopping center, restaurants, parks, water sports center, football academy, golf courses, etc.) cannot contribute to reducing riots in the stands caused by fan groups. The above result can be interpreted in the context of the still difficult to solve decades-long problem of hooliganism and vandalism by extreme fan groups present in Serbian sports, primarily at football matches (Gvozdenović et al., 2023). Namely, despite the fact that modern stadiums in the world have infrastructural features that greatly prevent the manifestation of hooliganism and vandalism by extreme fan groups, more than 50% of surveyed students believe that a national stadium with the aforementioned planned contents cannot contribute to reducing hooliganism. This result points to distrust in the relevant sports bodies and institutions that are expected to systematically solve the problem of hooliganism and vandalism of extreme fan groups, as was done, for example, at the FC Olympique Lyon stadium in Lyon in France. The considered result of our research indicates the necessity of a systematic solution to the problem of hooliganism and vandalism by the relevant sports bodies and institutions in the Republic of Serbia, in the context of improving the entire sports culture.

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UDK 796.02(497.11)

Sportska kultura i infrastruktura - mišljenja studenata Fakulteta sporta i fizičkog vaspitanja Univerziteta u Beogradu o značaju izgradnje nacionalnog stadiona

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Uvod

Sa sociološkog stanovišta, kultura određenog društva u najširem smislu obuhvata istovremeno nematerijalne i materijalne aspekte. Nematerijalni aspekti se odnose na verovanja, ideje, vrednosti, norme itd. koji čine sadržaj određene kulture, dok se materijalni aspekti odnose na objekte, simbole, arhitekturu i tehnologiju itd. kroz koje se izražava sadržaj određene kulture. Kao što nijedna kultura ne može postojati bez društva, tako nijedno društvo ne može postojati bez kulture (Gidens, 2005; Marković, Radenović, Bokan, 2016). Podsetimo na jedno sveobuhvatno sociološko shvatanje pojma kulture koje ističe višeznačnost pojma. Kultura je skladište informacija i nagomilanog znanja, načina mišljenja, osećanja i delovanja koji dominiraju u određenoj društvenoj zajednici i koje određena društvena grupa prenosi na svoje potomke (Golubović, 2007).

Navedena definicija kulture može se transponovati na široko polje sportske kulture jednog društva, ali i na polje globalne sportske kulture. Tako sportsku kulturu možemo definisati kao skladište informacija i nagomilanog znanja, načina mišljenja, osećanja, verovanja i delanja vezanih za sport i različite oblike sportskog ponašanja.

Kako globalna sportska kultura, tako i sportska kultura određenog društva sadrži istovremeno nematerijalne i materijalne aspekte. Nematerijalni aspekti sportske kulture se odnose na vrednosti na kojima se zasniva sistem sporta u najširem smislu, poput poštovanja pravila sportske igre i principa sportske etike: poštovanje i uvažavanje protivnika, fer-plej (fair-play), nekorišćenje doping sredstava i princip striktne odgovornosti sportiste – sportista je uvek odgovoran za ono što dospe u njegov/njen organizam. Vrednosti koje sport podrazumeva se odnose i na promovisanje napornog rada i truda, na jedinstvo i jačanje solidarnosti, kohezivnosti i patriotizma jedne zajednice (tima, kluba, naroda, nacije), na jedinstvo čovečanstva u borbi protiv različitih oblika nasilja u sportu, protiv huliganizma i vandalizma, nacionalizma, šovinizma, rasizma, seksizma u sportu, te na borbu protiv pomenutih 'izama' i van sportskog terena u smislu očuvanja univerzalnih vrednosti čovečanstva itd.

Kada je reč o materijalnim aspektima sportske kulture, podsetimo na spomenike, odnosno statue i biste kao izraz materijalne globalne sportske kulture koji su posvećeni poznatim sportistima. Najpre, spomenici kao izraz materijalne kulture određenog naroda i nacije nose ne samo nacionalni element čime čine deo nacionalnog identiteta (Gidens, 2005) i kulturne baštine jednog naroda i/ili nacije, već mogu imati i karakteristiku svetske kulturne baštine. Podizanje spomenika predstavlja veoma staru instituciju očuvanja pamćenja i kulture sećanja, kako na nacionalnom, tako i na globalnom nivou (Bulatović, 2019). U tom kontekstu, značajni su spomenici širom sveta koji su podignuti u čast brojnih sportista, kako iz individualnih, tako i iz timskih sportova (Stride, Thomas and Wilson, 2012). Posebnu pažnju istraživača privlače statue fudbalera preminulih sredinom svoje sportske karijere (Stride, Thomas and Chamorro, 2019), ali i statue i biste podignute širom sveta u čast još uvek živih proslavljenih sportista, poput Zlatana Ibrahimovića i Kristijana Ronalda (Cristiano Ronaldo) (Stride, Thomas and Wilson, 2012).

Pored spomenika kao nezaobilaznog izraza materijalne globalne sportske kulture, ne smemo izostaviti značaj sportske infrastrukture koju čine sportski objekti poput brojnih sportskih hala, dvorana, sportskih centara, a naročito stadiona neophodnih za održavanje sportskih događaja. Stadioni se sasvim opravdano mogu smatrati veoma otpornom i trajnom infrastrukturom ako imamo na umu namenu i svrhu određenog stadiona. Recimo, stadion JNA u Beogradu je prevazišao socijalističku ideologiju u kontekstu koje je sagrađen i nastavio je svoj rad i u 21. veku jer je izgrađen za potrebe savremenog sporta koji je imao i još uvek ima istaknutu ulogu u društvu (Mijatov, 2023). U tom smislu, „ideologija savremenog sporta čini stadione otpornim" (Mijatov, 2023: 267).

Veza između nematerijalnog i materijalnog izraza sportske kulture može se izdvojiti na primerima savremenih, modernih stadiona u okviru kojih su huliganizam i vandalizam ekstremnih navijačkih grupa gotovo iskorenjeni. Naime, podsetimo na najmodernije evropske stadione poput stadiona FK Olimpik Lion (Olympique Lyon) u Lionu u Francuskoj čija je izgradnja završena u januaru 2016. godine i koji ima 270 kamera unutar stadiona i u zoni od 1000 metara oko stadiona tako da je svaka osoba u svakom trenutku meča snimljena sa najmanje tri kamere (jedna kamera je na stativi, ostale su na krovu i na tribinama), što znači da se u slučaju eventualnog problema, u najkraćem mogućem roku može identifikovati osoba. Menadžment stadiona poseduje spisak 20 osoba kojima je zabranjeno da priđu stadionu, no ukoliko bi se desilo da ove osobe ipak dođu, interveniše policija i pravna služba koja te osobe momentalno sprovodi u zatvorsku ćeliju u okviru stadiona, a presude se mogu doneti u roku od samo nekoliko časova (Knežević, 2016). Monitoring svih 270 kamera vrši se iz režije programa klupske televizije FK Olimpik Lion koja se takođe nalazi unutar stadiona (Knežević, 2016), tako da se može zaključiti da su huliganizam i vandalizam u uslovima pomenute najmodernije infrastrukture gotovo nemogući. Sprečavanje huliganizma i vandalizma u kontekstu pomenutih bezbednosnih mera i celokupne infrastrukture ovog stadiona izgrađenog 2016. godine veoma je bilo važno zbog Evropskog prvenstva u fudbalu koje se iste godine održalo u Francuskoj. Dakle, na pomenutom primeru može se uočiti značaj moderne sportske infrastukture u sprečavanju huliganizma i vandalizma na sportskim događajima, a u cilju unapređivanja celokupne sportske kulture.

U ovom radu su razmotrena mišljenja studenata Fakulteta sporta i fizičkog vaspitanja Univerziteta u Beogradu o značaju izgradnje nacionalnog stadiona u kontekstu razvoja sportske infrastrukture.

Metod

U radu je primenjen metod teorijske analize i metod anketiranja. Istraživanje mišljenja studenata Fakulteta sporta i fizičkog vaspitanja Univerziteta u Beogradu o značaju izgradnje nacionalnog stadiona sprovedeno je krajem maja 2024. godine povodom održavanja panela pod nazivom „Srce miliona: Fudbal između ostvarenja profita i humanitarnih vrednosti. U

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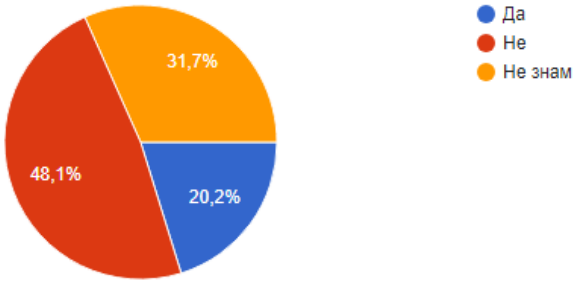
susret evropskom prvenstvu u fudbalu (Nemačka, 2024.)" koji se održao na Fakultetu sporta i fizičkog vaspitanja Univerziteta u Beogradu 31.05.2024. u organizaciji Fondacije Friedrich Ebert Stiftung, Fakulteta sporta i fizičkog vaspitanja i organizacije Football Friends .

Za potrebe istraživanja konstruisan je nestandardizovani upitnik, a podaci su prikupljani putem onlajn platforme Google Forms. Anketirano je 104 studenta: 45,2% studentkinja i 54,8% studenata. Ukupno 98,1% anketiranih jesu studenti završne godine osnovnih akademskih studija.

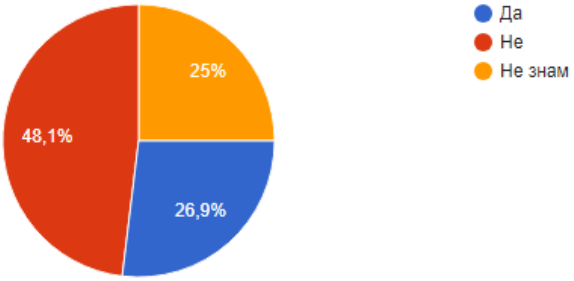
Rezultati

Anketirani studenti su iskazali pozitivno mišljenje prema izgradnji nacionalnog stadiona: smatraju da unapređivanje sportske infrastukture može uticati na promenu demografske strukture posetilaca stadiona (porodične posete utakmicama), može inicirati organizaciju mega sportskih događaja ubuduće i generalno može unaprediti celokupnu sportsku kulturu. Razmotrimo odgovore ispitanika na postavljena pitanja.

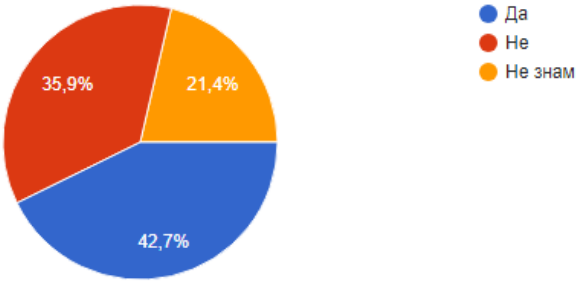
Na pitanje 'Da li smatrate da se u domaći fudbal dovoljno ulaže?', odgovorili su svi ispitanici na sledeći način: 48,1% smatra da se dovoljno ne ulaže, 20,2% smatra da se ulaže dovoljno, dok značajan procenat ispitanika 31,7% ne zna odgovor na postavljeno pitanje (Grafik 1). Na pitanje 'Da li smatrate da fudbal treba posmatrati kao investiciju, a ne samo kao sport?' odgovorili su svi anketirani studenti: 48,1% anketiranih je odgovorilo negativno, 26,9% je dalo pozitivan odgovor, dok čak 25% anketiranih navodi da ne zna odgovor na postavljeno pitanje (Grafik 2). Na pitanje 'Da li smatrate da je izgradnja nacionalnog stadiona opravdana?' odgovore je dalo 103 ispitanika i to: 42,7% ispitanika smatra da je izgradnja nacionalnog stadiona opravdana, 35,9% anketranih smatra da je izgradnja nacionalnog stadiona neopravdana, dok 21,4% ispitanika ne zna odgovor na postavljeno pitanje (Grafik 3). Na pitanje: 'Da li smatrate da je izgradnja nacionalnog stadiona neophodna radi unapređivanja celokupne sportske kulture?' odgovore je dalo 103 ispitanika na sledeći način: 47,6% ispitanika je pozitivno odgovorilo na pitanje, 37,9% ispitanika je dalo negativan odgovor, dok je 14,6% ispitanika navelo da ne zna (Grafik 4). Na pitanje 'Da li smatrate da izradnja nacionalnog stadiona može inicirati organizaciju mega sportskih događaja poput evropskog i/ili svetskog prvenstva ili Olimpijskih igara u Republici Srbiji ubuduće?' odgovorilo je 102 ispitanika i to: 54,9% ispitanika je dalo pozitivan odgovor, 26,5% anketiranih je dalo negativan odgovor, dok 18,6% ispitanika odgovara da 'ne zna' (Grafik 5). Na pitanje 'Da li smatrate da izradnja nacionalnog stadiona sa planiranim sadržajima (šoping-centar, restorani, parkovi, centar za vodene sportove, fudbalska akademija, tereni za golf itd.) može doprineti promeni demografske strukture posetilaca sportskih manifestacija (na primer, porodične posete stadionu)?' je odgovorilo 102 anketiranih na sledeći način: 56,9% anketiranih je dalo pozitivan odgovor, 25,5% ispitanika navodi negativan odgovor, dok 17,6% navodi da 'ne zna' (Grafik 6). Na pitanje 'Da li smatrate da izradnja nacionalnog stadiona sa pomenutim planiranim sadržajima može doprineti smanjenju nereda na tribinama koje izazivaju navijačke grupe?'odgovorilo je 103 ispitanika: 54,4% ispitanika je dalo negativna odgovor, 22,3% anketiranih je pozitivno odgovorilo, dok sličan postotak ispitanika (23,3%) izjavljuje da 'ne zna' (Grafik 7). Najzad, na pitanje 'Da li ste načelno ZA izgradnju nacionalnog stadiona?', odgovorilo je 100 ispitanika na sledeći način: 60% ispitanika je načelno 'ZA' izgradnju nacionalnog stadiona, dok je 40% ispitanika protiv (Grafik 8).



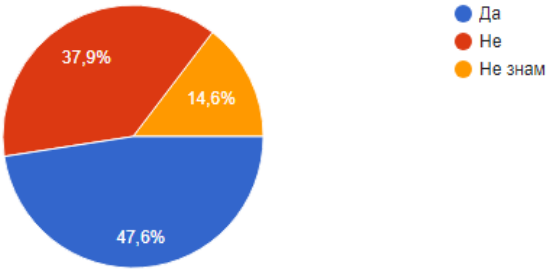
Grafik 1. Pitanje: Da li smatrate da se u domaći fudbal dovoljno ulaže?



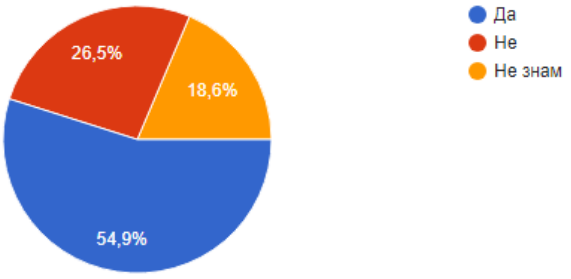
Grafik 2. Pitanje: Da li smatrate da fudbal treba posmatrati kao investiciju, a ne samo kao sport?



Grafik 3. Pitanje: Da li smatrate da je izgradnja nacionalnog stadiona opravdana?



Grafik 4. Pitanje: Da li smatrate da je izgradnja nacionalnog stadiona neophodna radi unapređivanja celokupne sportske kulture?



Grafik 5. Pitanje: Da li smatrate da izradnja nacionalnog stadiona može inicirati organizaciju mega sportskih događaja poput evropskog i/ili svetskog prvenstva ili Olimpijskih igara u Republici Srbiji ubuduće?

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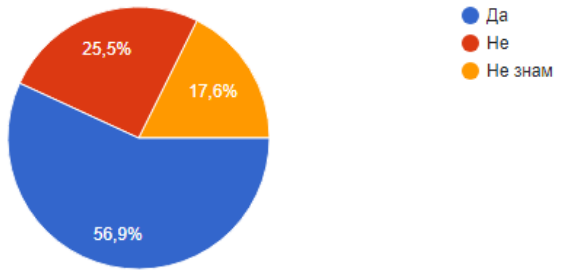
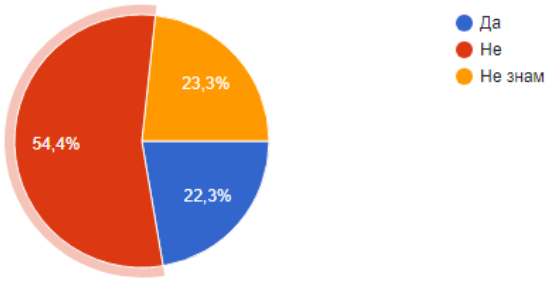
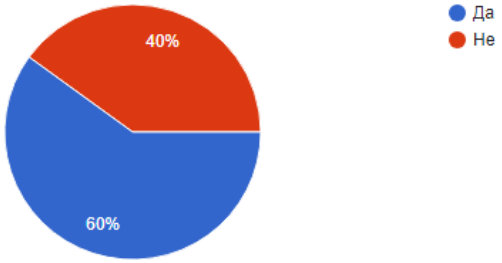


Grafik 6. Pitanje: Da li smatrate da izradnja nacionalnog stadiona sa planiranim sadržajima (šoping-centar, restorani, parkovi, centar za vodene sportove, fudbalska akademija, tereni za golf itd.) može doprineti promeni demografske strukture posetilaca sportskih manifestacija (na primer, porodične posete stadionu)?



Grafik 7. Pitanje: Da li smatrate da izradnja nacionalnog stadiona sa pomenutim planiranim sadržajima može doprineti smanjenju nereda na tribinama koje izazivaju navijačke grupe?



Grafik 8. Pitanje: Da li ste načelno ZA izgradnju nacionalnog stadiona?

Diskusija

Kako je pomenuto, istraživanje mišljenja studenata Fakulteta sporta i fizičkog vaspitanja Univerziteta u Beogradu o značaju izgradnje nacionalnog stadiona sprovedeno je 31. maja 2024. godine povodom održavanja panela pod nazivom „Srce miliona: Fudbal između ostvarenja profita i humanitarnih vrednosti. U susret evropskom prvenstvu u fudbalu (Nemačka, 2024.)“ koji se održao na Fakultetu sporta i fizičkog vaspitanja Univerziteta u Beogradu istog dana u organizaciji Fondacije Friedrich Ebert Stiftung, Fakulteta sporta i fizičkog vaspitanja i organizacije Football Friends. S obzirom na temu panela posvećenu, pored ostalog i mogućnosti razmatranja fudbala kao investicije u najširem smislu, osnovna ideja vodilja istraživanja bila je činjenica da su studenti Fakulteta sporta i fizičkog vaspitanja Univerziteta u Beogradu budući profesionalci u sportu – treneri i nastavnici fizičkog vaspitanja, te da s obzirom na obrazovni profil imaju određena znanja o karakteristikama i značaju savremene sportske infrastrukture i o značaju ulaganja u razvoj sportske infrastrukuture u kontekstu unapređivanja celokupne sportske kulture.

Uopšteno, može se primetiti da anketirana studentska populacija ima pozitivno mišljenje o značaju izgradnje nacionalnog stadiona i uopšte, o značaju ulaganja u razvoj sportske infrastrukture. Sa druge strane, značajan postotak anketiranih studenata nije znao odgovore na postavljena pitanja, tačnije, nije imao mišljenje o određenoj temi. Tako čak 31,7% ne zna odgovor na pitanje ‘Da li smatrate da se u domaći fudbal dovoljno ulaže?’; dalje, 25% anketiranih navodi da ne zna odgovor na pitanje ‘Da li smatrate da fudbal treba posmatrati kao investiciju, a ne samo kao sport?’; slično, 21,4% ispitanika ne zna odgovor na pitanje ‘Da li smatrate da je izgradnja nacionalnog stadiona opravdana?’; zatim 14,6% ispitanika navodi da ne zna odgovor na pitanje ‘Da li smatrate da je izgradnja nacionalnog stadiona neophodna radi unapređivanja celokupne sportske kulture?’; slično, 18,6% ispitanika navodi da ne zna odgovor na pitanje ‘Da li smatrate da izgradnja nacionalnog stadiona može inicirati organizaciju mega sportskih događaja poput evropskog i/ili svetskog prvenstva ili Olimpijskih igara u Republici Srbiji ubuduće?‘; dalje, 17,6% navodi da ne zna odgovor na pitanje ‘Da li smatrate da izradnja nacionalnog stadiona sa planiranim sadržajima (šoping-centar, restorani, parkovi, centar za vodene sportove, fudbalska akademija, tereni za golf itd.) može doprineti promeni demografske strukture posetilaca sportskih manifestacija (na primer, porodične posete stadionu)?’; i najzad, 23,3% izjavljuje da ne zna odgovor na pitanje ‘Da li smatrate da izradnja nacionalnog stadiona sa pomenutim planiranim sadržajima može doprineti smanjenju nereda na tribinama koje izazivaju navijačke grupe?’. Značajan postotak anketiranih studenata koji navodi da ne zna odgovor na pomenuta pitanja može uputiti istraživače ovog i sličnih fenomena na prisustvo, značaj i potrebu obrađivanja tematskih jedinica u vezi sa sportskom infrastukturom, organizacijom sportskih događaja, menadžmentom sportskih događaja itd. u kompleksnoj oblasti sociologije sporta, ali i drugih disciplina koje se izučavaju u okviru nastave predviđene programom osnovnih, integrisanih i master akademskih studija Fakulteta sporta i fizičkog vaspitanja Univerziteta u Beogradu.

Najzad, relevantno bi bilo uporediti mišljenja studenata Fakulteta sporta i fizičkog vaspitanja Univerziteta u Beogradu i drugih srodnih sportskih fakulteta sa mišljenjima studenata ostalih fakulteta na većem uzorku studentske populacije o značaju izgradnje nacionalnog stadiona, a što može biti potencijalni istraživački poduhvat za buduće istraživače ovog i sličnih fenomena.

Zaključak

S obzirom na velika ulaganja u infrastrukturu, na nedovoljnu iskorišćenost kapaciteta postojećih sportskih centara, kao i na još uvek nedovoljno bavljenje fizičkim vežbanjem stanovništva u Republici Srbiji (Radenović, 2021), značaj izgradnje nacionalnog stadiona, te mišljenja studenata Fakulteta sporta i fizičkog vaspitanja Univerziteta u Beogradu o značaju izgradnje nacionalnog stadiona jesu relevantne teme u okviru kompleksne i aktuelne oblasti sociologije sporta.

Veza između nematerijalnog i materijalnog izraza sportske kulture može se uočiti na primerima savremenih, modernih stadiona u okviru kojih su huliganizam i vandalizam ekstremnih navijačkih grupa gotovo iskorenjeni. Ipak, više od 50% anketiranih studenata uprkos pozitivnom mišljenju o izradnji nacionalnog stadiona, smatra da nacionalni stadion sa planiranim sadržajima (šoping-centar, restorani, parkovi, centar za vodene sportove, fudbalska akademija, tereni za golf itd.) ne može doprineti smanjenju nereda na tribinama koje izazivaju navijačke grupe. Navedeni rezultat se može protumačiti u kontekstu i dalje teško rešivog višedecenijskog problema huliganizma i vandalizma ekstremnih navijačkih grupa prisutnog u srpskom sportu, prevashodno na fudbalskim utakmicama (Gvozdenović i drugi, 2023). Naime, uprkos činjenici da moderni stadioni u svetu poseduju infrastrukturne karakteristike koje u ogromnoj meri sprečavaju ispoljavanje huliganizma i vandalizma ekstremnih navijačkih grupa, više od 50% anketiranih

UDK 796.02(497.11)

studenata smatra da nacionalni stadion sa pomenutim planiranim sadržajima ne može doprineti smanjenju nereda. Ovakav rezultat upućuje i na nepoverenje u relevantna sportska tela i institucije od kojih se očekuje da sistemski i sistematski rešavaju problem huliganizma i vandalizma ekstremnih navijačkih grupa, kao što je to, podsetimo, učinjeno na primer, na stadionu FK Olimpik Lion (Olympique Lyon) u Lionu u Francuskoj. Razmotreni rezultat našeg istraživanja ukazuje i na neophodnost sistemskog rešavanja problema huliganizma i vandalizma od strane relevantnih sportskih tela i institucija u Republici Srbiji, a u kontekstu unapređenja celokupne sportske kulture.

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UDK 793.31

Folk dances and attitude towards dance

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Introduction

Folklore is a traditional expression of a community, reflecting its cultural and sociological identity, or in other words, its national culture. In Croatia, the concept of folklore encompasses the meaning of traditional art, including folk or national literature, music, dance, theater, and visual arts (Croatian Encyclopedia, 2024). The invaluable wealth of Croatian folklore and folk tradition is positioned among the top in the world's cultural heritage (Vučić, 2011). One of the tasks of folkloristics and ethnology is to explore diverse applications in areas of contemporary culture (Rupčić, 2011). Dance is a harmonious spatial-temporal movement of the body and an aspect of creative human expression (Knežević, 2005), while from a kinesiology perspective, dance is viewed as a sporting activity that, due to its structural complexity, belongs to the conventional aesthetic group of sports (Milanović, 2010).

Until recently, it was an important element of social life and was promoted in urban areas where numerous dance schools opened to train young people, thereby contributing to the significance of dance culture (Galeković, 2018). The importance of folk dance in shaping national and cultural identity is evident in the continuity of Croatian cultural events that blend the dance and stylistic diversity of Croatian folk customs, such as the Vinkovci Autumn Festival, the Đakovo Embroidery, and other events that represent valuable cultural assets (Oreb, 2011). The application of folk dances in working with children and youth is an interdisciplinary activity incorporating ethnological, social, pedagogical, and performance knowledge and can serve as a means of promoting recreation, entertainment, and education in educational institutions through a tailored approach and guidance (Knežević, 2005). Dance activities are highlighted as an example of collaborative learning, aiming to develop communication and a culture of mutual respect, which holds significant sociological value. Additionally, they are well-suited for various forms of physical activity due to their impact on the anthropological status of children, youth, and adults and are thus included in the physical education curriculum throughout the entire educational structure. Folk dance, as such, is a valuable recreational activity for enhancing functional abilities, as evidenced by studies on dancers showing that heart rates reach 70–80% of maximum during certain folk dances (Kocić, Karanov & Šolaja, 2014).

Consequently, the physical demand placed on dancers during performances cannot be overlooked. On the other hand, Radonić's (2011) research on the motives for dancing, conducted on 60 dancers aged 11 to 25, revealed that 70% of younger dancers did not know a single folk dance, while more experienced dancers cited a love of dance (70%) as the primary motivation, followed by recommendations (42%) and gaining new experiences (38%) as second and third most common motives. When asked what they enjoy most about dancing, respondents often cited socializing, which provides a solid foundation for motivating youth to engage in folk activities. Croatia is one of the few regions worldwide with exceptionally rich folklore, which, according to musical, rhythmic, stylistic, and spatial features, relationships between dancers, dancers and musicians, analysis of circular movements and partner turns, and the role of the dance leader, is divided into four dance regions: Alpine, Pannonian, Adriatic, and Dinaric (Ivančan, 1996). The historical customs of the Croatian people, with an emphasis on community, permeate the choreographic structures of folk dances, highlighting a significant traditional value. This is present in the general characteristics of all dance regions and microregions, connected by common elements such as the circle dance. Besides these shared features, specific characteristics of certain regions also stand out, such as the distinct stylistic difference in the triple step between Posavina and Podravina in Slavonia and Baranja, as well as the unique partner dances typical of Baranja (Vinkešević, 2017).
Given that the value of folklore is increasingly unknown to younger generations, it is essential to educate, motivate, and engage them in studying and preserving folklore through dance, which has proven to be a practically applicable medium (Vučić, 2011).

Therefore, the aim of this paper is to determine attitudes toward dance among the student population at the University of Zagreb, Faculty of Kinesiology.

Methods

The study was conducted on a total of 124 participants, third-year students (both male and female) of the University of Zagreb's Faculty of Kinesiology (KIF). To collect data on dance attitude assessment, an anonymous Dance Attitude Assessment Questionnaire (SPP) (Vlašić, Bosnar, 2007; according to Vlašić, 2010) was used, along with an additional question on gender and birth year. Students completed the questionnaire at the beginning of the semester during the first session of the Dance course and again after completing folk dance lessons in the last week of the semester, with a three-month interval. The questionnaire consists of 20 items in the form of positive and negative statements, where agreement with each statement is indicated by circling numbers from 1 to 5. Based on a five-point Likert scale, each number on the scale represents an attitude, with 1 indicating total disagreement and 5 indicating total agreement with the statement circled. The overall attitude score is calculated by summing the scores, with negative items reverse-scored. Thus, the total score ranging from 20 to 100 represents the attitude toward dance, where a score of 60 indicates a neutral attitude, less than 60 a negative attitude, and more than 60 a positive attitude. Descriptive statistics using Statistica for Windows version 14.0 (StatSoft, Inc., Tulsa, OK, USA) determined the basic descriptive parameters of the participant groups, which were then used to compare measured attitudes.

Results

Among the 79 male and 45 female students, aged 21 to 25, an improvement in attitude toward dance was observed between the first and repeated measurements following the application of folk dance content. In the first measurement, the overall attitude score toward dance at the generational level was 70.97 ± 12.74.

When viewed by gender, the mean attitude score for female students was 74.62 ± 13.68, and for male students, it was 68.89 ± 11.76. The results of the second measurement showed better outcomes following the adoption of folk dance content, with a generational attitude score of 76.52 ± 11.58, 79.2 ± 11.6 for female students, and 75.01 ± 11.37 for male students.

Table 1. Dance Attitude Before and After Folk Dance Adoption

		BEFORE	AFTER
	N	Mean ± SD	
ALL	124	70,97 ± 12,74	76,52 ± 11,58
F	45	74,62 ± 13,68	79,2 ± 11,6
M	79	68,89 ± 11,76	75,01 ± 11,37

Legend: BEFORE – results of the first measurement, AFTER – results of the second measurement, N – number of participants, Mean ± SD – mean ± standard deviation, ALL – attitude toward dance for all participants, F – attitude for female students, M – attitude for male students.

The attitude of all participants toward dance was already positive before the folk dance lessons, as indicated by the mean attitude score (AS=70.97). This was also observed among female students (AS=74.62) and male students (AS=68.89), with female students showing a more positive attitude in the first measurement. The standard deviation values exceed 10, indicating high variability in scores around the mean, meaning there are significant differences in attitudes among participants. The second measurement at the end of the semester, reflecting attitudes after learning and adopting the folk dance curriculum, showed a more positive attitude compared to the first measurement. All mean attitude values (at the generational level and among male and female students) are more positive, while the standard deviations are similar (SD(all)=11.58; SD(male)=11.6; SD(female)=11.37) with reduced result dispersion compared to the first measurement. The overall results indicate an increase in dance attitudes across all groups, with mean increases of 5.55 points at the generational level (SPP(before)=70.97 and SPP(after)=76.52), 4.58 points among female students (SPP(before)=74.62 and SPP(after)=79.2), and the highest increase of 6.12 points among male students (SPP(before)=68.89 and SPP(after)=75.01).

Discussion

The study participants were KIF students who are athletes from various sports, with only a few being sports dancers. A previous study on the same population showed that 19% of participants had not encountered dance during high school, while of the 81% who did, only 3% had experience with folk dances (Topolovec, Pastuhović, and Vlašić, 2024). As a result, most students are unfamiliar with the dance curriculum at the university, and the first measurement provides relevant insights into the observed population's attitude toward dance. Similarly, the results of the second measurement accurately reflect their attitude toward folk dance introduced in the course. The significance of these results is evident in the importance of including dance in kinesiology education, as it has been shown to promote the development of functions related to various aspects of anthropological status (Srhoj, Katić, and Kaliterna, 2006) and serves multiple educational purposes: national, social, aesthetic, and health education. Folk dance aims to foster learning about one's cultural heritage and respect and tolerance for other cultures. The social aspect of dance is reflected in creating a good mood, unity, and bonding, indirectly providing social education for dancers. Moreover, dance, with its broad range of movements, enables the development of aesthetic awareness through a sense of beauty and harmony in movement, while health promotion, and the improvement and maintenance of anthropological status, are the objectives of health education through dance (Srhoj, 2000). Dance is also considered a valuable kinesiology operator in shaping human anthropological status, emphasizing its utilitarian value (Oreb, 2011). This justifies numerous definitions of dance, which is considered both a sport and an art form (Vlašić et al., 2014), possibly explaining varying attitudes toward dance, especially between men and women, stemming from different societal perceptions and expectations. However, more specific findings, such as «information about dance attitudes, should help in understanding why some people enjoy dancing and do so regularly, while others avoid this activity» (Vlašić, Oreb, and Bosnar, 2014). Therefore, past studies have shown a generally positive attitude toward dance among high school students, with a positive attitude noted among girls and a negative attitude among boys (Došen, 2021). Furthermore, only 15.6% of participants with a positive attitude actively engage in dance, indicating that a positive attitude does not necessarily lead to dancing (Došen, 2021). On the other hand, Vlašić, Oreb, and Katović (2012) have shown that dancing positively affects attitudes toward it, which this study has confirmed.

Conclusion

In conclusion, it can be said that positive experiences in engaging in a particular activity can, to some extent, influence attitude change. A positive attitude toward an activity does not necessarily mean the person will engage in it; however, positive experiences can contribute to an attitude change, as found in this study, potentially affecting activity choice. This research provides concrete evidence of the importance of incorporating folk dances into sports, recreational, entertainment, and educational programs and workshops at local and regional levels. Increasing the availability of these activities would encourage the preservation and promotion of folklore values among children and youth through folk dance, contributing to the dissemination and nurturing of Croatian tradition and cultural heritage

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UDK 796.012.11

Effects of „Special physical skills“ classes on handgrip strenght among students of the Academy for National Security

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Introduction

The hand is the most complex and specialized musculoskeletal tool in humans, capable of performing intricate and precise movements. These functions include gripping ability and manual dexterity, essential for everyday activities (Walankar et al., 2016). Handgrip strength is the gold standard for assessing mechanical muscle characteristics, including maximal muscle strength (Fmax) (Dopsaj et al., 2019). Muscle strength is often equated with muscle force. It can be defined as the ability of an individual muscle or group of muscles to generate force during contraction while resisting external load (Zatsiorsky, 2020). Handgrip strength can be quantified by measuring the amount of isometric force the hand can generate. Muscle strength can be measured using a «Jamar» dynamometer or a «Sports Medical Solutions» (SMS) dynamometer. These dynamometers (SMS and «Jamar») have shown high validity in previous studies (Vukadinović et al., 2024; Marković et al., 2020; Mathiowetz et al., 1984), confirming their use as reliable instruments for measuring handgrip strength. Wind et al., (2010), established that handgrip strength and overall muscle strength are strongly correlated, suggesting it can serve as an indirect indicator of upper body strength (Tyldesley & Grieve, 2002; Chan et al., 2008) and provide information about muscle mass, nutritional status, and health (Bohannon et al., 2015).

In previous research, handgrip strength has been used as an indicator of bone health, muscle strength, and other physiological parameters, showing that lower grip values may be associated with lower levels of bone density and mineral content (Legroux-Gérot et al., 2012). In the study by Cossio-Balanos et al. (2018), handgrip strength was used as a representative test for assessing isometric hand strength and its correlation with other physiological factors. The modern lifestyle and intensive use of new technologies, such as smartphones, can significantly affect students' health. For example, a study conducted by Alshahrani et al. (2021) indicated that smartphone dependency may negatively impact neck flexor endurance. In their study, Dopsaj et al. (2014) presented reference values for handgrip strength related to students in Belgrade and Russia. These values are key for better understanding the specific characteristics of handgrip strength in different populations, enabling its application in various systems, such as sports, education, health, and evaluation of physical functioning. Also, the research conducted by Vaidya et al. (2020) indicated that handgrip strength can be an effective tool for predicting physical fitness, identifying talented athletes, and detecting low levels of physical fitness early on, allowing for the prevention of future health problems and using the test as a predictive factor for general health (Vaidya et al., 2021). The significant correlation between dominant hand strength and anthropometric characteristics of the upper extremities suggests that body proportions may play a key role in determining hand strength (Koley & Singh, 2009). Additionally, the study by Ingrová et al. (2017) confirmed that handgrip strength is related to anthropometric characteristics and body composition, making it a suitable measure for assessing physical condition. Physical activity of varying intensity up to the age of 25–30 is crucial for developing motor skills and fitness (Blair et al., 2001). It is evident that there is an increase in the number of students with reduced general health status and low levels of physical fitness at the start and during their studies (Prysiazhniuk et al., 2018; Mozolev et al., 2019). Indeed, 90% of students have health problems, and over 50% have an unsatisfactory level of physical fitness. Some authors attribute these problems to the inefficient functioning of the physical education system (Maglyovanyi, 2010; Zavydivska et al., 2016). The study by Vukadinović et al. (2024) examined the physical status of students at the Academy for National Security, where the results showed that students had normal body mass index (BMI) values, while women had a higher percentage of body fat, exceeding the biological maximum. Also, students of both genders had muscle mass levels comparable to athletes, while the morphological status of the students corresponded to the average status of students at the University of Belgrade. In this regard, the aim of this study is to determine the effect of practical lessons on the handgrip strength of students at the Academy for National Security in the subject «Special Physical Skills.»

Methods

Sample

The sample consisted of 19 healthy first-year students from the Academy for National Security, of which 11 were male (age: 18.83 ± 0.93) and 8 were female (age: 19.25 ± 1.03). All participants voluntarily participated in the study and had no neuromuscular disorders, musculoskeletal dysfunctions, injuries, or previous surgeries on the hand or wrist. The research was conducted following the principles of the Helsinki Declaration and with the approval of the Ethics Committee of the Faculty of Sport and Physical Education, University of Belgrade (484-2).

Equipment

Data were collected using a dynamometer to measure handgrip strength. Force sensor signals (4.0, CZL302: Dongguan City, China) were collected using commercially available Isometrics software («Sports Medical Solutions,» Belgrade, Serbia), with a sampling frequency of 1000 Hz. The signals were filtered with a low pass (5 Hz), second-order Butterworth filter. The software automatically calculated Fmax.

Procedures

All measurements were conducted in the Methodological Research Laboratory (MIL) at the Faculty of Sport and Physical Education in Belgrade, between 08:00 and 12:00. Before the measurement, each participant was thoroughly informed about the testing procedures. The procedure applied is described in the study by Vukadinović et al. (2024). Participants performed three attempts (dominant and non-dominant hand) with a 1-minute rest. The instruction was to contract the hand as

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strongly and quickly as possible and maintain the maximum contraction for about 2 seconds. The measurement was conducted in a seated position (knee joint angle of 90°; normal anatomical position of the hand), with both hands measured alternately. Participants were tested twice over a three-month interval. During this period, students attended practical classes, which included general physical preparation exercises, lasting 45 minutes, twice a week.

Variable

The test included the analysis of the following variables:

- Maximum muscle strength for the left hand (FmaxL) and right hand (FmaxR), expressed in newtons (N).
- Relative maximum muscle strength for the left hand (FmaxL_rel) and right hand (FmaxR_rel), expressed in newtons per kilogram (N/kg).

Statistics

All results were first analyzed using basic descriptive statistical methods, where measures of central tendency (mean value of the variable - Mean), measures of dispersion (standard deviation - SD, coefficient of variation – CV%, range limits: minimum - Min and maximum - Max), as well as standard error of measurement (SE%) expressed as a percentage, were calculated. To examine differences between the two measurements for both genders, a paired-sample T-Test was used. To analyze differences in distribution, a nonparametric paired-samples T-Test was applied. All statistical analyses were conducted using the "MS Excel 2013" and "IBM SPSS v23.0" software packages.

Results

Tables 1 and 2 present the descriptive statistics of body characteristics and handgrip strength for male and female students. The tables display mean values (Mean), minimum and maximum values (Range, Min, Max), coefficient of variation (CV%), standard error of the mean (SEM%), and standard deviation (STD), providing an overview of the basic characteristics of variability and data distribution. The coefficient of variation (CV%) for male students ranges from 5.84% to 21.46%, while SEM% ranges from 1.69% to 7.07%. These values indicate a good level of variability and precision in estimating the mean values. Similar values were observed for female students. Specifically, the Fmax of the right hand is higher than that of the left hand in both absolute and relative terms for both male and female students. This difference suggests a potential asymmetry in strength between hands, which is commonly observed in the general population.

Table 1. Descriptive Statistics of Body Characteristics and Isometric Hand Strength in Male Students.

	BH	BM	FmaxR1	FmaxR2	FmaxL1	FmaxL2	FmaxR1_rel	FmaxR2_rel	FmaxL1_rel	FmaxL2_rel
N	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00
Range	38.20	44.30	288.00	359.00	243.00	259.00	3.32	4.63	2.79	5.71
MIN	155.80	57.70	396.00	329.00	370.00	340.00	4.92	4.09	4.60	4.16
MAX	194.00	102.00	684.00	688.00	613.00	599.00	8.24	8.72	7.39	9.88
Mean	181.82	82.98	512.25	510.17	484.17	477.58	6.21	6.22	5.86	5.87
STD	10.63	13.53	97.49	109.49	86.46	88.63	0.88	1.31	0.70	1.44
SEM%	1.69	4.71	5.49	6.20	5.15	5.36	4.08	6.09	3.46	7.07
CV%	5.84	16.30	19.03	21.46	17.86	18.56	14.15	21.11	11.98	24.49

Legend – BH – Body height; BM – Body mass; FmaxR1 – Right hand measured for the first time; FmaxR2 – Right hand measured for the second time; FmaxL1 – Left hand measured for the first time; FmaxL2 – Left hand measured for the second time.

Table 2.. Descriptive Statistics of Body Characteristics and Isometric Hand Strength in Female Students.

	BH	BM	FmaxR1	FmaxR2	FmaxL1	FmaxL2	FmaxR1_rel	FmaxR2_rel	FmaxL1_rel	FmaxL2_rel
N	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00
Range	29.00	36.00	113.00	139.00	180.00	186.00	1.33	1.60	1.55	1.84
MIN	156.00	56.00	245.00	219.00	185.00	191.00	3.50	3.23	3.31	2.61
MAX	185.00	92.00	358.00	358.00	365.00	377.00	4.83	4.83	4.86	4.45
Mean	171.50	68.88	290.38	276.63	267.63	245.00	4.28	4.05	3.90	3.56
STD	8.52	14.02	38.84	52.93	57.46	69.24	0.50	0.47	0.49	0.59
SEM%	1.76	7.20	4.73	6.76	7.59	9.99	4.09	4.12	4.46	5.85
CV%	4.97	20.36	13.38	19.13	21.47	28.26	11.56	11.65	12.60	16.53

Legend – BH – Body height; BM – Body mass; FmaxR1 – Right hand measured for the first time; FmaxR2 – Right hand measured for the second time; FmaxL1 – Left hand measured for the first time; FmaxL2 – Left hand measured for the second time.

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Table 3 shows the results of the t-test for handgrip strength of the left and right hands, with absolute and relative values, comparing the first and second measurements. For both genders, the mean values (Mean), t-value, and significance level (Sig) were analyzed. Although changes in the mean values between the left and right hands were observed, none of the differences were statistically significant ($p > 0.05$) for both genders.

Table 3. Results of the t-test for handgrip strength of the left and right hands: absolute and relative values (comparison of the first and second measurements – mean value (Mean), t-value, and significance level (Sig)).

Gender	**Male**				**Female**			
	ABSOLUTE		RELATIVE		ABSOLUTE		RELATIVE	
Hand	FmaxR1	FmaxL1	FmaxR1_rel	FmaxL1_rel	FmaxR1	FmaxL1	FmaxR1_rel	FmaxL1_rel
	FmaxR2	FmaxL2	FmaxR2_rel	FmaxL2_rel	FmaxR2	FmaxL2	FmaxR2_rel	FmaxL2_rel
Mean	10.636	24.545	-.01126	-.00813	13.750	22.625	.23382	.34427
t	.777	1.288	-0.053	-.023	1.659	1.837	1.839	1.911
SIG	.455	.227	.959	.982	.141	.109	.109	.098

Legend – FmaxR1 – Right hand measured for the first time; FmaxR2 – Right hand measured for the second time; FmaxL1 – Left hand measured for the first time; FmaxL2 – Left hand measured for the second time.

Table 4. shows the results of the nonparametric t-test for handgrip strength of the left and right hands, with absolute and relative values, comparing the first and second measurements. For both genders, the mean values (Mean), t-value, and significance level (Sig) were analyzed. Negative Z-values indicate that the second measurement is lower than the first, suggesting a decrease in handgrip strength in the second measurement. In all variables, p-values are greater than 0.05, meaning the differences are not statistically significant. For example, for male students, the p-value for the right hand is 0.906, indicating that the difference between these measurements is not statistically significant.

Similarly, for female students, the p-values are also above 0.05, indicating the lack of statistically significant differences between the first and second measurements

Table 4. Results of the nonparametric test for differences in the distribution of handgrip strength of the left and right hands (K-related samples): Z-value and significance level (Sig).

Gender	**Male**				**Female**			
	ABSOLUTE		RELATIVE		ABSOLUTE		RELATIVE	
Hand	FmaxR1	FmaxL1	FmaxR1_rel	FmaxL1_rel	FmaxR1	FmaxL1	FmaxR1_rel	FmaxL1_rel
	FmaxR2	FmaxL2	FmaxR2_rel	FmaxL2_rel	FmaxR2	FmaxL2	FmaxR2_rel	FmaxL2_rel
Z	-.118	-0.510	-0.157	-.706	-1.439	-1.402	-1.521	-1.540
SIG	.906	.610	.875	.480	.150	.161	.128	.123

Legend – FmaxR1 – Right hand measured for the first time; FmaxR2 – Right hand measured for the second time; FmaxL1 – Left hand measured for the first time; FmaxL2 – Left hand measured for the second time.

Discussion

The aim of this study was to determine the effect of practical classes on handgrip strength among students of the Academy for National Security within the subject «Special Physical Skills». Handgrip strength is a key indicator of muscular functionality and health. It can serve as an indirect measure of overall upper-body muscle strength (Tyldesley & Grieve, 2002; Chan et al., 2008). Moreover, it provides important information about muscle mass, nutritional status, and general health (Bohannon et al., 2015). Due to its practical application in assessing physical conditions and monitoring training effects, handgrip strength measurement is widely used in sports, rehabilitation, and clinical practice.

The results of this study showed no statistically significant differences ($p>0.05$) in handgrip strength for either hand (both in relative and absolute values) after attending the practical classes (Table 3). This indicates that the classes did not have a significant effect on changes in handgrip strength among the participants. Additionally, a trend of declining handgrip strength was observed from the pretest to the posttest, i.e., after attending the classes (Tables 1 and 2).

The average handgrip strength of the right hand was higher compared to the left hand, for both male and female students. Hand strength asymmetry was evident, with the dominant hand being stronger than the non-dominant hand, which is consistent with previous research showing differences of 2.4% in right-handed individuals and 11.2% in left-handed individuals (Ertem et al., 2003). Similarly, a study by Pavlović and Vrcić (2021) identified significant differences in handgrip strength between the dominant and non-dominant hand among students of the Faculty of Sports and Physical Education. These findings underscore the importance of analyzing hand strength asymmetry, which is used to assess physical abilities and monitor strength changes.

The results of this study align with previous research, showing that the average maximum handgrip strength values are consistent with previously published standards for the respective age groups (Marković et al., 2018; Dopsaj et al., 2019; Wang et al., 2018). However, it was also found that these values do not reach the levels expected of athletes (Leyk et al., 2007). Considering that maximum handgrip strength peaks between the ages of 30 and 35 (Marković et al., 2018), regardless of gender, the participants in this study,

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who are still young, have not yet reached their maximum potential. Therefore, it is recommended to monitor their further development during their years of study to observe changes and the attainment of their full biological capacity for maximum strength.

Handgrip strength plays a key role in injury prevention (Fry et al., 2006) and in the development of physical strength and performance (Vaidya et al., 2020), which is particularly important for students of the Academy for National Security. Since the contractile abilities of hand muscles can indicate functional limitations and motor disorders, handgrip strength can serve as an effective screening method for early detection of potential physical problems and monitoring overall strength levels (Kljajić et al., 2012).

The results of the nonparametric test (Table 4) revealed a redistribution within the sample. Improvements were observed among untrained students, bringing them closer to the average, while trained students experienced a decline in capabilities, reducing their maximum handgrip strength. These changes are because already trained students did not receive an adequate level of stimulus during the practical classes, whereas untrained students benefited positively from the classes. Although no significant changes were recorded in the average handgrip strength values, the classes had a redistributive effect on the group.

One possible reason for the absence of significant changes could be the relatively short intervention period and the low intensity and volume of exercises applied during the classes. The limitations of this study include smaller sample size, the specificity of the population that cannot be generalized to the broader public, and the fact that data were collected only once, emphasizing the need for further monitoring to identify potential strength changes over time.

For future research, it is recommended to extend the monitoring period and increase the sample size. The results of this study can serve as a basis for improving curricula aimed at achieving better physical performance among students within this specific population.

Conclusion

The practical classes in the subject «Special Physical Skills» did not have a significant impact on the handgrip strength of students. This is attributed to the training not being sufficiently specific, intense, or frequent enough to induce significant changes. To ensure the classes are purposeful and effective, it is recommended that they be conducted at least three times per week.

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UDK 796.012.11

Efekti nastave „Specijalne fizičke veštine“ na jačinu stiska šake studenata Akademije za nacionalnu bezbednost

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Uvod

Šaka predstavlja najkompleksniji i najspecijalizovaniji mišićno-koštani alat kod ljudi, sposobna da izvodi složene i precizne pokrete. Ove funkcije obuhvataju sposobnost stiskanja i manuelnu spretnost, koje su ključne za obavljanje različitih aktivnosti u svakodnevnom životu (Walankar i sar., 2016). Stisak šake je zlatni standard za procenu mehaničkih mišićnih karakteristika, uključujući maksimalnu mišićnu jačinu (Fmax) (Dopsaj i sar., 2019). Mišićna snaga se često poistovećuje sa mišićnom silom i može se definisati kao sposobnost pojedinačnog mišića ili grupe mišića da generiše silu tokom kontrakcije, dok se opire spoljašnjem opterećenju. (Zatsiorsky, 2020). Jačina stiska šake može se kvantifikovati merenjem izometrijske sile koju ruka može da generiše. Mišićna jačina se može meriti pomoću „Jamar“ dinamometra ili «Sports Medical Solutions» (SMS) dinamometra. Ovi dinamometri (SMS i „Jamar“) su pokazali visoku validnost u prethodnim studijama (Vukadinovic i sar., 2024; Markovic i sar., 2020; Mathiowetz i sar., 1984), što potvrđuje njihovu pouzdanost u merenju snage stiska šake. U studiji Wind i sar., (2010) utvrdili su da snaga stiska šake i ukupna snaga mišića jako koreliraju. Naime, može se korisiti kao indirektni pokazatelj ukupne mišićne jačine gornjeg dela tela (Tyldesley & Grieve, 2002; Chan i sar., 2008) i može pružiti informacije o mišićnoj masi, nutricionom statusu i zdravlju pojedinaca (Bohannon i sar., 2015).

U prethodnim istraživanjima, jačina stiska šake korišćena je kao indikator zdravlja kostiju, mišićne snage i drugih fizioloških parametara, pokazujući da niže vrednosti stiska mogu biti povezane sa nižim nivoima gustine kostiju i sadržaja minerala (Legroux-Gérot i sar., 2012). U studiji Cossio-Balanos i sar., (2018) jačina stiska šake je korišćena kao reprezentativan test za procenu izometrijske snage šake i njene povezanosti sa drugim fiziološkim faktorima. Savremeni način života i intenzivna upotreba novih tehnologija, poput pametnih telefona, mogu značajno uticati na zdravlje studenata. Naime, studija koju su sproveli Alshahrani i sar., (2021) ukazuje da zavisnost od pametnog telefona može negativno uticati na izdržljivost pregibača vrata. Dopsaj i sar., (2014) u svojoj studiji su prikazali referentne vrednosti za stisak šake koje se odnose na studente u Beogradu i Rusiji. Ove vrednosti su ključne za bolje razumevanje specifičnih karakteristika stiska šake u različitim populacijama, što omogućava primenu u različitim sistemima, kao što su sport, obrazovanje, zdravlje i evaluacija fizičkog funkcionisanja. Takodje, istraživanje koje su sproveli Vaidya i sar., (2020) ukazuje na to da snaga stiska šake može biti efikasan alat za predviđanje fizičke kondicije, identifikaciju talentovanih sportista i otkrivanje niskih nivoa fizičke kondicije u ranoj fazi, čime se omogućava prevencija budućih zdravstvenih problema i korišćenje testa kao prediktivni faktor za opšte zdravstveno stanje (Vaidya i sar., 2021). Značajna povezanost snage stiska dominantne šake i antropometrijskih karakteristika gornjih ekstremiteta ukazuje na to da telesne proporcije mogu igrati ključnu ulogu u određivanju snage šake (Koley & Singh, 2009). Zatim studija Ingrová et al., (2017) potvrđuje tvrdnju da je snaga stiska šake povezana sa antropometrijskim karakteristikama, ali i sa telesnim sastavom, što je čini pogodnom merom za procenu fizičkog stanja. Fizička aktivnost različitog intenziteta do 25–30 godina ključna je za razvoj motoričkih veština i kondicije (Blair i sar., 2001). Evidentno je da postoji porast broja studenata sa smanjenim opštim zdravstvenim statusom i niskim nivoom fizičke kodnicije na početku i tokom studiranja (Prysiazhniuk i sar., 2018; Mozolev i sar., 2019). Naime, 90% studenata ima zdravstvene probleme, a više od 50% nezadovoljavajući nivo fizičke kondicije. Neki autori ove probleme pripisuju neefikasnom funkcionisanju sistema fizičkog obrazovanja (Maglyovanyi, 2010; Zavydivska i sar., 2016). Studija Vukadinovic i sar., (2024) ispitivala je fizički status studenata Akademije za nacionalnu bezbednost, pri čemu su rezultati pokazali da studenti imaju normalne vrednosti indeksa telesne mase (BMI), dok žene imaju viši procenat telesnih masti, koji prelazi biološki maksimum. Takođe, studenti oba pola imaju nivo mišićne mase na nivou sportista, dok morfološki status studenata odgovara prosečnom statusu studenata Univerziteta u Beogradu. S tim u vezi, cilj ovog istraživanja je da se utvrdi kakav je efekat praktične nastave na jačinu stiska šake studenata Akademije za nacionalnu bezbednost u okviru predmeta „Specijalne fizičke veštine“.

Metode

Uzorak

Uzorak je činilo 19 zdravih studenata prve godine Akademije za nacionalnu bezbednost, od kojih je 11 bilo muškog pola (godine: 18.83 ± 0.93), i 8 ženskog pola (godine: 19.25 ± 1.03). Svi učesnici su dobrovoljno učestvovali u istraživanju i nisu imali neuromišićne poremećaje, disfunkcije mišićno-koštanog sistema, povrede ili prethodne operacije na ruci ili šaci. Istraživanje je sprovedeno u skladu sa principima Helsinške deklaracije, kao i uz odobrenje Etičkog komiteta Fakulteta sporta i fizičkog vaspitanja Univerziteta u Beogradu (484-2).

Oprema

Podaci su prikupljeni upotrebom dinamometra radi merenja sile stiska šake. Signali sa senzora sile 4.0 (CZL302: Dongguan City, Kina) prikupljeni su pomoću komercijalno dostupnog softvera Isometrics (“Sports Medical Solutions”, Beograd, Srbija), sa frekvencijom uzorkovanja od 1000 Hz. Signali su filtrirani pomoću niskopropusnog (5 Hz), “Butterworth” filtra II reda. Softver je automatski izračunavao Fmax.

Procedure

Sva merenja su obavljena u Metodičko-istraživačkoj laboratoriji (MIL) na Fakultetu sporta i fizičkog vaspitanja u Beogradu, između 08:00 i 12:00. Pre merenja, svaki učesnik bio je detaljno upoznat sa procedurama testiranja. Primenjena procedura opisana je u istraživanju Vukadinović i sar., (2024). Ispitanici su izvodili tri pokušaja (dominantom i

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nedominantnom rukom) sa pauzom od 1 minuta. Instrukcija je bila da se šaka kontrahuje što je moguće snažnije i brže, te da se zadrži maksimalna kontrakcija oko 2 sekunde. Merenje je sprovedeno u sedećem položaju (ugao zgloba kolena od 90°; normalan anatomski položaj ruke), pri čemu su obe ruke merene naizmenično. Ispitanici su podvrgnuti testiranju dva puta u razmaku od tri meseca. Tokom ovog perioda, studenti su pohađali praktičnu nastavu, koja je obuhvatala vežbe opšte fizičke pripreme, u trajanju od 45 minuta, dva puta nedeljno.

Varijable

Test uključuje analizu sledećih varijabli:

- Maksimalna mišićna sila za levu ruku (FmaxL) i desnu ruku (FmaxR) izražene u njutnima (N).
- Relativna maksimalna mišićna sila za levu ruku (FmaxL_rel) i desnu ruku (FmaxR_rel) izražene u njutnima po kilogramu (N/kg).

Statistika

Svi rezultati su prvo analizirani primenom osnovne deskriptivne statističke metode gde je izračunata mera centralne tendencije (srednja vrednost varijable - Mean), mera disperzije (standardna devijacija - SD, koeficijent varijacije – CV%, granice raspona minimum - Min i maksimum - Max), kao i standardna greška merenja (SE%) izražena u procentima. Radi ispitavanja razlika između dva merenja za oba pola, koristili smo T-Test za ponovljena merenja. Za ispitavanje razlika u distribuciji korišćen je neparametrijski T-Test za ponovljena merenja. Sva statistička testiranja su sprovedena uz pomoć softverskog paketa "MS Excel 2013" i "IBM SPSS v23.0".

Rezultati

U Tabelama 1. i 2. prikazana je deskriptivna statistika telesnih karakteristika i jačine stiska šake za studente i studentkinje. Prikazane su srednje vrednosti (Mean), minimalne i maksimalne vrednosti (Range, Min, Max), koeficijent varijacije (CV%), standardna greška srednje vrednosti (SEM%) i standardna devijacija (STD), što omogućava uvid u osnovne karakteristike varijabilnosti i distribucije podataka. Koeficijent varijacije (CV%) kod studenata se kreće od 5.84 % do 21.46 %, dok se (SEM%) kreće od 1.69 % do 7.07 %. Ove vrednosti ukazuju na dobar nivo varijabilnosti i preciznosti u proceni srednjih vrednosti. Slične vrednosti su zabeležene i kod studentkinja. Naime, Fmax desne šake je veća u odnosu na levu šaku, kako u apsolutnim, tako i u relativnim vrednostima i kod studentkinja i kod studenata. Ova razlika ukazuje na moguću asimetriju u snazi između ruku, što je često prisutno kod većine populacije.

Tabela 1. Deskriptivna statistika telesnih karakteristika i izometrijske snage šake kod studenata.

	BH	BM	FmaxR1	FmaxR2	FmaxL1	FmaxL2	FmaxR1_rel	FmaxR2_rel	FmaxL1_rel	FmaxL2_rel
N	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00
Range	38.20	44.30	288.00	359.00	243.00	259.00	3.32	4.63	2.79	5.71
MIN	155.80	57.70	396.00	329.00	370.00	340.00	4.92	4.09	4.60	4.16
MAX	194.00	102.00	684.00	688.00	613.00	599.00	8.24	8.72	7.39	9.88
Mean	181.82	82.98	512.25	510.17	484.17	477.58	6.21	6.22	5.86	5.87
STD	10.63	13.53	97.49	109.49	86.46	88.63	0.88	1.31	0.70	1.44
SEM%	1.69	4.71	5.49	6.20	5.15	5.36	4.08	6.09	3.46	7.07
CV%	5.84	16.30	19.03	21.46	17.86	18.56	14.15	21.11	11.98	24.49

Legenda – BH – telesna visina; BM – telesna masa; FmaxR1 - desna ruka merena prvi put; FmaxR2 – desna ruka merena drugi put; FmaxL1 – leva ruka merena prvi put; FmaxL2 – leva ruka merena drugi put

Tabela 2. Deskriptivna statistika telesnih karakteristika i izometrijske snage šake kod studenata.

	BH	BM	FmaxR1	FmaxR2	FmaxL1	FmaxL2	FmaxR1_rel	FmaxR2_rel	FmaxL1_rel	FmaxL2_rel
N	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00
Range	29.00	36.00	113.00	139.00	180.00	186.00	1.33	1.60	1.55	1.84
MIN	156.00	56.00	245.00	219.00	185.00	191.00	3.50	3.23	3.31	2.61
MAX	185.00	92.00	358.00	358.00	365.00	377.00	4.83	4.83	4.86	4.45
Mean	171.50	68.88	290.38	276.63	267.63	245.00	4.28	4.05	3.90	3.56
STD	8.52	14.02	38.84	52.93	57.46	69.24	0.50	0.47	0.49	0.59
SEM%	1.76	7.20	4.73	6.76	7.59	9.99	4.09	4.12	4.46	5.85
CV%	4.97	20.36	13.38	19.13	21.47	28.26	11.56	11.65	12.60	16.53

Legenda – BH – telesna visina; BM – telesna masa; FmaxR1 - desna ruka merena prvi put; FmaxR2 – desna ruka merena drugi put; FmaxL1 – leva ruka merena prvi put; FmaxL2 – leva ruka merena drugi put

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U Tabeli 3. su prikazani rezultati t-testa za stisak leve i desne šake, sa apsolutnim i relativnim vrednostima, u poređenju prvog i drugog merenja. Za oba pola, analizirane su srednje vrednosti (Mean), t-vrednost i nivo značajnosti (Sig). lako su zabeležene promene u srednjim vrednostima između leve i desne šake, nijedna od razlika nije bila statistički značajna ($p > 0.05$), kod oba pola.

Tabela 3. Rezultati t-testa za stisak leve i desne šake: apsolutne i relativne vrednosti (poređenje prvog i drugog merenja – srednja vrednost (Mean), t-vrednost i nivo značajnosti (Sig)).

Gender	**Male**				**Female**			
	ABSOLUTE		RELATIVE		ABSOLUTE		RELATIVE	
Hand	FmaxR1	FmaxL1	FmaxR1_rel	FmaxL1_rel	FmaxR1	FmaxL1	FmaxR1_rel	FmaxL1_rel
	FmaxR2	FmaxL2	FmaxR2_rel	FmaxL2_rel	FmaxR2	FmaxL2	FmaxR2_rel	FmaxL2_rel
Mean	10.636	24.545	-.01126	-.00813	13.750	22.625	.23382	.34427
t	.777	1.288	-0.053	-.023	1.659	1.837	1.839	1.911
SIG	.455	.227	.959	.982	.141	.109	.109	.098

Legenda – FmaxR1 - desna ruka merena prvi put; FmaxR2 – desna ruka merena drugi put; FmaxL1 – leva ruka merena prvi put; FmaxL2 – leva ruka merena drugi put

U Tabeli 4. su prikazani rezultati neparametrijskog t-testa za stisak leve i desne šake, sa apsolutnim i relativnim vrednostima, u poređenju prvog i drugog merenja. Za oba pola, analizirane su srednje vrednosti (Mean), t-vrednost i nivo značajnosti (Sig).

Negativne Z-vrednosti ukazuju na to da je drugo merenje niže u odnosu na prvo, što sugeriše na smanjenje snage stiska šake u drugom merenju. U svim variablama, p-vrednosti su veće od 0.05, što znači da razlike nisu statistički značajne. Na primer, za studente, p-vrednost za desnu šaku je 0.906, što znači da razlika između tih merenja nije statistički značajna. Slično, za studentkinje, p-vrednosti su takođe iznad 0.05, što ukazuje na nedostatak statistički značajnih razlika između prvog i drugog merenja.

Tabela 4. Rezultati neparametrijskog testa za razlike u distribuciji stiska leve i desne šake (K-related samples): Z-vrednost i nivo značajnosti (Sig).

Gender	**Male**				**Female**			
	ABSOLUTE		RELATIVE		ABSOLUTE		RELATIVE	
Hand	FmaxR1	FmaxL1	FmaxR1_rel	FmaxL1_rel	FmaxR1	FmaxL1	FmaxR1_rel	FmaxL1_rel
	FmaxR2	FmaxL2	FmaxR2_rel	FmaxL2_rel	FmaxR2	FmaxL2	FmaxR2_rel	FmaxL2_rel
Z	-.118	-0.510	-0.157	-.706	-1.439	-1.402	-1.521	-1.540
SIG	.906	.610	.875	.480	.150	.161	.128	.123

Legend – FmaxR1 – desna ruka merena prvi put; FmaxR2 – desna ruka merena drugi put; FmaxL1 – leva ruka merena prvi put; FmaxL2 – leva ruka merena drugi put.

Diskusija

Cilj ovog istraživanja je bio da se utvrdi efekat praktične nastave na jačinu stiska šake studenata Akademije za nacionalnu bezbednost u okviru predmeta „Specijalne fizičke veštine". Snaga šake predstavlja ključni pokazatelj mišićne funkcionalnosti i zdravlja. Naime, može se koristiti kao indirektni pokazatelj ukupne mišićne jačine gornjeg dela tela (Tyldesley & Grieve, 2002; Chan i sar., 2008). Pored toga, pruža važne informacije o mišićnoj masi, nutritivnom statusu i opštem zdravlju pojedinca (Bohannon i sar., 2015). Zbog svoje praktične primene u proceni fizičkog stanja i praćenju efekata treninga, merenje snage šake nalazi široku primenu u sportu, rehabilitaciji i kliničkoj praksi. Rezultati ove studije su pokazali da ne postoje statistički značajne razlike ($p>0.05$) u snazi stiska šake za obe ruke (ni u relativnim, ni u apsoulutnim vrednostima) nakon pohađanja nastave (Tabela 3). To znači da nastava nije imala značajan uticaj na promene u snazi stiska šake kod ispitanika. Primećen je i trend opadanja snage stiska šake, i to od pretesta do posttesta, odnosno nakon pohađanja nastave (Tabela 1. i 2.). Prosečna vrednost snage stiska šake desne ruke je veća u odnosu na levu, kako kod studentkinja, tako i kod studenata. Asimetrija u snazi ruku je prisutna, pri čemu je dominantna ruka jača od nedominantne, što je potvrđeno u istraživanjima koja pokazuju razlike od 2,4% kod desnorukih i 11,2% kod levorukih ljudi (Ertem i sar., 2003). Takodje, studija koju su sproveli Pavlović i Vrcić (2021) utvrdila je značajne razlike u snazi stiska šake između dominantne i nedominantne ruke kod studenata Fakulteta sporta i fizičkog vaspitanja. Ova istraživanja potvrđuju važnost analize asimetrije u snazi stiska šake, koja se koristi za procenu fizičkih sposobnosti i praćenje promena u snazi.

Rezultati ove studije pokazali su sličnosti sa prethodnim istraživanjima, pri čemu su prosečne vrednosti maksimalne sile stiska šake u skladu sa ranije objavljenim standardima za starosne grupe (Markovic i sar., 2018; Dopsaj i sar., 2019; Wang i sar., 2018). Međutim, takođe je utvrđeno da ove vrednosti nisu na nivou koji se očekuje kod sportista (Leyk i sar., 2007). S obzirom na to da maksimalna sila stiska šake dostiže svoj vrhunac između 30. i 35. godine (Markovic i sar., 2018), bez obzira na pol, ispitanici u ovoj studiji, koji su

još uvek mladi, nisu dostigli svoj maksimalni potencijal. Stoga je preporučljivo pratiti njihov dalji razvoj kroz godine studiranja kako bi se uočile promene i dostizanje punog biološkog kapaciteta maksimalne snage. Snaga stiska šake igra ključnu ulogu u prevenciji povreda (Fry i sar., 2006) i razvoju fizičke snage i performansi (Vaidya i sar., 2020), što je posebno značajno za studente Akademije za nacionalnu bezbednost. S obzirom na to da kontraktilne sposobnosti mišića ruku mogu ukazivati na funkcionalna ograničenja i motoričke poremećaje, stisak šake se može koristiti kao efikasna skrining metoda za ranu detekciju potencijalnih fizičkih problema i praćenje opšteg nivoa snage (Kljajic i sar., 2012). Rezultati neparametrijskog testa (Tabela 4.) pokazali su redistribuciju unutar uzorka. Kod neutreniranih studenata primećeno je poboljšanje, što ih je približilo proseku, dok kod utreniranih studenata zabeležen je pad sposobnosti, što je dovelo do smanjenja maksimalne sile stiska šake. Ove promene rezultat su činjenice da već utrenirani studenti nisu dobili adekvatan nivo stimulusa tokom praktične nastave, dok je kod neutreniranih studenata nastava imala pozitivan efekat. Iako nije zabeležena značajna promena u prosečnoj vrednosti sile stiska šake, nastava je imala redistributivni uticaj na grupu.

Jedan od mogućih razloga za izostanak značajnih promena mogao bi biti relativno kratak period intervencije i niski intenzitet i obim vežbi koji su primenjivani tokom nastave. Limitacije ove studije mogu biti manji uzorak i specifičnost uzorka koja se ne može generalizovati na širu populaciju, kao i činjenicu da su podaci prikupljeni samo jednom, što naglašava potrebu za daljim praćenjem kako bi se uočile eventualne promene u snazi tokom vremena. Za buduća istraživanja preporučuje se duži vremenski period praćenja i veći uzorak ispitanika. Rezultati ove studije mogu poslužiti kao osnova za unapređenje nastavnih planova u cilju postizanja boljih fizičkih performansi kod studenata ove specifične populacije.

Zaključak

Praktična nastava iz predmeta „Specijalne fizičke veštine" nije imala značajan uticaj na jačinu stiska šake kod studenata. Razlog tome je što trening nije bio dovoljno specifičan, intenzivan niti učestao da bi doveo do značajnih promena. Da bi nastava bila svrsishodna i efikasna, preporučuje se njeno izvođenje najmanje tri puta nedeljno.

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UDK 796.325:159.947.3

Initial validation of the primary appraisal of situations stressfulness in volleyball (PASS-Vb) questionnaire

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Introduction

Many studies confirm that stress is omnipresent in sports, especially in sports competitions (e.g., Litwic-Kaminska, 2020). Competitive stress is defined as the «negative emotions, feelings, and thoughts that one might have with respect to their athletic experience such as feelings of apprehension, anxiety, muscle tension, nervousness, physical reaction, thoughts centered on worry and self-doubt, and negative statements» (Scanlan, Stein, and Ravizza, 1991, p. 105). Feelings and emotions related to competitive stress arise from an imbalance between athletes' perceptions of their abilities and the perceived demands of the situation (Martens, 1987). Lazarus and Folkman (1984) distinguish between primary (whether something relevant or important to the individual's well-being will happen in a given situation), and secondary (whether individual possess the coping options in a given situation) cognitive appraisal.

Duda (1995, p. 11) determined seven areas of perceived sources of stress in youth talented female gymnastics: psychological factors related to performance (the gymnast worries about her pre-meet level of anxiety or her ability to concentrate), adequacy of performance (the gymnast worries about making mistakes or not performing well), losing (the gymnast worries about the competitive outcome of the meet), injury (the gymnast worries about getting hurt), weight and appearance (the gymnast worries about how much she weighs or how attractive she is), judges' scoring (the gymnast worries about how her routine will be scored), and significant others (the gymnast worries about disappointing and/ or the reactions of her parents, coach and teammates). Duda and Gano-Overway (1996) have found that youth talented female gymnasts define stress as a negative response which is encountered somatically, cognitively, and emotionally as well as in terms of the situation in which they find themselves. Gano-Overway and Duda (1996) determined many sources of stress that were revealed by the youth talented female gymnasts, and categorized them into eight broad thematic areas: performance of skills, fear of evaluation, aspects of competition, fear of making mistakes, expectations from self and others, time pressures, environmental conditions, and fear of injury.

In her doctoral dissertation, Hess (2018) investigated stress appraisal, perceived controllability, and coping function of a sample of 310 youth volleyball players aged 10–19 years (mean age of 14.52 years), consisting of 73% females and 27% males, who participated in the Florida Region series of tryouts, competing for a position on one of Florida's High Performance volleyball teams. She found few interesting findings (Hess, 2018, pp. viii-ix): greater perceived controllability, problem-focused coping, and emotion-focused coping predicted greater perceived coping effectiveness; results suggest some differences in coping according to gender and skill level; males were more likely to use avoidance-focused coping compared to females; results also suggest that youth athletes may not conceptualize effective coping according to Folkman's matching hypothesis of the goodness-of-fit model of coping effectiveness. For measuring of participants tryout event's stress appraisal Hess (2018) used «stress thermometer», single item measure of stress ranging from 0 (no stress at all) to 100 (extreme stress) by Kowalski & Crocker (2001) that had proven an adequate variability, and has demonstrated an approximately normal distribution of stress in previous research. Means of the assessed tryout's stress were 43.05 for males and 38.49 for females, where males and females were not significantly different regarding stress appraisal. Lazarus and Folkman (1984) define a stress coping as the voluntary and constantly changing use of cognitive, behavioral or emotional efforts to manage internal and/or external demands that are appraised as exceeding the resources of the individual. DeLenardo and Terrion (2014) recommend undertaking interventions related to the development of stress coping in youth athletes, and propose a target group of athletes, high school students, so that they can adopt appropriate tools to sustain good psychological health, to yield greater satisfaction with sport and to increase youth's likelihood of positive life outcomes.

Milavić, Pezelj and Trut (2024) constructed PASS-Vb questionnaire for measuring of the primary appraisal of situations stressfulness in volleyball on a sample of youth volleyball players, and 11 components were yielded. Seven scales with at least satisfactory metric characteristics (homogeneity, reliability, and sensitivity) were constructed: the high stressful situations scale, the decisive points scale, the serve reception scale, the my playing scale, the block - spike scale, the my team is losing scale and the low stressful situations scale. The situations (questionnaire items) that were considered as decisive and more significant for young player, as well as, for the whole team, were assessed as more stressful. Scales scores were ranged from a high score on the high stressful situations and decisive points scales, moderate on the serve reception, my playing, block-spike and my team is losing scales, up to a very low score on the low stressful situations scale. Authors of the study claim that the findings of the maximum possible scores on the PASS-Vb scales indicate that at least some of the young players find playing volleyball extremely stressful in many different situations. Overall PASS-Vb score was moderately expressed. Authors pointed the need for conducting of further research to determine the validity of the constructed scales, as well as, the entire PASS-Vb questionnaire. The aim of this study was to make an initial validation of the PASS-Vb questionnaire on the sample of youth volleyball players.

Methods

The study sample consisted of 145 young volleyball players (118 females and 27 males), average age of 14.99 ± 1.46 years. Young volleyball players anonymously filled PASS-Vb questionnaire (Milavić, Pezelj and Trut, 2024) making assessments of the volleyball's situations on the 10 point Likert's scale questions (values from 0 – not stressful at all to 9 – completely stressful), and determined the most frequent playing position they play in their team (setter, opposite player, passer-hitter, middle blocker, or libero player).

Statistical procedures in this study included using of:

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analysis of differences between sample subgroups of youth volleyball players [either t-test or One-way ANOVA with applying of the post-hoc Fisher's Least significance differences (LSD) test]; descriptive statistics (mean and standard deviation; as well, frequencies), and the K-means clustering procedure for determining the types of situations stressfulness assessment in youth volleyball.

Results and discussion

Table 1. Gender differences of situation's stressfulness assessment

Variable	Female players (n=118)		Male players (n=27)		t-test value	p=
	Mean	St.dev.	Mean	St.dev.		
High stressful situations	5.08	1.75	4.71	1.75	1.01	0.31
Decisive points	4.98	2.15	4.86	1.80	0.26	0.79
Serve reception	4.47	2.14	4.29	1.88	0.41	0.68
My playing	4.34	1.74	4.82	1.72	1.31	0.19
Block – spike	4.31	2.08	4.71	2.06	0.90	0.37
My team is losing	4.31	1.63	4.68	1.77	1.04	0.30
Low stressful situations	2.12	1.60	2.47	1.89	0.99	0.32
Overall PASS-Vb	4.23	1.48	4.36	1.38	0.42	0.67

Although there are noticeable differences in the ratings on the scales between the group of female and male young volleyball players, no gender differences were found according to the assessments of the PASS-Vb questionnaire scales. The lowest level of significance was not higher than p = 0.30 for the my team is losing scale. Therefore, it was possible to continue processing with the entire sample of examinees as a single entity. These results on the absence of gender differences in stress assessments in volleyball are consistent with the findings of Hess (2018), although in her study, participants assessed only a single-item measure of stress.

Table 2. Analyses of variance of the stressfulness assessment according to the player's age

Variable	Age group						F	p=
	13 – 14 years (n=64)		15 – 16 years (n=54)		17 – 18 years (n=27)			
	Mean	St.dev.	Mean	St.dev.	Mean	St.dev.		
High stressful situations	5.22	1.80	4.72	1.85	5.12	1.33	1.29	0.28
Decisive points	4.73	2.13	4.87	2.26	5.67	1.40	2.03	0.13
Serve reception	4.78	1.95	4.17	2.25	4.18	2.01	1.53	0.22
My playing	4.17	1.92	4.61	1.68	4.68	1.34	1.29	0.28
Block – spike	4.54	2.22	4.14	2.06	4.14	2.06	0.59	0.56
My team is losing	4.66	1.70	3.94	1.75	4.59	1.17	3.16*	0.045
Low stressful situations	1.85	1.69	2.31	1.61	2.71	1.54	2.87	0.06
Overall PASS-Vb	4.28	1.57	4.11	1.51	4.49	1.02	0.65	0.52

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Analysis of variance revealed significant differences on 3 of the PASS-Vb scales between subgroups of players of different chronological ages: first, in the my team is losing scale (F=3.16, p=0.045) between 13-14 years age subgroup who had higher, more stressful assessments compared to 15-16 years age subgroup; second, in the low stressful situations scale (LSD test p=0.02) between 13-14 years age subgroup who had lower, less stressful assessments compared to 17-18 years age subgroup; and third, in the decisive points scale (LSD test, p=0.049) between 13-14 years age subgroup who had lower, less stressful assessments compared to 17-18 years age subgroup. It is possible that the older volleyball players assess the decisive points scale and low stressful situations scale as more stressful because they are under a higher level of social pressure or to the higher expectations (either due to personal expectations or the expectations of others - coaches, parents or their teammates) compared to younger players. It is possible that the younger volleyball players assess the my team is losing scale due to the lower playing experience compared to older players.

Table 3. Analyses of variance of the stressfulness assessment according to the players playing position

Variable	Players position										F	p=
	Setter (n=32)		Opposite player (n=19)		Passer-hitter (n=45)		Middle blocker (n=34)		Libero player (n=13)			
	Mean	St.dev.	Mean	St.dev.	Mean	St.dev.	Mean	St.dev.	Mean	St.dev.		
High stressful situations	4.84	1.95	4.11	1.64	5.21	1.80	5.43	1.53	4.86	1.48	2.05	0.09
Decisive points	4.94	2.14	3.78	2.21	5.45	2.06	4.84	1.85	5.24	2.16	2.28	0.06
Serve reception	3.31	2.31	4.07	1.64	5.11	1.82	4.45	2.13	5.28	1.73	4.57**	0.002
My playing	4.64	2.07	3.68	1.79	4.54	1.71	4.45	1.44	4.74	1.48	1.16	0.33
Block – spike	4.19	2.21	3.26	1.54	4.66	1.99	5.10	1.70	3.62	2.88	3.29*	0.013
My team is losing	4.46	1.90	3.96	1.74	4.43	1.59	4.61	1.35	4.06	2.09	0.61	0.66
Low stressful situations	2.24	1.65	1.76	1.96	2.35	1.56	2.26	1.76	2.03	1.43	0.47	0.75
Overall PASS-Vb	4.09	1.61	3.52	1.43	4.53	1.47	4.45	1.24	4.26	1.47	1.92	0.11

Analysis of variance revealed significant differences on 5 of the PASS-Vb questionnaire scales between subgroups of players of different playing position: first, in the serve reception scale (F=4.57, p=0.002) between setters subgroup and almost all other subgroups, which was considered to be irrelevant because setters are not usually taking any direct action into the serve reception situations; second, in the block - spike (smash) scale (F=3.29, p=0.013) between opposite players subgroup who had lower, less stressful situations assessments compared to passer-hitter and middle blocker players subgroups who had higher, more stressful assessments; third, in the high stressful situations scale between opposite players subgroup who had lower, less stressful situations assessments compared to middle blocker (LSD test, p<0.01) and passer-hitter (LSD test, p<0.02) players subgroups; fourth, in the decisive points scale between opposite players subgroup who had lower, less stressful situations assessments and passer-hitter (LSD test, p<0.01) players subgroup; fifth, in overall PASS-Vb score opposite players subgroup had lower, less stressful assessments compared to the subgroups of passer-hitter and middle blocker subgroups. In order to determine and interpret possible reasons for the findings on differences in stress assessments of young volleyball players of different playing positions, the authors of this study recommend conducting of an additional discussion with experts in the field of volleyball. In doing so, special attention would be paid to the specific tasks that players of a particular playing position (e.g., passer-hitter playing position) typically have during the game in comparison to players of other playing positions.

Table 4. Situations stressfulness assessment types of players

Variable	Types of stressfulness assessment						F	p=
	Very low (n=37)		Moderate (n=63)		High (n=45)			
	Mean	St.dev.	Mean	St.dev.	Mean	St.dev.		
High stressful situations	2.91	1.15	5.14	1.19	6.57	0.82	117.68	<0.001
Decisive points	2.47	1.18	5.18	1.58	6.68	1.11	99.91	<0.001

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Serve reception	2.66	1.42	4.13	1.95	6.33	0.92	58.64	<0.001
My playing	2.60	1.33	4.42	1.26	5.94	1.06	75.74	<0.001
Block – spike	1.97	1.13	4.34	1.33	6.44	1.17	133.92	<0.001
My team is losing	2.53	1.13	4.49	1.20	5.74	1.06	80.99	<0.001
Low stressful situations	0.88	0.93	2.17	1.57	3.28	1.46	30.06	<0.001

Using of the K-means clustering procedure determined three different types of situations stressfulness assessment in a sample of youth volleyball players: very low stressful type consisted of 25.5% of players (characterized by low evaluations of all scales); moderate stressful type, 43.4% players, (characterized by moderate evaluations on most scales with two scales above a evaluation of 5.00, decisive points and high stressful situations scales); high stressful type, 31.0% players, (characterized by high evaluations of scales with average evaluations above the 6.00 on 4 scales: decisive points, high stressful situations, block–spike, and serve reception scales).

Determined differences between the three types of situations stressfulness assessment on each PASS-Vb scale by young volleyball players are clearly shown and can be seen in figure 1.

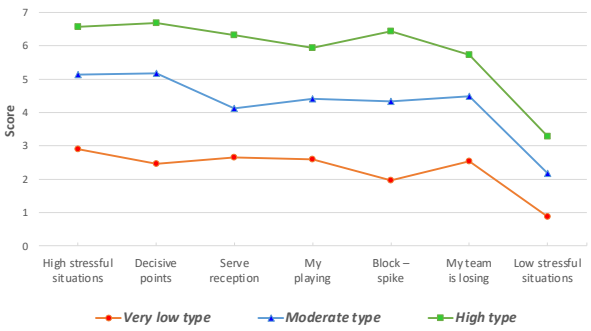

Figure 1. Types of situations stressfulness assessment

The findings of this study show that within the total sample of young volleyball players there were some subgroups of players who evaluate the stressful situations in the volleyball game in different ways then others: older players possibly to the higher expectations of themselves and to a social environment that is surrounding them; passer-hitter players possibly to the high responsibilities of their playing position in their team's game; high stressful assessment type of players who highly pronounced tendency to assess situations as stressful in the game.

The authors of this study claim that it is reasonable to assume that those groups of players with higher assessments of the stressfulness of situations that occur in the volleyball could more often provoke high-level state anxiety, which may impair the quality of their playing performance.

It is recommended to continue with further validation of the PASS-Vb questionnaire, investigating the relationships between primary appraisal of stressful situations in volleyball (as well as, in other youth sports) with other well-known questionnaires and with other psychological measures (e.g., self-confidence; cohesion; state anxiety; concentration; peaking under pressure; coping with adversity; coach leadership style; ...).

Conclusion

This study point primarily the need for further research to determine the possible reasons for the findings established. It would be desirable for more volleyball experts to be involved in the analysis of these results, especially those with long-term experience working with young players.

Secondly, it is recommended to carry out an additional education for coaches of young volleyball players: to improve the quality of their communication and leadership with young players, preferably with special attention to developing of the correct attitude of players towards making mistakes, and to forming of quality playing expectations of young volleyball players (either, coach's expectations, players' expectations of themselves, or the expectations of their close social environment, such as parents or peers).

Thirdly, the authors of present study strongly support the recommendations of other researchers for the development of quality interventions of coping with stress for young athletes, for volleyball players, as well as for young people in other sports.

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UDK 796.325:159.947.3

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UDK 796.332.012.11

The relationship between motor skills and dribbling speed in football

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Introduction

Football is a complex team sport that belongs to the group of the most developed sports games. The expansion of football has influenced the establishment of higher standards and quality of play, which is directly linked to the development of a wide range of abilities. To achieve top results in football, it is necessary to integrate a high level of technical, tactical, physical, and psychological abilities. Studies show that in addition to functional and anthropometric characteristics, the level of developed motor abilities is also of great importance in achieving success in specific sports (Karalejić & Jakovljević, 2008; Bubnjević et al., 2020).

Hadžić (2004) conducted a study to determine the impact of motor skills and morphological characteristics on results in situational-motor tests in football players. The study involved 147 football players aged 14 to 16 years. The general conclusion was that motor abilities (speed, strength, endurance, etc.) positively influence success in situational-motor tests. Ćorluka (2005) conducted a study on a sample of 120 football players aged 12 to 14 years. He aimed to determine how motor abilities affect situational-motor abilities and success in football. The results of the research by Ćorluka (2005) showed a relatively high correlation between the criteria and the predictor system, with the highest correlation coefficients observed in the following tests: 20m sprint from a standing start and slalom dribbling with two balls.

To establish the relationships between motor abilities (speed, strength, coordination, etc.) and situational-motor abilities (dribbling speed, etc.), and to more effectively track training success, regular testing is necessary. Various tasks (tests) are used to assess the motor abilities of younger football players, which evaluate speed, specific forms of strength expression, agility, and flexibility.

The first aim of this study was to determine the relationship between the results of motor skills tests and dribbling speed in younger football players. The second goal was to analyze the relationships between the tests defined as motor skills tests and those assessing dribbling speed.

Methods

The experimental method of transversal character was used in this research. It was conducted on a sample of 31 subjects aged 11 to 13 (10 subjects G3- juveniles, 11 subjects G2- younger cadets and 10 subjects G1-cadets). Experimental measurements were carried out in Pancevo on the field of FC Dinamo football club. The basic criterion in relation to which the selection of participants is made is that they are healthy, without any injuries of the locomotor system that could affect the accuracy of the measurements.

Testing was preceded by a warm-up consisting of running at a moderate intensity, dynamic stretching, sprint exercises with a gradual increase in intensity, and several sprints of 30 m length. During the testing, each subject had two attempts for each test, and only the better attempts were used for the analysis of the results.

Four tests were used to assess motor abilities:

1. Standing long jump (BJ)
2. 30m sprint from a standing start (S30m)
3. Sit-ups for 30 seconds (SU)
4. T-test (TT)

Three tests were used to assess dribbling speed:

1. 30m sprint with the ball (L30m)
2. Dribbling speed in the T-test (T-DRIB)
3. Zig-zag test with the ball (ZZ)

Motor ability tests:

BJ
The attempt is valid if the participant lands with both feet simultaneously in a squat or semi-squat position. The jump distance is measured as the shortest distance from the takeoff line to the landing line.

S30m
Participants start from a designated line and are required to run through a gate without slowing down. The test is measured manually with a stopwatch, starting when the last leg is raised at the start and stopping when the nearest part of the body crosses an imaginary line (the gate).

SU
The test is done in pairs, one player holds the other's feet, and the task is to complete as many sit-ups as possible in 30 seconds. A repetition counts if the participant touches the ground with the shoulder blades when lowering and with the elbows touching the knees when raising. The starting position is with elbows on the knees and hands crossed behind the neck.

TT
Participants start from a standing position and run in a straight line for 9.14m, touch the top of a cone with their right hand, move laterally to the left and touch the left cone, then laterally to the right to touch the cone again. The test ends when they return to the starting point.

Dribbling speed tests:

L30m
Participants start from a designated line and are required to run with the ball through a gate without slowing down. The test is measured manually with a stopwatch, starting when the ball makes contact and stopping when the chest crosses the finish line. The test is valid if the ball contacts at least four times during the run.

T-DRIB
Participants start from a standing position and run straight for 9.14m, then move laterally through a slalom, touching cones placed in a pattern, and return to the starting position.

ZZ
Participants run 5m straight to the first cone, around it, then continue to the second cone, turning left, and move to the third cone, turning right, then running to the finish line.

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Comparative and descriptive statistical procedures were applied. The relationship between the variables was determined using correlation analysis, and values in the range of 0.10 – 0.29 were considered low, 0.30 – 0.49 moderate, and over 0.50 high (Cohen, 1988). The level of statistical significance was $p < 0.05$ for all measurements. Statistical analysis was performed using SPSS 20.0 software (SPSS Inc, Chicago, IL, USA). The obtained high correlations are discussed in the paper.

Results

Table 1 presents the descriptive statistics for the entire sample. Group G1 (oldest group) achieved the best results in most tests, except for the SU test. The development of the tested abilities shows a trend of improvement as participants get older.

Table 2 reveals a high correlation between the S30m and L30m tests. The highest correlation is between the S30m and BJ tests, indicating the relationship between speed and explosive strength. L30m is highly correlated with both the TT and BJ tests, showing the connection between jump strength, agility, and dribbling speed. Smaller but significant correlations were found between the T-DRIB test and the S30m, TT, BJ, and L30m tests, suggesting that agility and speed (both with and without the ball) are related to dribbling speed.

Table 1. Descriptive statistics for the entire sample

GROUPS	**G1**		**G2**		**G3**	
VARIABLES	**A**	**SD**	**A**	**SD**	**A**	**SD**
S30m	4.5	0.2	4.79	0.18	4.98	0.19
TT	10.1	0.21	10.74	0.56	10.96	0.41
BJ	206.2	12.79	189.91	13.42	174	9.91
SU	28.3	2.16	28.36	2.24	28.7	2.11
L30m	5.02	0.2	5.13	0.25	5.58	0.37
T-DRIB	12.14	0.41	12.4	0.54	13.1	0.49
ZZ	6.88	0.23	7.28	0.21	7.22	0.23

Note: G3–juveniles, G2–younger cadets, and G1–cadets

Table 2. Correlations for the whole sample

VARIABLES	**S30m**	**TT**	**BJ**	**SU**	**L30m**	**T-DRIB**	**ZZ**
S30m	1						
TT	**.842***	1					
BJ	**-.847***	**-.813***	1				
SU	-0.197	-0.295	0.17	1			
L30m	**.811***	**.672***	**-.723***	-0.22	1		
T-DRIB	**.562***	**.535***	**-.542***	-0.213	**.634***	1	
ZZ	0.419	0.409	-0.297	0.11	0.297	0.473	1

Note: * – high correlation

In Table 3, a high correlation between S30m and BJ was observed, indicating that speed and speed-strength are interdependent. Group G1 showed the highest correlation between the mentioned tests, and it is assumed that the players in this group have developed speed-strength to a certain level, as they are the oldest, which is why the correlation between speed and explosiveness is higher compared to the younger groups. A significant correlation was also found between the S30m test and TT, L30m, as well as between TT and BJ, and L30m and BJ.

Table 3. Correlations for the Group G1

VARIABLES	**S30m**	**TT**	**BJ**	**SU**	**L30m**	**T-DRIB**	**ZZ**
S30m	1						
TT	**.631***	1					
BJ	**-.912***	**-0.722**	1				
SU	0.293	0.131	-0.207	1			
L30m	**.740***	0.276	**-0.606**	0.254	1		
T-DRIB	0.162	0.032	-0.42	0.218	0.241	1	
ZZ	0.023	-0.122	0.161	0.312	-0.147	0.384	1

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In Table 4, there is a high correlation between the variables L30m and TT, which indicates an interdependent relationship between ball dribbling speed and agility. The SU test shows a high correlation with S30m, confirming the importance of abdominal strength in tasks that require the expression of speed and explosive strength.

Table 4. Correlations for the Group G2

VARIABLES	S30m	TT	BJ	SU	L30m	T-DRIB	ZZ
S30m	1						
TT	**.873***	1					
BJ	**-.669***	**-.754***	1				
SU	**-.713***	**-.501***	0.476	1			
L30m	**.670***	**.757***	**-.601***	-0.353	1		
T-DRIB	0.339	0.213	-0.078	**-.663***	**.511***	1	
ZZ	0.041	0.09	0.206	-0.028	0.33	0.136	1

In Table 5, a positive relationship between movement speed with and without the ball is observed in the sprint tests over 30 meters for the youngest group of tested soccer players. There is also a high correlation between the variables SU and BJ.

Table 5. Correlations for the Group G3

VARIABLES	S30m	TT	BJ	SU	L30m	T-DRIB	ZZ
S30m	1						
TT	**.683***	1					
BJ	-.386*	**-.645***	1				
SU	**-.680***	**-.766***	**.856***	1			
L30m	**.871***	**.544***	**-.510***	**-.747***	1		
T-DRIB	0.195	**.567***	-0.43	-0.457	0.321	1	
ZZ	0.066	0.06	0.076	-0.018	0.266	**.643***	1

Discussion

Bubnjević and colleagues (2020) conducted a study with football players aged 6 to 12 years with the aim of determining the relationship between strength and speed. The study found a statistically significant correlation between the results in speed tests (30 m sprint) and strength tests (long jump), with better results observed in older participants. The results obtained in our study, which relate to these two variables, are in accordance with those in the Bubnjević study (2020). In the group of the oldest participants, a high correlation (the highest correlation between different tests in this study) was found between these two variables (r = -0.912), while no statistically significant correlation was found in the youngest group, indicating that the relationship between speed and strength increases with the participants' age.

Stević and Furulija (2012) conducted research to determine the relationship between motor abilities and situational-motor abilities in young football players. The participants were aged 8 to 14 years and had an average of three years of training. In the case of the criterion variable «slalom with the ball,» a statistically significant correlation coefficient was achieved with other predictor variables, proving the interrelation between motor and situational-motor abilities. In our research, a significant correlation was found across the entire sample between the 30m sprint (S30m) and situational-motor tests L30m and T-DRIB. When analyzing the correlation between motor and situational-motor abilities for individual groups, a statistically significant correlation was found between the S30m test and L30m for all groups.

The goal of the research by Pokrajčić et al. (2018) was to determine the progress in speed, agility and explosiveness in young soccer players after eight weeks of training. The research was conducted on a sample of 25 young football players aged 9.50 ± 0.50 years. A total of 3 tests were applied: 1. Running for 20 meters from a high start; 2. Running back and forth with a 90° change; 3. Zig-zag test. Correlation analysis showed that there is a statistically significant relationship between all three tests. The obtained correlation between the 20-meter run from a high start and the zig-zag test is over 0.80. The results of the study by Ćeremidžić and colleagues (2018) are in agreement with this, showing a significant correlation between the speed of the zig-zag test with the ball and the 10 m sprint from a standing start. In our study, no statistically significant correlation was found between the results of the zig-zag test and the 30 m sprint across the entire sample or within each group, but a significant correlation was found across the entire sample between S30m and T-DRIB (r = 0.563*). The disagreement between these studies and our study may be due to the fact that the 10 m and 20 m sprints are tests for assessing start-up acceleration, while the 30 m sprint evaluates both start-up acceleration and running speed in children.

The impact of motor test results on match performance (goal scoring) was examined and confirmed in the study by Wilson and colleagues (2014), which investigated the relationship between dribbling speed, short-distance speed, and match performance. A statistically significant correlation was found between match performance and the sprint test (r = 0.60; p = 0.014) and dribbling speed (r = 0.81; p <

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0.0001). This can be considered a limitation of our study, as the correlation between the results of motor tests and match performance was not examined.

Ejup and colleagues (2010) used regression analysis to examine the impact of motor abilities on results in situational football tests for evaluating dribbling speed and shooting accuracy. They found a statistically significant correlation between motor variables and results in each of the analyzed situational-motor tests. The results of the analysis suggest two main conclusions: the results in motor tests significantly influence ($p = 0.01$) achievement levels in all analyzed situational football tests (dribbling speed over 20 m from a standing start, slalom dribbling, and heading accuracy). For example, it was shown that the long jump and results in the 4x15 m sprint test had the greatest influence on dribbling speed over 20 m. Based on this study, it can be concluded that sprint power and coordination significantly affect dribbling speed over 20 m.

Conclusion

The tested motor abilities (particularly speed and speed-strength) in football players aged 11 to 13 are related to results in dribbling speed tests. This study also examined the relationship of the repetitive strength test (LŽ-SD) with other motor and situational-motor tests, with significant correlations found in two groups for speed, agility, and speed-strength tests. A review of the available literature did not reveal any studies that examined these correlations between these tests.

We believe that the results of this study have both practical and theoretical significance to some extent and can be useful for football coaches as a battery of tests for evaluating younger football players. In children's training, one should take into account the relationship between specific training and training aimed at all-round development, which will give the young athlete a better foundation for top performance.

Further research should investigate which tests show significant differences in the analyzed age groups, the extent of the correlations between these tests in older competitive categories, and whether there is a relationship between dribbling speed test results and success in competitions.

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UDK 796.332.012.11

Povezanost motoričkih sposobnosti i brzine vođenja lopte u fudbalu

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Uvod

Fudbal je kompleksna timska igra koja pripada grupi najrazvijenijih sportskih igara. Ekspanzija fudbala uticala je na postavljanje viših standarda i kvaliteta igre što je direktno povezano sa razvojem širokog dijapazona sposobnosti. Za postizanje vrhunskih rezultata u fudbalu, neophodno je integrisati visok nivo tehničke, taktičke, fizičke i psihološke sposobnosti. Studije pokazuju da pored funkcionalnih i antropometrijskih karakteristika, za postizanje uspeha u pojedinim sportovima veliki značaj ima i nivo razvijenosti motoričkih sposobnosti (Karalejić i Jakovljević, 2008; Bubnjević i sar. 2020).

Hadžić (2004) je sproveo istraživanje sa ciljem da se utvrdi uticaj motoričkih sposobnosti i morfoloških karakteristika na rezultate u situaciono-motoričkim testovima kod fudbalera. Istraživanje je sproveo na uzorku od 147 fudbalera uzrasta od 14 do 16 godina. Generalni zaključak je bio da motoričke sposobnosti (brzina, snaga, izdržljivost...) pozitivno utiču na uspeh u situaciono-motoričkim testovima. Ćorluka (2005) je sproveo istraživanje na uzorku od 120 fudbalera uzrasta od 12 do 14 godina. Pokušao je da utvrdi koliko motoričke sposobnosti utiču na situaciono-motoričke sposobnosti i uspeh u fudbalskoj igri. Rezultati istraživanja Ćorluke (2005) su pokazali realtivno visoku povezanost kriterijuma sa prediktorskim sistemom, a najveći koeficijenti korelacije uočeni su kod sledećih testova: trčanje na 20 m iz visokog starta i slalom nogama sa dve lopte. Da bi se utvrdile povezanosti između motoričkih (brzina, snaga, koordinacija...) i situaciono-motoričkih (brzina vođenja lopte...) sposobnosti, a u cilju kvalitetnijeg praćenja uspešnosti treninga, neophodno je sprovoditi redovna testiranja. Za procenu motoričkih sposobnosti fudbalera mlađeg uzrasta koriste se različiti zadaci (testovi) kojima se procenjuju brzinske sposobnosti, pojedini oblici ispoljavanja snage, agilnost i fleksibilnost.

Prvi cilj ovog istraživanja bio je da se utvrdi povezanost rezultata testova za procenu motoričkih sposobnosti i brzine vođenja lopte fudbalera mlađeg uzrasta. Drugi cilj je analiza povezanosti između testova koji se definišu kao testovi za procenu motoričkih sposobnosti, i povezanost između testova za procenu brzine vođenja lopte.

Metode

U ovom istraživanju korišćena je eksperimentalna metoda transverzalnog karaktera. Sprovedena je na uzorku od 31 ispitanika uzrasta od 11 do 13 godina (G3–petlići bilo je 10 ispitanika, G2–mlađi pioniri bilo ih je 11 ispitanika i G1–pioniri bilo je 10 ispitanika). Eksperimentalna merenja su realizovana u Pančevu na terenu fudbalskog kluba FK Dinamo. Osnovni kriterijum u odnosu na koji se pravila selekcija ispitanika jeste da su zdravi, bez ikakvih povreda lokomotornog sistema koji bi mogli da utiču na tačnost merenja.

Testiranju je prethodilo zagrevanje koje se sastojalo od trčanja umerenim intenzitetom, dinamičkog istezanja, sprinterskih vežbi sa postepenim povećanjem intenziteta i nekoliko sprinteva dužine 30 m. Prilikom testiranja svaki ispitanik je imao dva pokušaja za svaki test, a za analizu rezultata su korišćeni samo bolji pokušaji.

Korišćena su 4 testa za procenu motoričkih sposobnosti:

1. Skok udalj iz mesta (SUD);
2. Sprint na 30 m iz visokog starta (S30m);
3. Trbušnjaci za 30 s (LŽ-SD);
4. T-test (TT).

Korišćena su 3 testa za procenu brzine vođenja lopte:

1. Sprint na 30 m sa loptom (L30m);
2. Brzina vođenja lopte u T-testu (T-DRIB);
3. Zig-zag test sa vođenjem lopte (ZZ).

Testovi za procenu motoričkih sposobnosti:

SUD
Pokušaj je važeći ukoliko ispitanik doskoči na obe noge istovremeno u položaj čučnja ili polučučnja. Dužina skoka je merena kao najkraće rastojanje od linije odskoka do linije doskoka.

S30m
Ispitanici su kretali sa označene linije i zahtev je bio da protrče kroz postavljenu liniju (kapiju) bez usporavanja. Test je meren ručno - štopericom koja se startuje u momentu podizanja zadnje noge prilikom starta i zaustavlja kada najbližim delom trupa ispitanik prođe kroz zamišljenu liniju (kapija).

LŽ-SD
Test je rađen u paru, jedan igrač drži stopala drugog, koji ima zadatak da postigne što veći broj trbušnjaka za 30 sekundi. Ponavljanje se računa ukoliko je ispitanik prilikom spuštanja dotakao zemlju lopaticama i prilikom podizanja dotakao laktovima kolena. U početnoj poziciji laktovi su pozicionirani na kolenima, a šake ukrštene iza potiljka.

TT
Ispitanici započinju test iz pozicije visokog starta i trče pravolinijski 9.14 m, desnom rukom moraju da dotaknu vrh čunja, lateralno se kreću ulevo – bočnim dokoracima, moraju da dotaknu levom šakom vrh čunja koji je na udaljenosti od centralnog 4.57 m, zatim lateralno udesno do čunja koji je na istoj udaljenosti od centralnog kao prethodni čunj i treba da se dodirne desnom šakom. Zatim je kretanje opet bočnim dokoracima do centralnog čunja koga dodiruju levom rukom i zatim trče unazad kroz kapiju. Test je meren ručno-štopericom koja se startuje u momentu podizanja zadnje noge prilikom starta i zaustavlja kada ispitanici prođu sa obe noge kroz kapiju.

Testovi za procenu brzine vođenja lopte:

L30m
Ispitanici su kretali sa označene linije i zahtev je bio da što brže protrče vodeći loptu kroz postavljenu kapiju bez usporavanja. Test je meren ručno - stopericom koja se startuje u momentu kontakta sa loptom i zaustavlja kada grudima prođu kroz ciljnu liniju. Da bi se test smatrao ispravnim bilo je neophodno ostvariti minimum 4 kontakta sa loptom tokom trčanja, ne računajući prvi kontakt pri startu.

T-DRIB
Ispitanici su započinjali test iz pozicije visokog starta i trčali

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pravolinijski 9.14 m, obilazali su centralni čunj sa desne strane i kretali se u slalomu prema levom čunju, nakon obilaska levog čunja pravolinijski prema desnom čunju, a nakon obilaska desnog ponovo u slalomu prema centralnom čunju koga su obilazili i vraćali se nazad prema startnoj poziciji.

ZZ
Ispitanici su se kretali pravolinijski 5 m prema prvom čunju koji su obilazili sa desne strane, nastavljali su kretanje narednih 5 m do drugog čunja koji su obilazili sa leve strane, zatim nakon 5 m su obilazili poslednji čunj sa desne strane i trčali prema cilju.

Primenjene su komparativna i deskriptivna statistička procedura. Povezanost između varijabli utvrđena je primenom korelacione analize, a vrednosti u opsezima 0.10 – 0.29 su smatrane niskim, 0.30 – 0.49 umerenim, a preko 0.50 visokim (Cohen, 1988). Nivo statističke značajnosti je bio $p < 0.05$ za sva merenja. Statistička analiza je urađena pomoću softvera SPSS 20.0 (SPSS Inc, Chicago, IL, USA). U radu su diskutovane dobijene visoke korelacije.

Rezultati

U Tabeli 1 je prikazana deskriptivna statistika za celokupan uzorak ispitanika. Grupa G1 (koja je najstarija) ostvarila je najbolje rezultate u većini testova, izuzev u testu LŽ-SD. Razvoj testiranih sposobnosti ukazuje da postoji tendencija napredovanja i da su rezultati bolji kod većine testova što su ispitanici stariji.

Tabela 1. Deskriptivna statistika za celokupan uzorak ispitanika

GRUPE	**G1**		**G2**		**G3**	
VARIABLE	**A**	**SD**	**A**	**SD**	**A**	**SD**
S30m	4.5	0.2	4.79	0.18	4.98	0.19
TT	10.1	0.21	10.74	0.56	10.96	0.41
SUD	206.2	12.79	189.91	13.42	174	9.91
LŽ-SD	28.3	2.16	28.36	2.24	28.7	2.11
L30m	5.02	0.2	5.13	0.25	5.58	0.37
T-DRIB	12.14	0.41	12.4	0.54	13.1	0.49
ZZ	6.88	0.23	7.28	0.21	7.22	0.23

Legenda: G3–petlići, G2–mlađi pioniri i G1–pioniri

U Tabeli 2 se vidi visoka povezanost između testova S30m i L30m. Najviša povezanost je između testova S30m i SUD što govori o vezi brzine i brzinske snage. U Tabeli 2 test L30m ima visoku povezanost i sa varijablom TT i SUD što govori o vezi skočnosti i agilnosti sa brzinom vođenja lopte na 30 m. Manja, ali takođe značajna povezanost je između varijable T-DRIB sa varijablama S30m, TT, SUD i L30m što ukazuje na povezanost između testa za procenu agilnosti tokom koga se vodi lopta sa testovima: za procenu brzine trčanja bez i sa loptom na 30 m, brzinske snage i agilnosti bez lopte.

Tabela 2. Korelacije za celokupan uzorak ispitanika

VARIABLE	**S30m**	**TT**	**SUD**	**LŽ-SD**	**L30m**	**T-DRIB**	**ZZ**
S30m	1						
TT	**.842***	1					
SUD	**-.847***	**-.813***	1				
LŽ-SD	-0.197	-0.295	0.17	1			
L30m	**.811***	**.672***	**-.723***	-0.22	1		
T-DRIB	**.562***	**.535***	**-.542***	-0.213	**.634***	1	
ZZ	0.419	0.409	-0.297	0.11	0.297	0.473	1

Legenda: * – visoka korelacija

U Tabeli 3 uočena je visoka povezanost S30m i SUD što upućuje na to da su brzina i brzinska snaga međuzavisne. Grupa G1 ostvaruje najvišu povezanost između pomenutih testova, a pretpostavka je da su fudbaleri ove grupe razvili brzinsku snagu do određenog nivoa, s obzirom da su najstariji i da je zbog toga kod njih povezanost brzine i skočnosti veća u odnosu na mlađe grupe. Dobijena je i značajna povezanost testa S30m sa TT i L30m, zatim TT i SUD, i L30m i SUD.

Tabela 3. Korelacije testova za grupu G1

VARIABLE	**S30m**	**TT**	**SUD**	**LŽ-SD**	**L30m**	**T-DRIB**	**ZZ**
S30m	1						
TT	**.631***	1					
SUD	**-.912***	**-0.722**	1				

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LŽ-SD	0.293	0.131	-0.207	1			
L30m	**.740***	0.276	**-0.606**	0.254	1		
T-DRIB	0.162	0.032	-0.42	0.218	0.241	1	
ZZ	0.023	-0.122	0.161	0.312	-0.147	0.384	1

U Tabeli 4 postoji visoka povezanost varijabli L30m sa varijablom TT što ukazuje na međuzavistan odnos brzine vođenja lopte i agilnosti. Test LŽ-SD pokazuje visoku povezanost sa S30m što potvrđuje značaj snage trbušnog zida u zadacima koji zahtevaju ispoljavanje brzine i brzinske snage.

Tabela 4. Korelacije testova za grupu G2

VARIABLE	S30m	TT	SUD	LŽ-SD	L30m	T-DRIB	ZZ
S30m	1						
TT	**.873***	1					
SUD	**-.669***	**-.754***	1				
LŽ-SD	**-.713***	**-.501***	0.476	1			
L30m	**.670***	**.757***	**-.601***	-0.353	1		
T-DRIB	0.339	0.213	-0.078	**-.663***	**.511***	1	
ZZ	0.041	0.09	0.206	-0.028	0.33	0.136	1

U Tabeli 5 se vidi kod najmlađe testirane grupe fudbalera pozitivan odnos brzine kretanja sa i bez lopte na testovima sprinta na 30 m, a visoka je povezanost i između varijabli LŽ-SD i SUD.

Tabela 5. Korelacije testova za grupu G3

VARIABLE	S30m	TT	SUD	LŽ-SD	L30m	T-DRIB	ZZ
S30m	1						
TT	**.683***	1					
SUD	-.386*	**-.645***	1				
LŽ-SD	**-.680***	**-.766***	**.856***	1			
L30m	**.871***	**.544***	**-.510***	**-.747***	1		
T-DRIB	0.195	**.567***	-0.43	-0.457	0.321	1	
ZZ	0.066	0.06	0.076	-0.018	0.266	**.643***	1

Diskusija

Bubnjević i saradnici (2020) sproveli su istraživanje sa fudbalerima uzrasta od 6 do 12 godina sa ciljem utvrđivanja povezanosti snage i brzine. U navedenoj studiji je utvrđena statistički značajna povezanost između rezultata u testovima brzine (sprint na 30 m) i snage (skok udalj) i da su rezultati bolji što su ispitanici stariji. Rezultati dobijeni u našem istraživanju koji se odnose na ove dve varijable su u saglasnosti sa rezultatima u studiji Bubnjević i saradnici (2020). Kod grupe najstarijih ispitanika dobijena je visoka povezanost (najveća povezanost između različitih testova u ovoj studiji) ove dve varijable (r = -0.912), a kod najmlađe grupe ispitanika nije dobijena statistički značajna povezanost što pokazuje da se povezanost brzine i snage povećava što su ispitanici stariji.

Stević i Furulija (2012) su sproveli istraživanje sa ciljem da utvrde povezanost motoričkih sposobnosti sa situaciono-motoričkim sposobnostima mladih fudbalera. Ispitanici su bili uzrasta od 8 do 14 godina i u proseku tri godine u trenažnom procesu. Na primeru kriterijumske varijable slalom sa loptom u odnosu na druge prediktorske varijable ostvaren je statistički značajan korelacioni koeficijent čime je dokazana međusobna povezanost motoričkih sa situaciono-motoričkim sposobnostima. U našem istraživanju je dobijena značajna povezanost na celokupnom uzorku između S30m i situaciono-motoričkih testova L30m i T-DRIB. Kada se analizira povezanost motoričkih sa situaciono-motoričkim sposobnostima pojedinačnih grupa statistički značajna povezanost je dobijena između testa S30m i L30m kod svih grupa.

Cilj istraživanja Pokrajčića i saradnika (2018) je bio da se utvrdi napredak u brzini, agilnosti i eksplozivnosti kod mladih fudbalera nakon osam nedelja treninga. Istraživanje je sprovedeno na uzorku od 25 mladih fudbalera starosti 9,50 ± 0,50 godina. Primenjena su ukupno 3 testa: 1. Trčanje na 20 metara iz visokog starta; 2. Trčanje napred-nazad sa promenom od 90°; 3. Zig-zag test. Korelaciona analiza je pokazala da postoji statistički značajna veza između sva tri testa. Dobijena korelacija između testova trčanje na 20 metara iz visokog starta i zig-zag testa je preko 0,80. U saglasnosti sa navedenom studijom su i rezultati studije Ćeremidžića i saradnika (2018) koji su dobili značajnu povezanost brzine izvođenja testa zig-zag sa loptom i trčanja na 10 m iz položaja visokog starta. U našem istraživanju nije dobijena statistički

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značajna povezanost između rezultata u zig-zag testu i trčanju na 30 m na celokupnom uzorku i kada se posmatraju rezultati u svakoj od grupa, ali je dobijena značajna povezanost na celokupnom uzorku između S30m i T-DRIB (r = 0.563*). Možda je razlog u neslaganju rezultata navedene dve studije sa našom studijom zato što je trčanje na 10 m i 20 m test za procenu startnog ubrzanja, a na 30 m se kod dece pored startnog ubrzanja procenjuje i brzina trčanja.

Uticaj rezultata u testovima motoričkih sposobnosti na uspešnost na utakmici je ispitivana i potvrđena u studiji Vilsona i saradnika (Wilson et al., 2014) u kojoj je istražena povezanost brzine driblinga, brzine na kratkoj distanci i uspešnosti na utakmici. Dobijena je statistički značajna povezanost uspešnosti na utakmici sa sprintom (r = 0.60; p = 0.014), i brzinom driblinga (r = 0.81; p < 0.0001). Može se smatrati nedostatkom u našem istraživanju to što nije ispitivana povezanost rezultata u motoričkim testovima sa uspešnošću na utakmici.

Ejup i saradnici (Ejup et al., 2010) su regresionom analizom ispitivali uticaj motoričkih sposobnosti na rezultate u situacionim fudbalskim testovima za procenu brzine vođenja lopte i preciznosti šuta. Dobili su statistički značajnu povezanost motoričkih varijabli sa rezultatima u svakom od analiziranih situaciono-motoričkih testova. Rezultati analize sugerišu dva osnovna zaključka: rezultati u motoričkim testovima značajno utiču (p = 0.01) na nivo dostignuća u svim analiziranim situacionim fudbalskim testovima (brzina vođenja lopte na 20 m sa startom iz mesta, vođenje lopte slalom, preciznost udarca glavom). Od motoričkih testova pokazalo se na primer, da za brzinu vođenja lopte na 20 m najveći uticaj ima skok udalj iz mesta i rezultat u testu trčanja 4 x 15 m. Na osnovu navedenog istraživanja može se reći da na brzinu vođenja lopte na 20 m značajno utiče brzinska snaga i koordinacija.

Zaključak

Testirane motoričke sposobnosti (naročito brzina i brzinska snaga) kod fudbalera uzrasta od 11 do 13 godina povezane su sa rezultatima na testovima brzine vođenja lopte. U ovoj studiji se ispitivala i povezanost testa za procenu repetitivne snage (LŽ-SD) sa ostalim motoričkim i situaciono-motoričkim testovima i kod dve grupe je dobijena značajna povezanost sa testom brzine, agilnosti i brzinske snage. Pregledom dostupne literature nije pronađena ni jedna studija koja je ispitivala navedene povezanosti između ovih testova.

Smatramo da rezultati ovog istraživanja imaju u određenoj meri praktični i teorijski značaj i da mogu biti korisni trenerima u fudbalu kao baterija testova koja se može koristiti u testiranju fudbalera mlađeg uzrasta. Na dečjim treninzima treba voditi računa o odnosu specifičnih i treninga usmerenih na svestrani razvoj, koji će mladom sportisti dati bolju osnovu za vrhunske performanse.

U narednim istraživanjima treba ispitati u kojim testovima postoji značajna razlika kod analiziranog uzrasta, zatim kolika je povezanost ovih testova na uzorcima starijih takmičarskih kategorija i da li postoji povezanost rezultata u testovima brzine vođenja lopte sa uspešnošću na takmičenjima.

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UDK 796.54.02

Optimization of warehouse space for the needs of educational camp at faculty of sport and physical education in Belgrade

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Introduction

A few decades ago, the material and technical base of the *Faculty of Physical Culture* for the subject *Camping* was at an enviable level and represented a shining example to other educational institutions. The material and technical resources needed for the teaching of subjects are organized so that they are deposited in the teaching base in *Džanići* during the year. The equipment was stored as part of the base, on the ground, in two warehouse facilities designed exclusively for that purpose (picture 1).

Picture 1. Former semi-open warehouse space in the teaching base of FPC from Belgrade, intended for accommodation of floating objects (https://www.youtube.com/@aktivnostiuprirodi5872)

Unfortunately, at the beginning of the nineties of the last century, at the location of the teaching base of the faculty, due to war actions, the equipment was stolen, and the faculty was left without a complete material and technical base (Miletić et al., 2024). This can be considered the first financial „blow" to the subject from which it has not recovered to this day. Since then, affected by financial problems, the Faculty has been a „guest" on „its subject" for many years. The reason was the expensive and diverse equipment needed for the quality implementation of fieldwork in *Camping* (today the subject of *Outdoor activities*).

The current material and technical base is modest and as such serves to ensure that teaching is carried out smoothly with the efforts made and continuously. Today's applied logistics model is designed in such a way that the entire equipment is mobile, i.e. it is transported from the Faculty's warehouse to the field and after the classes are finished, it is returned to the same warehouse. This is otherwise the best model applied within the armed forces and requires a well-established system of logistical support (Uprava inžinjerije, 1971). The problem with this model is that the logistics organization is much more complex compared to the fact that the warehouse is constantly stationed in *Džanići*. The complexity is reflected in the fact that the costs of transportation are significantly more expensive, the manipulation of the equipment is multiplied several times, as well as the possibility of the equipment being damaged or destroyed during transportation or manipulation.

It should be emphasized that the problem of lack of usable space is increasingly pronounced due to the impossibility of expanding the current spatial capacities (Stević et al., 2020). This fact comes to the fore especially when considering the area of institutions whose main activity description does not include storage as a primary function.

As an educational institution, the Faculty disposes of a complex of facilities. As such, the objects were purposely created for the needs of teaching (Petrović, 1997). In its complex, the faculty as an institution contains the main building, a sports hall, a tennis court, a football field and other larger areas, a gym, a threatening object of football fields, etc. (Juhas, 2018). Within the field there is a boiler room with a work room (picture 2). As most of the mentioned facilities are already in use, it remains to additionally use certain free spaces for the storage of teaching equipment and camping equipment.

Picture 2. Boiler room facility with utility room

Until the use of the described storage area, the material and technical resources were stored in various places: in the warehouses of the HPP „Bajina Bašta", in the courtyards in *Perućac*, the basement of the faculty building, the locker room of the football fields, in offices, private garages, etc.

A few years ago, starting with the restoration of the material base of the subject, the aforementioned area of the old boiler house was made available, where the decommissioned equipment of the faculty was also stored (chairs, tables, tires, air conditioners, boilers...).

With adequate organization of resources, all equipment has been successfully packed into this space so far. The found state of free available warehouse space is inherited. Teaching equipment was stored as free space allowed at the given moment. The previous practice was to quickly unload the means of transport, whereby the equipment was placed where it could fit at that moment. As such, it was stored on the floor of the warehouse without any organization, but according to the priority of emptying the means of transport. All the equipment stored in this warehouse is visibly badly organized and piled up without any order (picture 3). The problem that caused the funds to be packed in this way is related to the students who did this work voluntarily, but mostly with the absence of a responsible person who would give them organizational instructions.

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Picture 3. Display of the current state of the warehouse with various equipment stored without sorting

In the picture you can see the stored equipment in the warehouse. The permanent parts inside the warehouse [A] are clearly visible, as well as the previously stored assets [B], then the equipment of the items that came later and is divided into water equipment [1], waste bins [2], mattresses [3], vessels [4], alpinism equipment [5] and others. This system of disposing of assets clearly affects the reduction of their working life in addition to standard problems arising during use and transportation. Another present problem is the access and movement of personnel to other equipment, tools, parts of the room, windows, etc.

The displayed stored teaching and technical resources in themselves represented a problem for which an appropriate solution had to be found. It has been stated many times so far that tracing the path of future science and profession is reflected in an interdisciplinary approach to solving most incoming problems. This view included traffic engineering and activities in nature (as a special segment of physical culture), which contributed to a concrete solution to a long-standing, current problem.

Methods

The methods represented in this work were the observation and measurement of storage space, inventory of the current state of the warehouse, the *ABC analysis method* for creating a new layout through the *Pareto rule*, and detailed specifications of an optimally filled warehouse. The *Pareto Rule*, also known as the *80/20 Rule*, is a principle that states that close to 80% of results come from 20% of the effort or resources. This means that a small number of factors usually have the greatest impact. This rule can be applied in many areas such as: business, time management, in everyday life (Waters, 2003).

A digital representation was made, i.e. a three-dimensional model was created with the help of *Maxon 4D Cinema* software, where a fully arranged and organized warehouse ready for use was presented.

The aim of the research was to create the best possible solution from the current state of the warehouse for the accommodation of found equipment, current material and technical resources and planned (future) resources.

The tasks of the space organizer and the creation of a new layout were: a detailed inventory of the complete equipment in the warehouse, measurement of the available space, measurement of each individual element of the complete equipment, creation of a working sketch, organization of warehouse elements using the *ABC analysis* method, *Pareto's rule*, and creation of a 3D model of the future solution for the use of warehouse space.

Results

The main task of optimizing the warehouse space was to ensure unhindered access, or rather **create a free corridor**, for easier access to every necessary element, regardless of where it was at that moment. Based on the dimensions of the corridor, which should ensure the movement of personnel with the largest equipment, individual storage elements were set up.

Due to the presence of a certain category of highly flammable materials (canisters for fuel, chemicals, paints, etc.), a cage is provided for accommodation right next to the entrance to the warehouse, which **ensures a constant flow of air** to carry the vapors outside the warehouse.

By placing and fitting racks with shelves, **more useful space was obtained** in relation to the height of the warehouse. In addition to this, things with a larger volume served to store smaller equipment elements inside them.

For the final solution of the treated problem, elements such as: threaded rods, wall supports, ceiling supports, holders, pins, racks, shelves, etc. were used.

By applying the *ABC analysis*, which is based on the *Pareto rule*, which considers that 20% of the resources are used in 80% of cases, an attempt was made to make the best possible new rearrangement of the warehouse and that the closest racks and shelves to the entrance are A objects and equipment, at a little further positions the B segment of objects and equipment, and on the farthest shelves in the warehouse are positioned objects and equipment in the C segment. Objects and equipment are segmented by ABC analysis in such a way that they are in the A segment, which contains 10-20% of the equipment, 50-70% of the equipment that is used most often, in the B segment, which contains about 20% of the equipment, is used in 20% of cases, and the C segment, which is the largest 60-70% and is used the least often and is used in some 10-30% (Waters, 2003).

Discussion

Space as a dimension should certainly be viewed with all its useful and unusable capacities. Only in this way can the most realistic picture of the problem of space be seen and as such it is taken into planning. Examining the Faculty's warehouse space, it can be seen that it has a lot of volumetric „surpluses", which are elements left over from the previous use. These elements mainly consist of two clearly visible groups shown as:

A. permanent static structures built into the space (concrete supports for working machines, pipeline installations, water installations and electrical installations, drainage channels...) and

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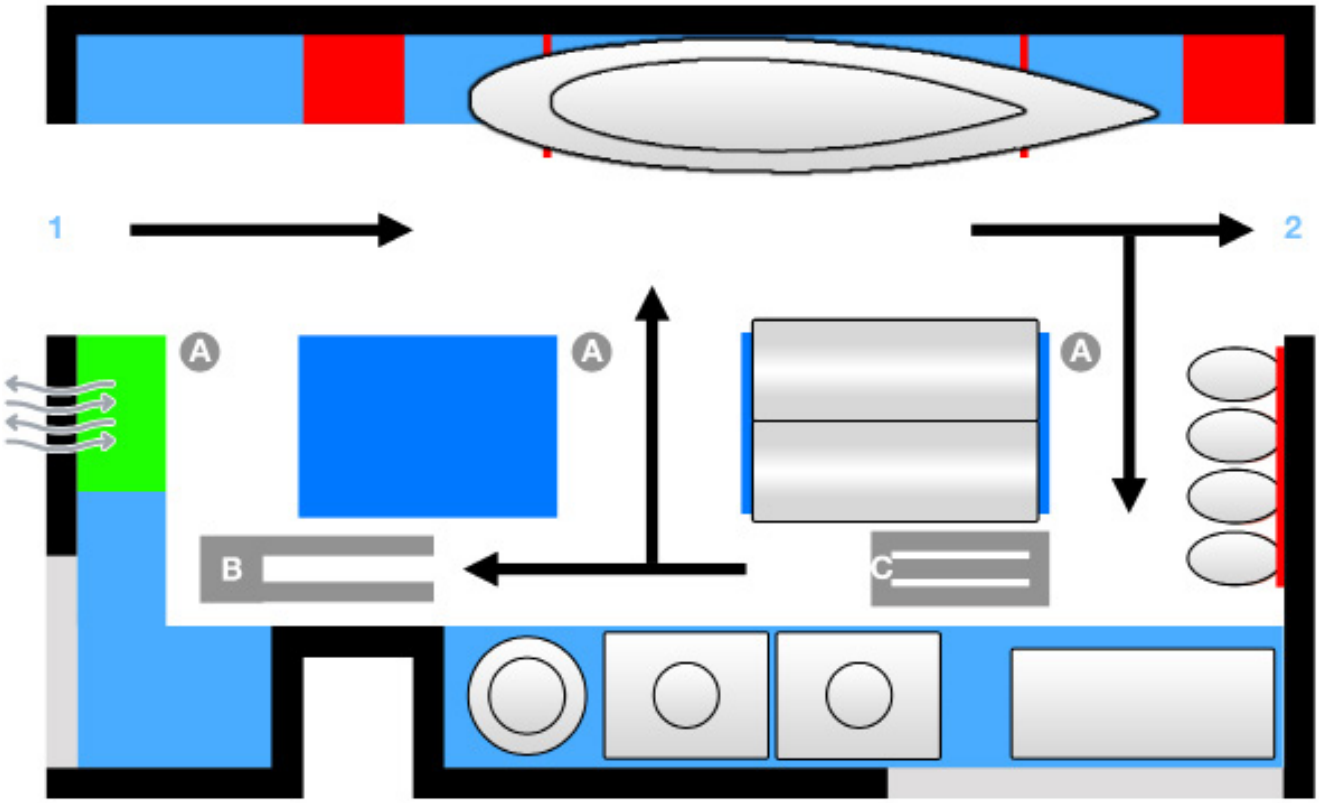
B. found deposited items in the warehouse, i.e. different items for which an adequate place should definitely be found in that area (chairs, car tires, scrapped air conditioners, tables, benches, refrigerator...).

By analyzing the current state of the warehouse space, and based on the creation of a new layout, a more optimal warehouse space was created (picture 4). The results of this research will be applied in practice, whereby a better organization of the warehouse space will be enabled, seen through simpler access and manipulation of assets (Waters, 2003), which will affect their preservation, i.e. extending their working life, and consequently also the economic profitability, i.e. the ecological aspect (Miletić, 2023).

With this procedure, more usable space will be obtained, by rearranging current resources according to priority of use, requirements, degree of utilization, etc. (Miletić et al., 2025).



Picture 4. Plan of an organized space filled with racks and shelves at the height of the walls

The legend below explains the tabulated parts. The arrows show the direction of movement within the warehouse corridor. Other elements are dedicated and each has its own purpose (table 1).

Table 1. Graphic explanation (legend) of the organized warehouse space

SYMBOL	EXPLANATION
	Wall
	Corridor
	Windows
	Permanent structures
	Shelves
	Racks
	Cage for flammable substances
	Means and equipment
A	Fire extinguishers
B	Palette knife
C	The ladder

1	Entry / exit
2	Entrance to another room

It is interesting that by inventorying and adequately organizing assets according to certain characteristics or purpose (vessels, water equipment, electrical equipment, recreational equipment, propulsion engines, fuel storage...) in the future, a database can be created, thanks to which it will be known exactly where a certain item or asset is located in the warehouse. This is the future direction of solving problems related to the complete logistics of the subject as an integral part of its study.

The main achievements of this research are reflected in its high utility value in practice. The process of optimizing the warehouse space of the FSPE included a lot of related procedures, and among other things, a detailed list of material and technical means, in the possession of the item, which practically put control over each element individually. Thanks to several months of work on warehouse optimization, further procedures resulting from the research are:

- **Digitization of the complete equipment** (availability and monitoring with the entire specification on the online presentation of the item https://www.aktivnostiuprirodi.

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com/logorovanje/) whereby it will be known where each piece of equipment in the item's possession is located, its current condition, the need for repair or the purchase of a new one;

- **Technical arrangement of the warehouse space** (setting and organization of storage elements) which will enable the achievement of the main goal of this work, which is above all the longevity of the equipment, its easier storage and storage, but also the current place in the warehouse.

Conclusions

Using the method of *ABC analysis* and the *Pareto rule*, along with the existing spatial resources of the faculty, by applying elementary knowledge of logistics as part of the supply chain, it is possible to successfully solve storage problems by adequately reorganizing the existing warehouse space and means for the realization of educational camps. According to Stević et al., the purpose of applying this analysis is to establish a functional system of control and management in the framework of procurement, storage, and thus the possibility of achieving greater economy (Stević et al., 2020), in this case significant savings in the business of the *Faculty of sports and physical education* from *Belgrade*. In simpler words, by analyzing the concept of correct storage of equipment in adequate accommodation, it is possible to extend the working life of the equipment, and thus influence the reduction of the total costs of teaching, consequently the economy of the Faculty as an institution.

Thanks to this procedure, equipment and teaching aids are more easily sorted, stored, managed and transported ("Sl. glasnik RS" бр. 13/2013). Practically, the overall optimization of the space for the storage of material and technical means is an integral part of camp life and work and generally staying in field conditions.

In addition to the above, a major role in this complex process is played by the educational component, which includes the segment called *Care and maintenance of the material and technical base* (Miletić et al., 2023), in which students participate, as part of the compulsory teaching defined by the plan and program of the *Outdoor activities* course.

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UDK 796.54.02

Optimizacija magacinskog prostora za potrebe nastavnog logorovanja na Fakultetu sporta i fizičkog vaspitanja u Beogradu

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Uvod

Pre nekoliko decenija, materijalno-tehnička baza, tada *Fakulteta fizičke kulture* za predmet *Logorovanje* bila na zavidnom nivou i predstavljala je svetli primer drugim obrazovnim institucijama. Materijano-tehnička sredstva potrebna za nastavu predmeta su organizovana tako da su tokom godine deponovana u nastavnoj bazi *Džanići*. Oprema je bila skladištena u sastavu baze, na terenu, u dva magacinska objekta predviđena isključivo za tu namenu (slika 1).

Slika 1. Nekadašnji poluotvoreni magacinski prostor u nastavnoj bazi FFK iz Beograda, namenjen za smeštaj plovnih objektata (https://www.youtube.com/@aktivnostiuprirodi5872)

Na žalost, početkom devedesetih godina prošloga veka, na lokalitetu nastavne baze fakulteta usled ratnih dejstava, došlo je do otuđenja opreme, pri čemu je Fakultet ostao bez kompletne materijalno-tahničke baze (Miletić i sar., 2024). Ovo se može smatrati prvim finansijskim „udarom" na predmet od koga se ni do dan danas nije oporavio. Od tada, pogođen finansijskim problemima, Fakultet je dugi niz godina „gostovao" na „svom predmetu", Uzrok je bila skupa i raznovrsna oprema koja je potrebna za kvalitetnu realizaciju terenske nastave *Logorovanja* (danas predmeta *Aktivnosti u prirodi*).

Aktuelna materijalno-tehnička baza je skromna i kao takva služi da se nastava uz uložene napore i u kontinuitetu nesmetano realizuje. Današnji primenjeni model logistike je tako koncipiran da je celokupna oprema mobilna, odnosno iz magacina Fakulteta transportuje se na teren i nakon završene nastave, ponovo se vraća u isti magacin. Ovo je inače najbolji model koji se primenjuje u sastavu oružanih snaga i zahteva dobro ustanovljen sistem logističke podrške (Uprava inžinjerije, 1971). Problem kod ovog modela je to što je organizacija logistike dosta kompeksnija u odnosu na to da se magacin nalazi konstantno stacioniran u *Džanićima*. Kompleksnost se ogleda u tome što su troškovi transporta značajno skuplji, manipulacija opremom je više puta umnožena kao i postojanje mogućnosti da se oprema prilikom transporta ili manipulacije ošteti ili uništi.

Treba istaći činjenicu da je problem nedostatka korisnog prostora sve više izražen usled nemogućnosti proširivanja aktuelnih prostornih kapaciteta (Stević i sar., 2020). Ova činjenica posebno dolazi do izražaja kada se razmatra prostor institucija kojima u opisu matične delatnosti ne stoji skladištenje kao primarna funkcija.

Fakultet kao obrazovna institucija raspolaže kompleksom objekata. Kao takvi, objekti su namenski kreirani za potrebe izvođenja nastave (Petrović, 1997). U svom kompleksu fakultet kao institucija sadrži glavnu zgradu, sportsku halu, teniski, fudbalski teren i druge veće površine, teretanu, preteći objekat fudbalskih terena i dr. (Jyxac, 2018). U okviru terena nalazi se kotlarnica sa radnom prostorijom (slika 2). Kako su uglavnom svi pomenuti objekti već u upotrebi, tako je preostalo da se određeni slobodni prostori dodatno iskoriste za potrebe odlaganja nastavne opreme i sredstava za logorovanje.

Slika 2. Objekat kotlarnice sa pomoćnom prostorijom

Sve do ustupanja na korišćenje opisanog skladišnog prostora, materijalno-tehnička sredstva su bila skladištena na raznim mestima: u magacinima HE „Bajina Bašta", u dvorištima u *Perućcu*, podrumu zgrade fakulteta, svlačionici fudbalskih terena, po kancelarijama, privatnim garažama i sl.

Nekoliko godina unazad, počevši sa obnavljanjem materijalne baze predmeta, na raspolaganje je stavljen navedeni prostor stare kotlarnice u koji se takođe skladištila otpisana oprema fakulteta (stolice, stolovi, gume, klime, bojleri…).

Uz adekvatnu organizaciju sredstava, do sada je sva oprema uspešno pakovana u ovaj prostor. Zatečeno stanje slobodnog raspoloživog magacinskog prostora je nasleđeno. Nastavna oprema je odlagana kako je u datom trenutku dozvoljavao slobodni prostor. Dosadašnja praksa bila je takva da se radilo brzo pražnjenje transportnog sredstva, pri čemu se oprema odlagala gde je tog trenutka mogla stati. Kao takva bila je odlagana na podu magacina bez ikakve organizacije, već po prvenstvu pražnjenja transportnog sredstva. Sva oprema odložena u ovaj magacin vidno je loše organizovana i nabacana bez ikakvog reda (slika 3). Problem zbog čega su se ovako pakovala sredstva vezan je za studente koji su dobrovoljno radili ovaj posao, ali uglavnom uz odsustvo odgovornog lica koje bi im davalo organizacione instrukcije.

Na slici se može uočiti odložena oprema u magacinu. Jasno su uočljivi stalni delovi unutar magacina [A], kao i do tada odlagana sredstva [B], zatim oprema predmeta koja je došla kasnije i podeljena je na opremu za vodu [1], kante za

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Slika 3. Prikaz trenutnog stanja magacina sa različitom opremom odloženom bez sortiranja

otpad [2], dušeke [3], plovila [4], alpinističku opremu [5] i dr. Ovakav sistem odlaganja sredstava jasno utiče na smanjenje njihovog radnog veka uz standardne probleme nastale pri upotrebi i transportu. Drugi prisutni problem je pristup i kretanje ljudstva ka drugoj opremi, alatu, delovima prostorije, prozorima i sl.

Prikazana skladištena nastavno-tehnička sredstva sama po sebi predstavljala su problem za koji je trebalo naći odgovarajuće rešenje. Mnogo puta do sada je konstatovano, da se trasiranje staze buduće nauke i struke ogleda u interdisciplinarnom pristupu rešavanja većine dolazećih problema. Upravo ovaj pogled obuhvatio je saobraćajni inženjering i aktivnosti u prirodi (kao posebni segment fizičke kulture), čime je doprineo konkretnom rešenju dugogodišnjeg, aktuelnog problema.

Metode

Metode zastupljene u ovom radu bile su opservacija i merenje skladišnog prostora, popis trenutnog stanja magacina, metoda *ABC analize* za kreiranje novog rasporeda (layout-a) kroz *Paretovo pravilo* i detaljne specifikacije optimalno popunjenog skladišta. *Paretovo pravilo*, poznato i kao *Pravilo 80/20*, je princip koji kaže da se blizu 80% rezultata ostvaruje kroz 20% napora ili resursa. To znači da mali broj faktora obično ima najveći uticaj. Ovo pravilo se može primeniti u više oblasti kao što su: poslovanje, upravljanje vremenom, u svakodnevnom životu (Waters, 2003).

Urađen je digitalni prikaz, odnosno kreiran je trodimenzionalni model uz pomoć *Maxon 4D Cinema* softvera, gde je prezentovan kompletno sređen i organizovan magacin spreman za upotrebu.

Cilj istraživanja je bio da se od trenutnog stanja magacina kreira najbolje moguće rešenje za smeštaj zatečene opreme, aktuelnih materijalno-tehničkih sredstava i planiranih (budućih) sredstava.

Zadaci organizatora prostora i kreiranja novog rasporeda bili su: detaljan popis kompletne opreme u magacinu, merenje raspoloživog prostora, merenje svakog pojedinačnog elementa kompletne opreme, kreiranje radne skice, organizacija skladišnih elemenata metodom *ABC analize*, *Paretovog pravila* i izrada 3D modela budućeg rešenja upotrebe magacinskog prostora.

Rezultati

Glavni zadatak optimizacije magacinskog prostora je bio obezbeđenje nesmetanog pristupa, tačnije **stvaranje slobodnog koridora**, radi lakšeg dolaska do svakog potrebnog elementa bez obzira gde se on u tom trenutku nalazio. Na osnovu dimenzija koridora koje trebaju da osiguraju kretanje ljudstva sa najgabaritnijom opremom vršena je postavka pojedinih skladišnih elemenata.

Zbog prisustva određene kategorije sredstava koja su visoko zapaljiva (kanisteri za gorivo, hemija, farbe i sl.) obezbeđen je kavez za smeštaj neposredno pored ulaza u magacin čime je obezbeđen **konstantan protok vazduha** za odnošenje isparenja izvan prostora magacina.

Postavljanjem i uklapanjem regala sa policama dobijeno je **više korisnog prostora** u odnosu na visinu magacina. Pored ovoga, stvari sa većom zapreminom su poslužile da se unutar njih skladište sitniji elementi opreme.

Za konačno rešenje tretiranog problema korišćeni su elementi kao što su: navojne šipke, zidni nosači, plafonski nosači, držači, soške, regali, police i dr.

Primenom *ABC analize* koja se zasniva na *Paretovom pravilu*, koje smatra da se 20% sredstava koristi u 80% slučajeva pokušano je da se najbolje odradi novo preslaganje skladišta i da se na najbližim regalima i policama ulazu nalaze A objekti i oprema, na malo daljim pozicijama B segment objekata i opreme, a na najudaljenijim policama u skladištu su pozicionirani objekti i oprema u C segmentu. ABC analizom su segmentisani objekti i oprema i to tako da su u A segmentu koji sadrži 10-20% opreme čini 50-70% opreme koja se najčešće koristi, u B segmentu koji sadrži oko 20% opreme se koriste u 20% slučajeva i C segment koji je i najveći 60-70% i koji se najređe i koriste i koriste se u nekih 10-30% (Waters, 2003).

Diskusija

Prostor kao dimenziju svakako treba posmatrati sa svim njegovim korisnim ali i neupotrebljivim kapacitetima. Jedino se na ovaj način sagleda najrealnija slika problematike prostora i kao takav se uzima u planiranje. Razmatrajući prostor magacina Fakulteta, uočava se da isti ima dosta zapreminskih „viškova", koji su elementi zaostali od prethodne namene. Ove elemente uglavnom čine dve jasno primetne grupe prikazane kao:

A. **stalne statične strukture** ugrađene u prostor (betonski nosači za radne mašine, cevovodne instalacije, vodo instlacije i električne instalacije, odlivni kanali…) i

B. **zatečene deponovane stvari** u magacinu, odnosno različite stvari za koje u tom prostoru svakako treba pronaći adekvatno mesto (stolice, auto gume, rashodovane klime, stolovi, klupe, frižider…).

Analizom zatečenog stanja magacinskog prostora,

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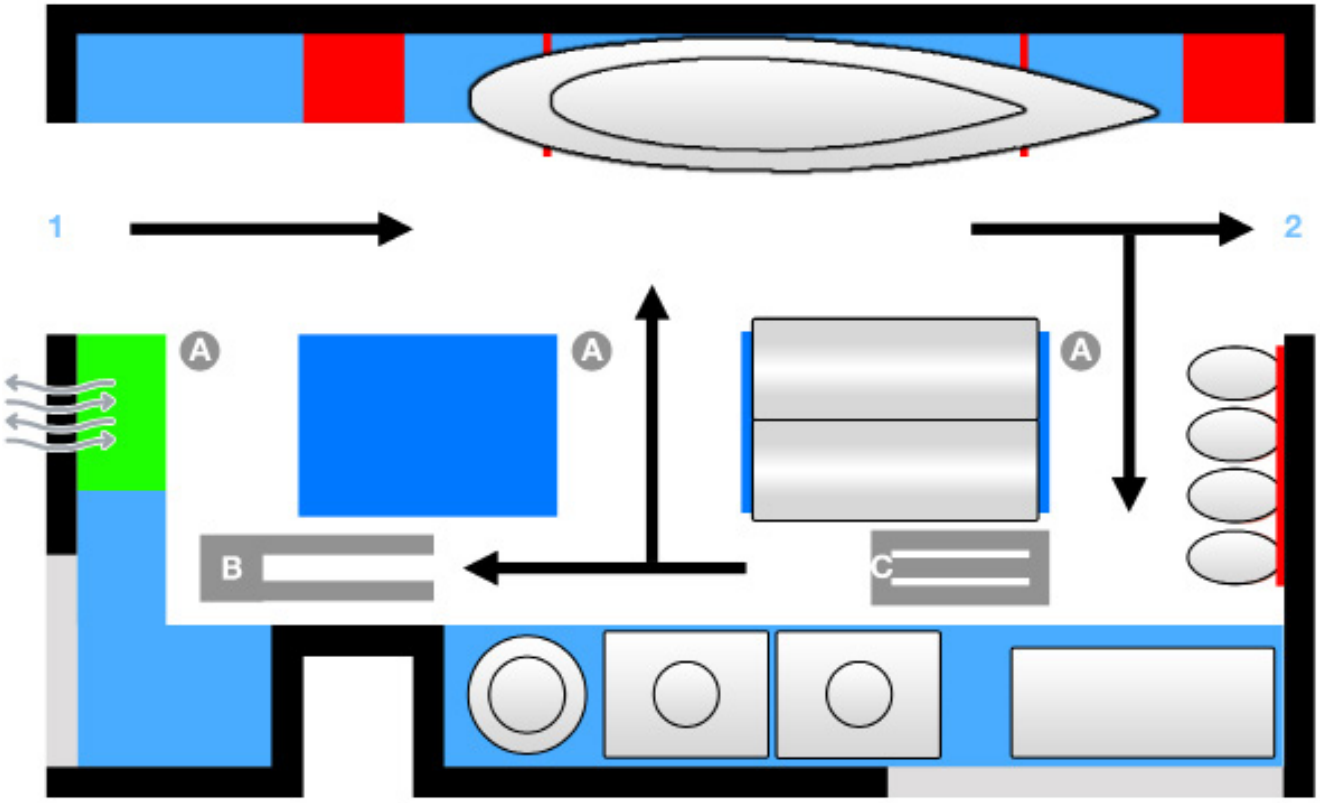
a na osnovu izrade novog rasporeda (layout), kreiran je optimalniji magacinski prostor (slika 4). Rezultati ovog istraživanja biće primenjeni u praksi, pri čemu će se omogućiti bolja organizacija magacinskog prostora sagledana kroz jednostavniji pristup i manipulaciju sredstvima (Waters, 2003), što će uticati na njihovo čuvanje, odnosno produženje radnog veka, a posledično i ekonomskoj isplativosti, odnosno ekološkom aspektu (Милетић, 2023).

Ovim postupkom će se dobiti više korisnog prostora, preslaganjem trenutnih resursa prema prvenstvu upotrebe, zahtevima, stepenu iskorišćenosti i sl. (Miletić i sar., 2025).



Slika 4. Nacrt organizovanog prostora ispunjenog regalima i policama u visini zidova.

Legenda ispod objašnjava tabelarno predstavljene delove. Strelice prikazuju smer kretanja unutar magacinskog koridora. Ostali elementi su namenski i svaki ima svoju svrhu (tabela 1).

Tabela 1. Grafičko razjašnjenje (legenda) uređenog magacinskog prostora

SIMBOL	OBJAŠNJENJE
	Zid
	Koridor
	Prozori
	Stalne strukture
	Police
	Regali
	Kavez sa zapaljivim sredstvima
	Sredstva i oprema
A	Protivpožarni aparati
B	Paletarka
C	Merdevine
1	Ulaz / izlaz
2	Ulaz u drugu prostoriju

Interesantno je da se popisom i adekvatnom organizacijom sredstava prema određenim svojstvima odnosno nameni (plovila, oprema za vodu, oprema za struju, rekviziti za rekreaciju, pogonski motori, spremište za gorivo…) u budućnosti može napraviti baza podataka zahvaljujući kojoj će se znati gde se tačno u magacinu nalazi određeni predmet ili sredstvo. Ovo je budući smer rešavanja problematike vezane za kompletnu logistiku predmeta kao sastavni deo njegovog izučavanja.

Glavna postignuća ovog istraživanja ogledaju se u njegovoj visokoj upotrebnoj vrednosti u praksi. Proces optimizacije magacinskog prostora FSFV uključio je dosta vezanih postupaka, a između ostalog i detaljan popis materijalno-tehničkih sredstava, u posedu predmeta, čime je praktično stavljena kontrola na svaki element pojedinačno. Zahvaljujući višemesečnom radu na poslovima optimizacije magacina, dalji postupci proizašli iz istraživanja su:

- **Digitalizacija kompletne opreme** (dostupnost i praćenje uz celokupnu specifikaciju na mrežnoj prezentaciji predmeta https://www.aktivnostiuprirodi.com/logorovanje/) pri čemu će se znati gde se nalazi svaki deo opreme u posedu predmeta, njegovo trenutno stanje, potreba za reparacijom ili nabavka nove;
- **Tehničko uređenje magacinskog prostora** (postavkom i organizacijom skladišnih elemenata) što će omogućiti ostvarenje glavnog cilja ovog rada, a to je ispred svega

dugovečnost opreme, njeno jednostavnije odlaganje i čuvanje ali i trenutno mesto u magacinu.

Zaključci

Pomoću metode *ABC analize* i *Paretovog pravila* uz postojeće prostorne resurse fakulteta, primenom elementarnih znanja logistike kao dela lanca snabdevanja, moguće je uspešno rešiti skladišne probleme adekvatnom reorganizacijom postojećeg magacinskog prostora i sredstava za realizaciju nastavnog logorovanja. Prema Steviću i saradnicima, svrha primene ove analize je uspostavljanje funkcionalnog sistema kontrole i upravljanja u okvirima nabavke, skladištenja, te na taj način mogućnost postizanja veće ekonomičnosti (Stević i sar., 2020), u ovom slučaju značajne uštede u poslovanju *Fakulteta sporta i fizičkog vaspitanja* iz *Beograda*. Jednostavnije rečeno, analizom koncepta ispravog skladištenja opreme u adekvatnom smeštaju omogućeno je produženje radnog veka opreme, a time i uticaj na smanjenje ukupnih troškova nastave, konsekventno tome i ekonomike Fakulteta kao institucije.

Zahvaljujući ovom postupku dolazi se do jednostavnijeg sortiranja opreme i nastavnih sredstava, njenog skladištenja, upravljanjem i transportu ("Sl. glasnik RS" бр. 13/2013). Praktično, ceolokupna optimizacija prostora za odlaganje materijalno-tehničkih sredstava sastavni je deo logorskog života i rada i uopšte boravka u terenskim uslovima.

Pored navedenog, veliku ulogu u ovom složenom procesu igra i obrazovna komponenta u koju ulazi segment pod nazivom Briga i održavanje materijalno-tehničke baze (Милетић i sar., 2023) u kojoj učestvuju studenti, kao delu obavezne nastave definisane planom i programom predmeta Aktivnosti u prirodi.

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UDK 796.012.11:572-053.6

The realtionship between handgrip strength and anthropometric characteristics of adolescents

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Introduction

Adolescence is a developmental period in life characterized by rapid changes in emotional, physical, cognitive and psychosocial aspects (Lassi et al., 2017). During this period of rapid growth, there is an increase in height and weight, often accompanied by an increase in muscle and fat mass, and these changes can significantly affect the body proportions of adolescents (Suwandi, Prastowo, Haryono and Gunawan, 2024). Biological and social factors such as family, media, school and environment play a key role in shaping adolescents. This period begins with the clear event of puberty, while its end is not precisely defined. Chronologically speaking, adolescence usually ends around the age of twenty, but the psychological tasks associated with this period often extend into early adulthood. The development of adolescence can be divided into four stages: preadolescence (11–13 years), early adolescence (13–15 years), middle adolescence (15–17 years) and late adolescence (17–19 years) (Abdullahi, Audu and Goon, 2020).

The hand is the most active part of the upper limb in humans. The role of the hands in daily life activities as well as in sports and physical activities, especially those that include catching, lifting and throwing, is extremely important (Abdullahi et al., 2020). The force produced by the muscles of the hand and forearm refers to the strength of the handgrip. It can be measured with a device for measuring hand and forearm muscle strength called a dynamometer. handgrip strength is a simple, practical and irreplaceable indicator of overall muscle strength (Lee, 2021). Measuring handgrip strength is a quick and affordable method for assessing muscle strength, and research has shown that it is closely related to overall muscle strength (Wind, Takken, Helders, & Engelbert, 2010). Because it is related to different aspects of physical fitness, handgrip strength can also provide insight into overall physical fitness (physical fitness, fitness), independent of age, gender, and level of sexual maturity (Matsudo, Matsudo, Rezende, & Raso, 2015). Therefore, handgrip strength is considered a significant indicator of health (Leong et al., 2015).

Several studies have shown that age, sex, body height and body mass affect the strength of the handgrip in children, especially in the initial phase of puberty (Hogrel et al., 2012). Also, previous studies have shown that factors such as body height and forearm circumference have a significant impact on handgrip strength in children before puberty (Jürimäe, Hurbo and Jürimäe, 2009). Body mass and body height are key indicators of human growth, especially in children. There is a significant association between the maximum handgrip strength of the dominant hand and general anthropometric variables in all age groups (Visnapuu and Jürimäe, 2007). Luna-Heredia, Martin-Pena, and Ruiz-Galiana (2005) found that handgrip strength in healthy individuals is positively related to body height, while Liao (2014) found a relationship between handgrip strength and body height and body mass.

The relationship between anthropometric characteristics such as height, mass, body mass index and handgrip strength in healthy young adults is still insufficiently investigated to fully understand their interdependence. Most studies at the national or international level have focused on the elderly or athletes (Koley and Singh, 2009). Therefore, the main goal of this research was to examine the relationship between body height, body mass and body mass index with handgrip strength in adolescents. An additional goal was to determine if there are differences in the strength of the left and right hand and to determine if there are differences by gender.

Method

The study involved 154 adolescents (88 girls and 66 boys) with an average age of 16.45 ± 1.03 years, an average height of 172.99 ± 9.58 cm, and an average weight of 65.71 ± 13.17 kg. All participants were high school students from the Osijek-Baranja County, Croatia. Testing was conducted over three weeks during regular physical education classes in March 2024. Before participating in the study, parents provided written consent for their children's involvement. The study was approved by the Ethics Committee of the Faculty of Kinesiology in Osijek (classification number 029-01/24-01/05 and reference number 2158-110-01-24-3) and conducted in accordance with the current Declaration of Helsinki.

Body height was measured using a validated anthropometer (Seca 217 Stadiometer Mobile Height Measurement Scale), while body mass was measured using a diagnostic scale (Omron BF-511, Kyoto, Japan) with an accuracy of 0.1 kg, with the subject standing barefoot in the center of the scale platform. Handgrip strength was measured using a handheld digital dynamometer (Saehan DHD-1).

Participants were first measured for body height, followed by body mass. Finally, handgrip strength was assessed. The measurement was conducted with participants sitting upright on a chair, holding the device so that the upper arm and forearm formed a 90° angle at the elbow joint, with the forearm and wrist in a neutral position. The device was to be squeezed without jerking or sudden movements. The measurement was repeated three times for the left hand and three times for the right hand, with the arithmetic mean of the three measurements serving as the final value for each hand individually. The body mass index of the participants was calculated using the formula BMI= kg/m^2. Malnutrition was defined as BMI less than 18.5, while the body mass index range from 18.5 to 24.99 was considered normal body weight. People with a BMI above 25 are considered overweight, and those with a BMI above 30 are classified as obese. In the case of a more detailed classification of obesity, a BMI above 40 indicates extreme obesity (Prevalence of overweight and obesity in the United States, 1999–2004).

For testing purposes, the Tibco Statistica Enterprise program (version 14.0.1.25) was used. Among the basic descriptive parameters, the following are shown: arithmetic mean (AS), minimum measurement value (MIN), maximum measurement value (MAX) and standard deviation (SD). The Shapiro-Wilk W test was used to assess the normality of the distribution, where it was determined that all variables were not normally distributed and were analyzed using non-parametric

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tests. The Wilcoxon test was used to determine differences between left and right handgrip strength, and the Mann-Whitney U test was used to determine gender differences in left and right handgrip strength. Spearman's correlation test was used to determine the relationship between body height, body mass, body mass index and handgrip strength. Specifically, the level of association is described as negligible when the correlation coefficient is less than 0.29, low when it ranges from 0.30 to 0.50, moderate when it is between 0.50 and 0.70, high when it is between 0.70 and 0.90 and very high when it is between 0.90 and 1.00 (Mukaka, 2012). Statistical significance in all tests was set at $p < 0.05$.

Results

Table 1. presents the basic descriptive parameters for the entire sample. Table 2. shows the basic descriptive parameters for the girls, while table 3. presents the same parameters for the boys.

Table 1. Basic descriptive parameters for the total sample

Variables	N	MEAN	MIN	MAX	SD
AGE	154	16,45	14,00	19,00	1,036
BH	154	172,99	154,00	194,00	9,58
BM	154	65,71	40,40	125,90	13,17
BMI	154	21,90	16,70	36,00	3,43
HGS-L	154	29,34	5,40	98,23	10,81
HGS-R	154	31,33	8,57	103,30	11,36

Legend: MEAN- average, SD- standard deviation, MIN- smallest measurement result, MAX- largest measurement result, BH- body height, BM- body mass, BMI- body mass index, HGS-L- handgrip strength of the left hand, HGS-R- handgrip strength of the right hand

Table 2. Basic descriptive parameters for girls

Variables	N	MEAN	MIN	MAX	SD
AGE	88	16,49	14,00	19,00	1,07
BH	88	167,14	154,00	188,50	6,36
BM	88	60,53	40,40	103,10	11,12
BMI	88	21,68	16,70	32,70	3,59
HGS-L	88	23,41	5,40	57,47	6,23
HGS-R	88	25,22	8,56	69,33	6,96

Legend: MEAN- average, SD- standard deviation, MIN- smallest measurement result, MAX- largest measurement result, BH- body height, BM- body mass, BMI- body mass index, HGS-L- handgrip strength of the left hand, HGS-R- handgrip strength of the right hand

Table 3. Basic descriptive parameters for boys

Variables	N	MEAN	MIN	MAX	SD
AGE	66	16,41	14,00	18,00	0,99
BH	66	180,78	164,00	194,00	7,36
BM	66	72,61	49,80	125,90	12,58
BMI	66	22,20	17,00	36,00	3,19
HGS-L	66	37,25	16,30	98,23	10,58
HGS-R	66	39,48	16,97	103,30	11,00

Legend: MEAN- average, SD- standard deviation, MIN- smallest measurement result, MAX- largest measurement result, BH- body height, BM- body mass, BMI- body mass index, HGS-L- handgrip strength of the left hand, HGS-R- handgrip strength of the right hand

Table 4. shows the results of the Wilcoxon test for comparing the differences between the grip strength of the left and right hands for the total sample. Table 5. shows the results in left and right handgrip strength in girls, and table 6. shows the results in left and right handgrip strength in boys.

Table 4. Results of the Wilcoxon Test for handgrip strength between the left and right hands for the total sample

Variables	N	T	Z	p-value
HGS-L & HGS-R	153	2072,00	6,96	0,001

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Legend: T - t test value; Z - z value of the test; p - statistical significance p<0.05, HGS-L- handgrip strength of the left hand, HGS-R- handgrip strength of the right hand

Table 5. Results of the Wilcoxon test for handgrip strength between the left and right hands in girls

Variables	N	T	Z	p-value
HGS-L & HGS-R	87	505,00	5,96	0,001

Legend: T - t test value; Z - z value of the test; p - statistical significance p<0.05, HGS-L- handgrip strength of the left hand, HGS-R- handgrip strength of the right hand

Table 6. Results of the Wilcoxon test between left and right hand in handgrip strength in boys

Variables	N	T	Z	p-value
HGS-L & HGS-R	66	483,50	3,97	0,001

Legend: T - t test value; Z - z value of the test; p - statistical significance p<0.05, HGS-L- handgrip strength of the left hand, HGS-R- handgrip strength of the right hand

The results of the Wilcoxon test show the existence of a statistically significant difference in the strength of the handgrip between the left and right hands in the entire sample, but especially in girls and boys. Table 7. shows the results of the Mann-Whitney U test between boys and girls in the strength of the left and right hands.

Table 7. Results of the Mann-Whitney U test between boys and girls

Variables	RANK BOYS	RANK GIRL	U	Z	p-value
HGS-L	7584,50	4350,50	434,50	9,01	0,001
HGS-R	7577,50	4357,50	441,50	8,99	0,001

Legend: HGS-L- handgrip strength of the left hand, HGS-R- handgrip strength of the right hand

The results of the Mann Whitney-U test show the existence of a statistically significant difference in handgrip strength between left and right hands by gender.

Spearman's correlation test, which examines the relationship between body height, body mass, body mass index and left and right handgrip strength, is shown in tables 8., 9. and 10.

Table 8. Correlation between body height, body mass, body mass index and left and right handgrip strength for the total sample

Variables	N	r	p
BH & HGS-L	154	0,59	0,001
BM & HGS-L	154	0,54	0,001
BMI & HGS-L	154	0,27	0,001
BH& HGS-R	154	0,64	0,001
MM & HGS-R	154	0,55	0,001
BMI & HGS-R	154	0,26	0,001

Legend: r- Spearman's correlation coefficient, BH- height, BM- body mass, BMI- body mass index, HGS-L- handgrip strength of the left hand, HGS-R- handgrip strength of the right hand

Table 8. shows the existence of a statistically significant relationship between the variables body height, body mass, body mass index and the variable handgrip strength of the left and right hand in the entire sample.

Table 9. Correlation between body height, body mass, body mass index and left and right handgrip strength in girls

Variables	N	r	p
BH & HGS-L	88	0,11	0,31
BM & HGS-L	88	0,14	0,19
BMI & HGS-L	88	0,15	0,28
BH & HGS-R	88	0,19	0,07
BM & HGS-R	88	0,15	0,16
BMI & HGS-R	88	0,11	0,29

Legend: r- Spearman's correlation coefficient, BH- height, BM- body mass, BMI- body mass index, HGS-L- handgrip strength of the left hand, HGS-R- handgrip strength of the right hand

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In girls, no statistically significant association was observed in any variable.

Table 10. Correlation between body height, body mass, body mass index and left and right handgrip strength in boys

Variables	N	r	p
BH & HGS-L	66	0,23	0,06
BM & HGS-L	66	0,52	0,001
BMI & HGS-L	66	0,50	0,001
BH & HGS-R	66	0,39	0,001
BM & HGS-R	66	0,57	0,001
BMI & HGS-R	66	0,45	0,001

Legend: r- Spearman's correlation coefficient, BH- height, BM- body mass, BMI- body mass index, HGS-L- handgrip strength of the left hand, HGS-R- handgrip strength of the right hand

Table 10. shows a statistically significant association between the variables body mass, body mass index and the variable grip strength of the left and right hand, as well as between the variable body height and the variable grip strength of the right hand in boys.

Discussion

This research was focused on investigating the relationship between body height, body mass, body mass index and handgrip strength in adolescents, as well as determining differences in left and right hand strength and gender differences in the aforementioned variables. Based on this, the following findings were obtained in this study.

First, the relationship between the variables of body height and left handgrip strength, body mass and left handgrip strength, and body mass index and left handgrip strength was determined. A similar connection was observed for the right hand, where handgrip strength is related to body height, body mass and body mass index. These results confirm the existence of significant correlations between anthropometric characteristics and handgrip strength in the entire sample, which is in line with previous research (Bim, Pinto, Scarabelot, Claumann and Pelegrin, 2021; Steiber, 2016). However, in girls, no significant correlation was observed between handgrip strength and anthropometric characteristics, while in boys, a correlation was observed in almost all variables. A possible reason is that young men usually have greater muscle mass and stronger bones, which may contribute to greater handgrip strength (Bim et al., 2021). Girls, on the other hand, may have different patterns of muscle development and body composition that do not affect strength in the same way. In addition, boys are more likely to engage in physical activities that involve a stronger grip and develop arm muscles, while girls are less likely to participate in these types of activities. Furthermore, differences in height, weight, arm length, and other anthropometric variables can affect how strength is developed and expressed (Steiber, 2016; Harris, 1997). It may be that the girls in this study had less variation in these characteristics, reducing the possibility of seeing an association.

Second, the results show that there are differences in handgrip strength between left and right hands in the total sample and separately for girls and boys, which is in line with existing research (Chattopadhyay, Ray, Chanda, & Chakraborti, 2024). Possible explanations for this finding are as follows: during growth and development, certain parts of the body can develop at different speeds, which can affect the overall strength and functionality of the hands. Then, if individuals engage in activities that use more of the dominant hand and side of the body, it will develop better and stronger than the non-dominant hand and side of the body. The different physical activity and sports habits of girls and boys can also affect strength development. In addition, there are anatomical variations between left and right hands, such as differences in bone size or muscles, which can also result in different strength.

Finally, a difference in handgrip strength between the gender for both hands was determined in favor of boys, which is expected and in line with previous research (Abdullahi et al., 2020). During adolescence, there is a more pronounced growth and development of strength in young men, which can further influence the differences in handgrip strength between the gender and further increase them. Also, during this period, young men usually have a lower percentage of body fat and a higher percentage of muscle mass compared to girls. Greater muscle mass contributes to stronger strength and endurance, especially in the hand area. Additionally, social norms and expectations can influence the type of physical activities that adolescents engage in. Thus, young men are often encouraged to engage in physical activities that directly affect the development of strength and power.

Conclusion

In this study, the analysis of the relationship between body height, body mass, body mass index and handgrip strength in adolescents revealed significant correlations, especially in boys, while no such relationships were observed in girls. The results indicate that anthropometric characteristics, such as height, mass and body composition, are key factors influencing handgrip strength, and gender differences suggest that young men, due to greater muscle mass and more active participation in physical activities, achieve better results. Also, differences in strength between the left and right hand were observed in the subjects, which may be the result of the development and functioning of the dominant hand, as well as differences in sports habits. Representation of male competitive norms and physical activities that focus on strength development additionally contribute to greater grip strength in young men. These findings suggest the importance of considering gender differences when assessing physical fitness and strength in adolescents.

Although the results of this research are useful for understanding the relationship between anthropometric characteristics and measures of physical fitness as important determinants of health, further research should focus on a

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more detailed understanding of gender differences and their causes. Further study of the influence of specific physical activities as well as social factors on the development of hand strength is recommended, with the aim of developing more effective physical activity programs that aim to improve the physical fitness of all adolescents, regardless of gender. These findings have important implications for understanding adolescent physical development and can serve as a basis for future research dealing with the development of adolescent physical fitness.

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UDK 796.929.035

Health status and health literacy in adults practicing Nordic walking

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Introduction

Health status is mainly determined by healthy habits such as regular physical activity. However, more and more people of all ages are not reaching the recommended levels of physical activity, on a global scale (Guthold, Stevens, Riley, & Bull, 2018). Therefore, it is crucial to determine the factors which can be modified in order to increase physical activity levels. Health literacy (HL) may influence the prevention of many chronic diseases and be a modifiable driver of health behavior. Physical activity and HL are strongly correlated. Namely, higher HL increases a person's likelihood of understanding the advantages of engaging in regular physical activity, having access to trustworthy health information, and making well-informed exercise regimen options (Miljanovic Damjanovic et al., 2024). On the other hand, a lack of HL can make it more difficult for people to understand health-related information, which can result in misunderstandings about exercise, a decline in motivation, and eventually reduced levels of physical activity. Therefore, it is crucial to determine the levels of HL in relation to physical activity and health parameters.

Nordic walking (NW) is a physical activity gaining more and more interest among adults. It has been demonstrated that NW significantly improves people' health status. Research has shown that NW enhances cardio-metabolic indices, such as lipid profiles, systolic blood pressure, and fasting glucose reductions (Hagner-Derengowska et al., 2015). In addition, NW improves quality of life and physical fitness in older persons with type 2 diabetes (Della Guardia et al., 2023). Also, NW improves bone mineral density in elderly, which lowers the risk of fractures in an older age (Rodrigues et al., 2021). Also, one research has shown that NW exhibits more notable changes in cholesterol and glucose levels when compared to other exercise regimens like Pilates (Hagner-Derengowska et al., 2015). A comprehensive analysis of randomized controlled trials verifies the positive effects of NW and shows that NW can be suggested to a wide range of people as primary and secondary prevention since it has positive benefits on resting heart rate, blood pressure, exercise capacity, maximal oxygen consumption, and quality of life in patients with various conditions (Tschentscher, Niederseer, & Niebauer, 2013).

The aim of this study was to determine the health status (lipid profile, glucose parameters, and hemoglobin) and health literacy in adults practicing Nordic walking. Also, the aim was to determine whether there is a correlation between health literacy and health parameters in this population.

Methods

Participants

This study included 43 female adults aged 42-87 years who were regularly practicing Nordic walking as an organized recreational activity. The inclusion criteria were that participants were involved in Nordic walking for at least 6 months and were regular at their training sessions.

Variables and measurement

This study included health parameters and health literacy levels, collected at one point.

The health parameters included lipid profile and hemoglobin parameters. We employed point-of-care testing (POCT) to assess the lipid profile in this investigation. Total cholesterol (TCHOL), triglycerides (TG), high-density lipoprotein (HDL-C), non-high-density lipoprotein-cholesterol (non-HDL-C), low-density lipoproteins (LDL-C), and the CHOL/HDL ratio made up the participant's lipid profiles. The Mission Cholesterol Test Devices (ACON Laboratories, Inc., San Diego, CA, USA) was used in this study. The levels of hematocrit and hemoglobin were among the blood parameters. They were assessed prior to the test while the subjects were at rest, using the StatStrip Connectivity hemoglobin analyzer (Nova Biomedical, Waltham, MA). Whereas hematocrit levels display the ratio of blood volume to cells, hemoglobin levels display the total amount of hemoglobin in the blood. Also, the fasting blood glucose was measured as part of health parameters.

The European Health Literacy Survey Questionnaire 47 (HLS-EU-Q47), which has been shown to be valid among Croatian adolescents, was translated into Croatian and used to measure the HL level (Kesic, Savicevic, Peric, Gilic, & Zenic, 2022). The 47 questions on the questionnaire focused on a person's capacity to get, process, and comprehend fundamental health information and related services, enabling them to obtain, comprehend, evaluate, and act upon it or them, or to make appropriate health decisions. A 4-point Likert scale was used to create an overall indicator of HL, with responses ranging from very difficult (1) to very easy (4). The formula used to determine the score was index = (mean – 1) × (50/3). A scale of 0 to 50 was used for scoring, with 0 being the lowest score and 50 representing the greatest. The scoring index was separated into four sections of HL: inadequate (from 0 to 25); problematic (26–33); sufficient (34–42); excellent (43–50).

All measurements were conducted in biochemical laboratories to ensure a safe and clean environment. The blood tests were conducted by an experienced medical doctor, while participants filled out the health literacy survey via SurveyMonkey platform and using their mobile phones or predetermined tablets.

Statistical analysis

All variables were checked for normality using the Kolmogorov Smirnov test. Afterwards, descriptive statistics including means, standard deviation, minimum and maximum values were calculated for all included variables. The correlation between health parameters and health literacy were calculated using Pearsons Correlation coefficients. The level of significance was set at $p<0.05$, and the statistical package Statistica v15 was used for all analysis.

Results

According to the results of Table 1, the cholesterol value of participants is higher than desirable value. Also, low-density lipoprotein and non-high-density lipoprotein are higher than the recommended levels. Glucose and hemoglobin parameters are falling in desirable value. Related to health literacy score, majority of participants had problematic levels.

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Table 1. Descriptive statistics of health parameters and health literacy

Variable	Mean	SD	Minimum	Maximum	Desirable value
Age (years)	63.00	11.72	42.00	87.00	n/a
Glucose mmol/L	4.93	0.88	2.70	7.40	3.9-6.7
Hemoglobin g/dL	16.65	17.57	11.90	129.00	F:12-16 M:14-17
Hematocrit	41.86	3.11	35.70	47.70	F:36-47% M:41-51%
Cholesterol (mmol/L)	6.41↑	1.54	2.62	9.87	3.88-5.15
HDL (mmol/L)	1.71	0.42	0.88	2.59	≥ 1.04
TRIGL (mmol/L)	1.64	0.66	0.64	3.62	< 2.82
LDL mmol/L	3.92↑	1.41	0.88	7.11	≤3.36
CHOl/HDL ratio	3.98	1.22	2.10	6.30	Below 5.1
nonHDL mmol/L	4.71↑	1.48	1.40	8.16	<3.37
Health literacy (score)	32.58	6.67	18.06	49.65	Problematic limited

Legend: TCHOL—total cholesterol, TG—triglycerides, HDL-C—high-density lipoprotein, non-HDL-C—nonhigh-density lipoprotein-cholesterol, LDL-C—low-density lipoproteins, ↑ - increased values

According to the results in Table 2, there are no significant correlations between health parameters and health literacy.

Table 2. Correlation coefficients between health parameters and health literacy

Variable	Health literacy
Glucose	0.01
Hemoglobin	0.15
Hematocrit	0.15
Cholesterol	-0.19
HDL	-0.18
TRIGL	-0.04
LDL	-0.11
CHOl/HDL	0.03
nonHDL	-0.12

Legend: TCHOL—total cholesterol, TG—triglycerides, HDL-C—high-density lipoprotein, non-HDL-C—nonhigh-density lipoprotein-cholesterol, LDL-C—low-density lipoproteins.

Discussion

There are several most important results of this research: Participants included in the Nordic walking program had lipid profile values higher than the desirable levels and had problematic health literacy levels. Secondly, there were no associations between health literacy and health parameters.

The first finding can be explained as follows. The majority (68%) of the included participants had chronic diseases including hypertension, diabetes mellitus and thyroid conditions, which could have influenced the results. Namely, we consider NW as a highly influential activity when it comes to health status, but chronic illnesses might have higher impact on adverse health status than the activity itself can have (Della Guardia et al., 2023). The results of the study indicate that while NW has been demonstrated to offer a number of health benefits, including better cardiovascular health, it might not be enough to dramatically lower lipid profiles, especially in people whose levels are already elevated. It's likely that lipid profiles are also significantly influenced by other lifestyle factors, such as food and level of exercise. This shows that despite engaging in a physical activity that promotes health, individuals were not able to effectively acquire, comprehend, and use health information to make decisions. The co-existence of increased cholesterol levels and low health literacy may present considerable obstacles to enhancing or preserving general health.

One of the results that should be paid special attention is that participants displayed problematic HL levels. The consequences of low HL on health outcomes can be profound. Low HL can make it difficult for people to comprehend medical information, make wise healthcare decisions, and follow treatment regimens (Kesic et al., 2022). Given the circumstances of this study, it is possible that the participants' limited HL prevented them from getting the most out of the Nordic walking program and from participating to the fullest extent possible.

Given the potential influence of health literacy on health behaviours and outcomes, it is rather unexpected that there was no direct correlation found in this study between health literacy and health indicators. Indeed, previous studies showed that individuals with higher HL have better lipid profiles (Cheng et al., 2018). However, HL may not have had as much of an impact on the participants' health outcomes as other variables, such as socioeconomic status, access to healthcare, and genetic predisposition. This study suggests that there may be variables at work that go beyond a person's capacity to comprehend and assimilate health information. These could be environmental factors, socioeconomic level, healthcare access, genetic predispositions, or behavioural patterns like exercise and nutrition. For example, even a very health-literate someone may experience high cholesterol because of inherited diseases or unhealthful habits that continue even after being made aware of their negative consequences. Conversely, in ways that health literacy alone cannot, social support, access to treatment, or the availability of money may impact health outcomes. This implies that increasing health literacy is not a stand-alone solution; rather, it may need to be a component of a larger, multifaceted strategy to improve health outcomes.

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Therefore, all of the previously mentioned factors should be considered in future studies. Noteworthy, it was shown that there was no correlation between HL and lipid profile in people undergoing dialysis, which is in line with the results of our study (Adeseun, Bonney, & Rosas, 2012).

Conclusion

This study concluded that those who participated in the NW program had problematic HL ratings and lipid profile values that were higher than recommended. Even though NW has been shown to have health benefits, including improvements in cardiovascular health, the elevated levels of cholesterol and lipids raise the possibility that other factors, such as dietary habits, lifestyle choices, or chronic conditions, may have had a greater influence than the exercise itself. Furthermore, the participants' HL was subpar, suggesting that there may be obstacles preventing them from understanding and acting upon health-related information, which could further impede their ability to improve their general health.

The study also disproves the conventional wisdom that higher HL is directly correlated with better health outcomes by finding no significant link between HL and health indicators. This surprising discovery raises the possibility that other factors, besides HL, may also be influencing this population's health results. Their financial situation, access to healthcare, and genetic predispositions are presumably important factors that influence these people's health. These results show that in order to effectively improve health outcomes, health interventions must use a multimodal strategy that addresses HL as well as other important characteristics.

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UDK 796.322:612.766

Analysis of rolling landings after shooting in handball

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Introduction

Handball is a fast-paced team sport that demands both high physical and mental performance, intertwining intense athletic activity with complex tactical strategies (Bragazzi et al., 2020; Ilić, 2016; Manchado et al., 2013; Wallace & Cardinale, 1997; Ziv & Lidor, 2009). The sport's high-impact movements, rapid transitions, and continuous interplay between offense and defense impose significant biomechanical stresses on players (Ilić et al., 2020, Karcher & Buchheit, 2014; Póvoas et al., 2014; Wagner et al., 2014). Handball players frequently face the risk of injury during both competitive matches and training sessions, as the pursuit of success often pushes the limits of their physical capabilities (Andersson et al., 2017; Langevoort et al., 2007; Olsen et al., 2006).

A critical component in mitigating these injury risks is the mastery of effective landing techniques (Myklebust et al., 2018; Petersen et al., 2002, 2005). In handball, landing is not merely a passive recovery phase following a collision or player's action, such as a jump or shot (Wagner et al., 2010), but an essential technical-tactical skill (Lehnert et al., 2023). By properly controlling, reducing, and redirecting the forces generated by the body's inertia, players can significantly diminish the impact of ground reaction forces (Cadens et al., 2023). This controlled dissipation of kinetic energy is especially important after shooting actions, where an improper landing can lead to severe musculoskeletal injuries (Barendrecht et al., 2011).

Of particular interest in this study are rolling landing techniques executed immediately following shots. These techniques incorporate a controlled rotational movement that disperses kinetic energy over a broader surface area, thereby attenuating the stress transmitted to the joints and soft tissues. Grounded in fundamental biomechanical principles, such as the management of inertia and the modulation of ground reaction forces, post-shot rolling landings offer a sophisticated method for reducing impact while ensuring a smooth transition from aerial to grounded motion (Benjaminse et al., 2017).

This research aims to analyse rolling landing techniques following shots in handball, exploring their benefits and associated risks. By integrating detailed motion analysis with tactical considerations, the study seeks to elucidate how these refined landing strategies can be systematically incorporated into training regimens to enhance performance and safeguard athlete well-being.

Methods

This theoretical study employs bibliographic and causal methodologies, complemented by inductive and deductive reasoning methods. These methods facilitate a structured exploration of landing techniques, integrating insights from the authors' extensive experience in physical education, handball, gymnastics, and martial arts.

Results

General analysis of the principles of landings

To comprehensively examine landing in handball, it is essential to situate the concept within a broader biomechanical and tactical framework. In its fundamental sense, a landing is a deliberate action undertaken by a player to attenuate the force exerted by the ground upon impact. This controlled reduction in force is pivotal in mitigating the risk of injury, as inadequate landing strategies may lead to the transmission of excessive ground reaction forces to the body.

A cornerstone of landing mechanics is encapsulated in Newton's Third Law of Motion, which asserts that every action is met with an equal and opposite reaction (Newton, 1846). In the context of handball, when a player makes contact with the ground, the force imparted by the body is counterbalanced by an equivalent force from the surface (Podraza & White, 2010). Without the proper application of landing techniques, this reactive force, also known as ground reaction force, can result in significant musculoskeletal stress.

The reduction of impact forces during a landing is achieved through the concurrent application of three fundamental principles: deceleration, increasing the contact surface with the ground, and redirection of the force vector.

It is important to recognize that these methods are not mutually exclusive. They are used together to varying extents depending on the specific situation. When a landing is executed without employing any of these principles the result is an uncontrolled descent, i.e. fall, during which the body is subjected to an almost vertical impact. Such falls convey a substantial proportion of the accumulated kinetic energy to the player, amplifying the risk of injury.

Deceleration refers to the process by which the velocity of a moving body is gradually reduced through the application of muscular force. In sports, and handball in particular, successful deceleration necessitates a controlled reduction in speed to allow for the smooth dissipation of kinetic energy, thus reducing ground reaction force (McBurnie et al., 2022). This principle is most commonly observed in two scenarios: 1. When an athlete's movement is decelerated by contact with a static or moving object, such as another player, the ground, or a fixed structure like a goal; 2. When an athlete deliberately reduces the speed of an object in motion, as in the act of catching a ball.

Within the context of landing, deceleration largely relies on the athlete's muscular strength to counteract the body's inertia (Harper et al., 2021). While the technique is relatively straightforward and requires minimal specialized training, its efficacy is intrinsically linked to the strength of the muscles, the mass of the athlete, and the available distance over which deceleration can occur (Iacono et al., 2016). A limited deceleration distance necessitates a more abrupt reduction in speed, thereby increasing muscular demands and, potentially, the risk of injury (Shin et al., 2007; Tamura et al., 2017).

Increasing the contact surface with the ground during landing is a strategic method to reduce the pressure exerted on the athlete's body. The theoretical basis for this approach lies in the definition of pressure (P), which is the force (F) applied per unit area (S). By increasing the area over which the impact force is distributed, the pressure imposed on any specific

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part of the body is correspondingly diminished. A practical illustration of this principle in sport is observed in the world record jump into a shallow pool of water, where an expanded contact area significantly mitigates the impact force (ESPN, 2019). Therefore, increasing the contact surface is an integral component in the design of effective landing techniques by reducing primarily vertical component of ground reaction force.

Force vector redirection entails altering the angle at which the body contacts the ground to reduce the resulting ground reaction force. In a hypothetical scenario where a player lands perpendicularly, the entire force is concentrated vertically, resulting in maximal stress on the body. However, by actively modifying the angle of incidence during landing, the resultant force is spread over a less direct trajectory. This strategic reorientation not only diminishes the magnitude of the ground reaction force but also aligns with Newton's Third Law by reducing the corresponding ground reaction force exerted on the player. In effect, the redirection of the force vector facilitates a smoother and less injurious transition from airborne to grounded motion.

Landing with rotation around the body's longitudinal axis

Landing with rotation around the body's longitudinal axis of the body is widely used in the handball game. It represents a complex element of landing, the application of which makes it possible to significantly cancel the forces acting on the handball player's body during contact with the ground (Figure 1). It's used in situations when a large lateral force acts on the player during the shot, which gives him lateral movement and rotation, during which he is forced to land with rotation around the longitudinal axis of the body. It should be noted that, in addition to the above situation, the rotation of the handball player's body can be caused by the swinging action of the shooting arm during the shooting phase, and this technique can be applied in that case as well. Landings with rotation around the longitudinal axis of the body are most common from the position of the pivotman, where they are often applied after a simultaneous double leg jump, as well from a winger position when performing an eret shot, where the jump is often performed with a single leg.

Figure 1. Landing with rotation around the body's longitudinal axis

During the forward flight phase, a lateral force acts upon the player's body during the shot which results in the loss of balance. After the shot, the body is lowered towards the ground, with simultaneous directing and contact with the ground with both hands or with the hand that was not used to make the shot first, usually the subdominant one. By activating the muscles of this arm and bending the elbow joint, a partial slowing of movement occurs. Almost simultaneously with this action, the phase of rotation around the longitudinal axis of the body occurs with the swing of the free hand with which the shot was previously performed. Depending on whether and with what intensity the rotation was induced by the action of an external lateral force, e.g. if someone pushed the player, the swing of the free hand in the context of additionally inducing body rotation on landing will be of lower or higher speed. After this, the rotation of the body is carried out over the back, with the arms in a triangle position closer to the body, similar to a landing by "stopping", which increases cushioning. It is crucial that the initial ground contact occurs via the shoulder blades rather than the lateral aspect of the shoulder, and that at that moment the athlete has already started rotation. The rotation ends by arriving in the same position as when landing by "stopping". During and after the rotation, the hips must not drop. The feet are slightly wider than the hips. In order to avoid hitting the knees on the ground and avoid injuries, the knee joint and ankle joints during and after the rotation must be locked by the contraction of the musculature of the upper and lower leg. Finally, it is important to note that during rotation the neck muscles are active, and the head is in extension of the spinal column, which prevents it from hitting the ground.

As already mentioned, the technique of landing with rotation around the longitudinal axis of the body allows a high degree of reduction of the force exerted by the ground on it. The reason for this is the large representation of the principle of force vector redirection, as well as the significant representation of the principle of increasing the contact area and cushioning.

The positive aspects of the landing with rotation around the longitudinal axis of the body are reflected first of all in that its application greatly reduces the forces acting on the body in the moment of contact with the ground. Also, since it involves lateral movement after the initial contact with the ground, it is suitable for avoiding contact with the goalkeeper after the shot is taken.

The negative aspects can first of all be reflected in its incorrect execution, where it is especially important to emphasize the moment of body contact with the ground. If the contact is made with the lateral side of the shoulder, serious injury may occur, since all the force will act on this region. There may also be an injury to the joint of the hand that initially makes contact with the ground if, in addition to the cushioning action, a simultaneous redirection of the vector of movement towards the hand with which the shot was executed is not applied. The mentioned errors can lead to upper limb injuries such as contusions, distortions, and fractures. Finally, the notes on potential injuries to the leg and neck regions that are given in case of poor execution of the landing by the "stopping" technique are also reflected here. If during rotation the knees are not extended and the feet locked at an angle of 90° by contraction of the muscles of the lower legs, partial or complete strain of the anterior cruciate ligament of the knee may occur, followed by meniscus injuries, contusions and concussions of the knees, as well as contusions of the ankle joint. Inadequate activation of the neck muscles and a position of the head that is not in the continuation of the spinal column can lead to the head hitting the ground during rotation.

Landing with a back roll over one shoulder

We can see the widespread application of the landing with a back roll over one shoulder in modern handball games both in the attack and in the defence phase. The application of this type of landing in attack is typical after shots from winger positions. Figure 2 demonstrates a landing with a back roll over one shoulder from the left winger position.

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Figure 2. Landing with a back roll over one shoulder

In the example of a shot by a right-handed player from the position of the left wing, after the execution of the shot and the action of the force that results in the loss of body balance, the player lands on his left leg, where due to the force of inertia and rotational force produced by the swing of the shooting arm, his body is in a position with his back facing the goal, after which the body descends to the ground. From the semi-squatting through the squatting position, the body redirects the direction of movement backwards by activating the muscles of the legs and back, which initiates the rotation phase. Initial contact is made by landing on the gluteal region and, if possible, also using the hands, after which a back roll is initiated by swinging the legs over the left shoulder. At the moment of the beginning of the rotation, the most important thing is to move the head laterally towards the right shoulder. During the roll, the head is stuck to the right shoulder, and the right ear touches the right shoulder. Both or one hand can make contact with the ground, the action of which provides an additional redirection of the initial body direction movement, thus facilitating rotation. It should be noted that this technique can also be performed without using the hands, but in that case, its execution is more difficult. During the rotation, the legs are bent at the knee joint. After swinging the legs over the left shoulder during the final rotation, contact with the ground is made with the toes, with the legs extended at the knee joint. It is with this contact that the final phase of landing begins. After the contact of the toes with the ground, the player activates the muscles of the legs to cushion the movement, and by pushing the hands off the ground, they reach a crouching position.

The body regions involved in this grounding are: cervicalis, acromialis, scapularis, vertebralis, lumbalis, glutei.

Like other landing techniques that rely predominantly on rotations, the technique of landing with a back roll over one shoulder allows the force exerted by the ground on the body to be greatly reduced. The reason for this is the large representation of the force vector redirection principle, as well as the significant participation of the principle of increasing the area and cushioning.

The special significance of this technique is reflected in the fact that it can be performed with ease in situations where the player is moving forward at a high horizontal speed during the flight phase of the shot. Also, it is of great importance that the technique can be applied equally successfully using both or one hand, as well as without using the hands.

Injuries that can occur when performing this technique are in the regions of the neck, coccyx, wrist joint, and knee joint. Of these, the most dangerous are injuries to the neck and head region, which can occur if, during rotation, the head and neck are not laterally close to the shoulder of the hand used to perform the shot. In this case, there may be contusions of the cervical part of the spinal column, distortion of the muscles of this region, as well as contusions of the skull. A contusion or fracture of the coccyx and wrist joint occurs if in the moment of contact with the ground, instead of redirecting the direction of the body's movement, cushioning is attempted. Cushioning is impossible considering the fact that the speed with which the body is moving at that moment is too great, and the distance in which it is necessary to perform the action of the opposite force is too small. As far as knee injuries are concerned, they occur in the case of their bending at the moment when the toes come into contact with the ground at the end of the rotation phase. In this case, the front part of the knee region hits the ground, which can cause a partial or complete strain of the anterior cruciate ligament or a fracture of the patella.

Side roll landing

The side roll landing is an element of movement that is rarely encountered in physical education. Its application is characteristic in martial arts originating from Asia, primarily China and Japan. In handball, it can be successfully used after shots from the winger position.

Figure 3. Side roll landing

Side roll landing share many common characteristics with the landing with a back roll over one shoulder. In this regard, the analysis of the technique of side roll landing will also be performed on the example of a right-handed shooter from the position of a left winger (Figure 3). The handball player, after the jump with the left leg and the flight phase during which he executes the shot, initially makes contact with the ground with his left and then with his right foot. It is important to note that the foot in contact with the ground is placed in the same direction as the movement of the player. After foot contact, partial cushioning is performed by the muscles of the right leg, during which flexion occurs in the knee joint. Critical to the successful execution of the technique is that the front of the knee, as well as the front foot, are facing in the same direction as the player's movement through the air. After that, the player makes contact with the ground with both hands or with one hand, and it is important to note that the technique can be performed without using the hands. If the hands are used, they participate in the cushioning. It is of great importance that in the case when using the shooter's arm during cushioning, the elbow must not cross the imaginary line in front of the knee. The direction of the hands when placing them is also important. The hand of the shooting arm is placed with the fingers facing backwards, while the opposite hand is placed with the fingers facing forward in relation to the direction of the movement of the player. This is followed by the descent of the body towards the ground. When lowering the trunk and initial contact with the ground, it

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is important that, as with the technique of landing with rotation around the longitudinal axis of the body, the initial contact is not made with the outer part of the right shoulder, but with the shoulder blade. Also in this case the contact of the right scapula with the ground must occur during the trunk rotation that has already started in the air. The position of the head and neck is shifted laterally towards the left shoulder, in order to provide more space for the execution of the technique and to prevent injuries. After this, the rotation of the body is done through the shoulder region, without contact of the lower back with the ground. If it is necessary to speed up the rotation, the left leg can also perform an additional swing movement to the left. Otherwise, it moves closer to the body, through flexions of the hip and knee, to facilitate rotation and reduce the possibility of injury. At the end of the roll, it's important to note that the foot of the left leg is locked at an angle of 90° by the contraction of the lower leg muscles so that the lateral part of the foot at the moment of contact with the ground can also participate in the redirection of the movement force, this time in the upward-forward direction. At this stage, care should be taken that the outer part of the knee of the left leg does not come into contact with the ground first. In the end, the right leg also comes into contact with the ground and provides cushioning, supported by the eventual use of the arms, which completes the rotation. The regions of the body that are active during this landing are: cervicalis, acromialis, scapularis, carpalis, palmaris, vertebralis, lumbalis.

Side roll landing enables a high degree of reduction of the force exerted by the ground on the handball player, even at higher performance speeds. This is achieved thanks to the large representation of the force vector redirection principle when performing this landing, while there is also a significant use of the principle of increasing the contact area and cushioning.

The advantages of applying the side roll landing are primarily reflected in the fact that this technique can also be applied in situations where the player moves forward at a high horizontal speed during the flight phase when taking a shot. Applying this landing technique allows the player to stay in contact with the target at all times, even while performing a rotation, which allows him to take additional actions as the situation changes. Also, it is of great importance that the technique can be successfully applied using both or one hand, and without using hands.

The risks of applying the technique of side roll landing are primarily reflected in the inadequate execution of the technique, which can lead to serious injuries, primarily to the forearm, but also to the knees, upper leg muscles, shoulders, neck, and head. The most serious of the above is the forearm injury, which occurs if, when lowering the hands after the shot to make contact with the ground, the elbow of the shooter's hand is on the outside of the right knee, and the hand that is placed on the floor is on the inside. This can cause the right knee, whilst lowering to the ground, to hit the forearm with great force, which can lead to a fracture. Knee injuries when performing this technique can happen in one of two ways. In the first case, due to an inadequate phase of starting the rotation, the knee can hit the ground directly with its front region, which can be the cause of a potential strain of the anterior cruciate ligament or a fracture of the patella. Also, if the knee is not positioned in the direction of movement of the body and the foot during the contact phase of the leg with the ground, an injury may occur to the inner or outer muscles of the upper leg. The risk of shoulder injuries is the same as with the technique of landing by rotating around the longitudinal axis of the body. If contact is made with the outside of the shoulder, serious injury can occur, as all the force will be focused on this region. It is also important to note that if the position of the neck and head is not optimal, distortion and contusion of the cervical region of the spinal column can occur, as well as contusion and fracture of the skull.

Discussion

This paper analyses several rolling landing techniques that could be performed after shooting, including landing with rotation around the body's longitudinal axis, back roll landing over one shoulder, and side roll landing. The analysis indicates that the correct implementation of these techniques can improve players' shooting efficiency by allowing them more confidence to delay and wait for the last moment to shoot, knowing that they will make a safe landing (Benjaminse et al., 2017; Rousanoglou et al., 2014). Also, the correct implementation of rolling landing techniques has the potential to mitigate the risk of impact injuries that are the result of falls caused by contact with opposing players (Barendrecht et al., 2011). The paper also notes the risks of injuries due to suboptimal selection and execution of the rolling landing techniques and offers suggestions on how to alleviate them (Petersen et al., 2002).

Coaches are encouraged to incorporate drills that emphasize these landing techniques, tailoring training to individual player profiles to maximize both performance gains and injury prevention. However, given the theoretical nature of this study, further empirical research is warranted to validate these findings and to explore the long-term impact of integrating these techniques into training programs.

Conclusion

This study demonstrates that rolling landing techniques could significantly improve shooting performance and mitigate biomechanical stress, thereby reducing injury risk in handball. Future training programs should integrate elements from floor gymnastics and martial arts to enhance general motor skills, particularly among younger athletes. Moreover, mastering a comprehensive range of landing techniques is essential to minimise injuries to critical areas such as the knees, shoulders, elbows, and ankles. Future research should undertake longitudinal assessments to quantify the impact of these training interventions on both performance and injury incidence rate.

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UDK 796.332:616-001

Analysis of the frequency of physical injuries among futsal players in the Serbian First League

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Introduction

Futsal is a sport derived from football played on a larger field, adapted due to the lack of space for play. Due to the size of the field the number of players was changed, and some rules were adjusted, all in order to play soccer. In this way, indoor football was created, now known as futsal (Voser, 2001). Futsal is a team sport played indoors between two teams of five players, including a goalkeeper, on a flat and smooth wooden floor. Matches last a total of 40 minutes, divided into two halves of 20 minutes each, with time stopped when the ball is not in play (FIFA, 2021/22). For better clarity and understanding, the basic differences between football and futsal are shown in Table 1. A large number of players worldwide play this sport, and its popularity is growing in many countries. Futsal originated in South America in 1930, and the first Futsal World Championship was held in 1982 in Brazil. Since 1989, the Futsal World Cup has been organized by the Federation Internationale de Football Association (FIFA).

Table 1. Fundamental differences between football and futsal

	FOOTBALL	**FUTSAL**
PITCH	90-120 x 45-90m	38-42 x 20-25m
BALL	410-450g; C= 68-70cm	400-440g; C= 62-64cm
PLAYERS ON THE PITC	11	5
SUBSTITUTIONS	5	Unlimited (flying substitutions)
DURATION	2x45 min without stoppage time	2x20 min with stoppage time
TIME-OUT	No	1 per half
OFFSIDE	Yes	No
ACCUMULATION OF FOULS	No	Yes (penalty kick)

Despite the global popularity of football in terms of the number of participants and children training, futsal is particularly appealing to older individuals, which gives it greater potential for development and the maintenance of intrinsic motivation among participants, thus gaining significant popularity among recreational players (Helge, Aagaard, Jakobsen, Sundstrup, Randers Karlsson, & Krustrup, 2010).

Like football, the athlete performance in the game of futsal is contingent on various technical, tactical, physical and psychological factors. Due to the increasing number of competitions (European and World Championships, the establishment of new teams and leagues of varying quality), training sessions are becoming more intense to prepare teams for new challenges. As a result, athletes are exposed to greater physical strain. Such conditions can lead to overtraining and attribute to various types of musculoskeletal injuries. Furthermore, futsal is a sport characterized by frequent direction changes, hard playing surfaces, repeated sprints, reactions to numerous external stimuli, as well as high-intensity actions with varying rest periods, ranging from complete to partial recovery (Gene-Morales, Saez-Berlanga, Bermudez, Flández, Fritz, & Colado, 2021; Ferreira, Gomes, Ferreira, Arruda, & França, 2010). Based on these facts, it is essential to adapt training to the game's demands to reduce the risk of player injuries. Considering the specificity of futsal, the training structure should not be long (up to an hour and a half), interspersed with high-intensity periods and rest periods ranging from partial to complete.

Futsal in the Republic of Serbia has been at a higher level in recent years, from the conditions that players have to the architecture and halls where matches are played. In the Republic of Serbia, there are two leagues of national importance, the First and Second Futsal League of Serbia, and lower leagues depending on which district they belong to. In recent years, teams have been playing an increasingly prominent role on the international stage.

In line with the structure of the game and its physical demands, futsal is considered one of the top 10 sports with the highest injury risk, with an injury incidence rate of 55.2 injuries per 10,000 hours of sports activity (Schmikli, Backx, Kemler, & Van Mechelen, 2009). Jung and Dvorak studied injury characteristics at top international futsal tournaments and reported an incidence rate of 195.6 injuries per 1,000 hours of play and 130.4 injuries per 1,000 matches (Junge & Dvorak, 2010). The injury rate in futsal is higher than in football, ranging from 6 to 9 injuries per 1,000 hours of sports activity (Ekstrand, 2008). When it comes to injury location and type, ankle sprains are the leading injuries, with a similar frequency of muscle strains and knee joint injuries (Jianxi, Xianxiao, Lei, & Shushu, 2019; Junge, Dvorak, Graf-Baumann, & Peterson, 2004; Ribeiro, Akashi, Sacco, & Pedrinelli, 2003). This is explained in the literature by the fact that the ankle is one of the most important joints for human movement, as it carries the weight of the entire body. Due to its biomechanical and anatomical characteristics (poor stability, a small number of muscles in the lateral ligament area, and weak muscle protection), the ankle is prone to injuries caused by impacts and improper technical movements of the body (Fong, Hong, Chan, Yung, & Chan, 2007). During futsal matches, the knee is often slightly bent to maintain body balance and enable a quick reaction. Because of this position, the knee endures considerable stress throughout the match, making it susceptible to injury (Lei, 2006). Lower extremities are constantly exposed to stress during futsal matches due to ball control, movement, and interaction with opponents (Lago-Fuentes, Jiménez-Loaisa, Padrón-Cabo, Calvo, García-Pinillos, & Rey, 2020; Cherati, Dousti, & Younespour, 2016). Considering the importance of goalkeepers in the team, the number of injuries and their frequency, there are few studies on this topic. A group of Chinese authors states that the most common injuries among futsal goalkeepers are lumbar spine injuries, hand injuries, ankle sprains, and shoulder injuries (Jianxi, Xianxiao, Lei, & Shushu, 2019). On the other hand, the most common injuries in football are fractures, dislocations, and joint dislocations in the fingers, hands, and wrists (Muracki, Klich, Kawczyński, & Boudreau, 2021). Furthermore, the same group of authors notes that football goalkeeper injuries differ in

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type, location, and frequency compared to field players.

The results of previous studies indicate the need for strategic approaches in injury prevention and effective rehabilitation of athletes. It is also important to develop individualized training programs that take into account the specificities of futsal and reduce the risk of overtraining and musculoskeletal injuries, thereby contributing to the safety and effectiveness of athletes. Therefore, the aim of this research is to examine the prevalence of injuries during the preparatory period of futsal players in Serbia.

Methods

The study included 3 futsal clubs competing in the First Futsal League of Serbia: Ekonomac Futsal Club (KMF), Smederevo Futsal Club (KMF), and Fon-Banjica Futsal Club (KMF). Since this research was conducted as part of a larger study aimed at examining the biomechanical characteristics of sprints and jumps in futsal players, (the attention has been mostly focused on lower extremity injuries) the focus was on clubs that have regular training sessions and gave their consent for their players to participate. The study included 40 futsal players, who were divided into two groups based on different game requirements: outfield players (n=30, age 26.2±6.1 years, body mass 77.8±8.0 kg, height 180.5±6.4 cm) and goalkeepers (n=10, age 24.7±7.9 years, body mass 83.9±10.4 kg, height 181.2±5.0 cm). Of the total sample, 14 players transitioned from football to futsal. During data collection, all participants were officially healthy players who had received medical clearance to participate in sports activities. Demographic data and injury history were collected through questionnaires (Picture 1). The research was conducted in accordance with the Declaration of Helsinki and approved by the Ethics Committee of the Faculty of Sport and Physical Education, University of Belgrade (02-1991/24-1).

Upitnik o povredama

1. **Ime i prezime:** _____
2. **Datum rodjenja:** _____
3. **Telesna masa:** _____
4. **Telesna visina:** _____
5. **Sportski staž:** _____
6. **Klub:** _____
7. **Pozicija:** _____
8. **STARTER/NE-STARTER (zaokružiti)**
9. **Dominantna noga šuterska: LEVA/DESNA (zaokružiti)**
10. **Dominantna noga odskočna: LEVA/DESNA (zaokružiti)**
11. **Da li ste imali povrede: DA/NE (zaokružiti)**

Ukoliko ste zaokružili DA odgovorite na sledeća pitanja.

12. **Kada se desila povreda (mesec/godina):** _____
13. **Mehanizam nastanka povrede: KONTAKTNO/NEKONTAKTNO (zaokružiti)**
14. **Koji deo tela je bio povredjen?** _____
15. **Koja je vrsta povrede: KIDANJE LIGAMENATA/TETIVA/MIŠIĆA; PRELOM KOSTI; UGANUĆA; IŠĆAŠENJA; RUPTURE MIŠIĆA (zaokružiti)**
16. **Kako je lečena povreda: OPERATIVNO/TERAPIJA (zaokružiti)**

Ukoliko ste zaokružili OPERATIVNO odgovorite na sledeća pitanja.

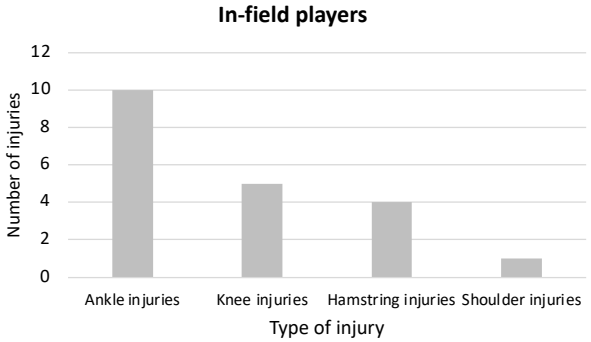
17. **Koliko je prošlo od povrede do operativnog zahvata?** _____
18. **Koliko je prošlo od operativnog zahvata do dana popunjavanja upitnika?** _____
19. **Ako je ACL operativno lečen, odakle je uzet graft: ZADNJA LOŽA/PATELA/TETIVA KVADRICEPSA? (zaokružiti)**

Picture 1. Questionnaire

Data were processed using descriptive statistics. The minimum and maximum, mean, and total values, standard deviation as well as the percentage values for the observed variables, were determined. Statistical analyses were performed using the Excel 2010 software package for tabular data presentation and processing (Microsoft Corporation, Redmond, WA, USA).

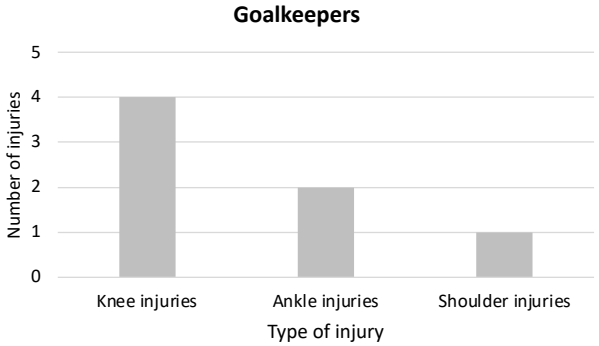
Results

When observing the results for players, out of a total of 30, 67% (20 players) reported a history of injuries. 65% of the injuries occurred through a non-contact mechanism, and three knee injuries required surgical treatment. The results clearly indicate that the most common injuries are to the ankle, followed by injuries to the knee, hamstrings, and shoulder joint (Graph 1). All injuries examined in this study occurred within a period of up to three years prior to the testing date. Additionally, the most common injuries among young players (under 20 years old) were ankle sprains and knee dislocations (patellar luxation).



Graph 1. Number and type of injuries among players

When observing the results for goalkeepers, out of a total of 10, 70% (7 goalkeepers) reported a history of injuries. 60% of the injuries occurred through a non-contact mechanism, with one knee injury requiring surgical treatment. The presented results indicate that the most common injuries involve the knee joint, followed by ankle and shoulder injuries (Graph 2). All injuries examined in this study occurred within a period of up to three years prior to the testing date.



Graph 2. Number and type of injuries among goalkeepers

Discussion

The aim of this research is to examine the prevalence of injuries during the preparatory period among players of the Serbian First Futsal League. The analysis and interpretation of the results obtained show that the injury rate in futsal is very

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high, which underlines the need for individualization of the training process.

The results of this study show that out of the total sample of players, 67% reported a history of injuries, of which 65% occurred through non-contact mechanisms. Junge and Dvorak reported in their study that a higher percentage of injuries in futsal resulted from non-contact mechanisms (37%) compared to football (27%) (Junge & Dvorak, 2010). These data suggest that injuries are caused by excessive effort, sudden direction changes, improper techniques, and not by direct impacts from other players. Additionally, non-contact injuries may be linked to a lack of strength and conditioning, periods of overtraining, and inadequate recovery (Aminiaghdam, 2012; Gayardo, Matana & Silva, 2012). Considering the type of playing surface, when comparing the results of this study with injuries in handball, the findings are similar. Vila and colleagues reported that the most common injuries involve the lower extremities (hamstring strains, knee, and ankle injuries) as well as shoulder injuries due to the specific nature of handball (Vila, Barreiro, Ayán, Antúnez, & Ferragut, 2022). However, when making between sports comparisons, the results should be interpreted with caution as the definition of injury adopted by authors may also influence outcomes. In this study, the most common injuries among players were ankle injuries (50%), followed by knee injuries (25%), hamstring injuries (20%), and shoulder injuries (5%). Three injuries required surgical treatment. Among goalkeepers, 70% reported an injury, of which 60% occurred through non-contact mechanisms. The most common injuries among goalkeepers were knee injuries (57%), followed by ankle injuries (29%) and shoulder injuries (14%).

The results of previous studies align with this research, showing that knee and ankle injuries are the most prevalent among players (Gene-Morales, Saez-Berlanga, Bermudez, Flández, Fritz, & Colado, 2021; Varkiani, Alizadeh, & Pourkazemi, 2013). Conversely, Ribeiro and colleagues found that the most common injuries among Brazilian futsal players were ankle injuries (46%) and knee injuries (19%). Despite regional differences, lower extremity injuries are the most common problem among futsal players, indicating a universal risk pattern associated with the sport. A group of Chinese researchers determined that ankle injuries are the most frequent among players in China, while goalkeepers most commonly experience lumbar spine injuries, followed by hand, ankle, and shoulder injuries (Jianxi, Xianxiao, Lei, & Shushu, 2019). Our results indicate that ankle injuries are the most frequent among players, whereas knee injuries are most common among goalkeepers. This difference may result from the specific role of goalkeepers, where injuries may occur due to frequent falls and abrupt movements during saves. Additionally, most injuries in this study were lower extremity injuries, with the majority caused by non-contact mechanisms. Comparing these results with the best teams and leagues globally (Spanish and French leagues), the frequency and topology of injuries are similar, as confirmed by previous findings. However, the number of matches (and consequently the number of training sessions and season length) for top-tier teams worldwide is 67% higher than in Serbia. Therefore, improvements in training quality and recovery strategies are essential for Serbian teams to compete with the best European teams.

One limitation of this study is the small sample size. Including a larger number of players from different leagues and age groups would provide a more representative sample. Furthermore, injuries were self-reported by players and goalkeepers, which may lead to bias as some athletes might not report minor injuries or attribute them to fatigue. Future research should include larger samples and develop targeted studies focusing on position-specific injuries. In Serbia, there is no data on injury incidence during training and matches, which could also serve as a direction for future studies.

Conclusion

Based on the presented results, it is evident that lower extremities are the most commonly affected by injuries among players of the Serbian First Futsal League, with most injuries resulting from non-contact mechanisms. The ankle joint is the most frequently injured among players, while the knee joint is the most common injury among goalkeepers. These findings suggest that injury causes are linked to intense efforts, sudden direction changes, and performing technical movements on hard surfaces. Special attention should be given to strengthening the muscles around injured joints, correcting techniques, and ensuring adequate recovery to reduce injury risks and increase athlete safety. A detailed analysis of kinetic and kinematic movements is necessary to enable the development of individualized training aimed at mitigating variable risk factors, enhancing safety, and improving player performance. Additionally, understanding injury mechanisms is crucial for adopting preventive measures.

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UDK 796.035

Current exercise engagement is differentially motivated by previous involvement in organized recreational activities

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Introduction

The health advantages of physical activity are well known, and they include enhanced mental and cardiovascular health as well as general well-being (Warburton & Bredin, 2017). Even with these benefits, regular exercise participation varies by population (i.e., decreases). Motivation, which propels people to start and continue physical activity, is a major element determining this diversity (Teixeira et al., 2012). Designing successful programs that encourage lifetime physical activity habits requires an understanding of the factors that motivate individuals to exercise.

The impact of past participation in structured leisure activities is one facet of exercise motivation that has drawn interest. Individuals' attitudes and behaviours regarding exercise in later life may be influenced by their involvement in organised physical activities during childhood and adolescence, such as team sports or club-based fitness programs (Howie et al., 2020; Taylor et al., 1999). This is particularly interesting because early experiences can shape attitudes and behaviors towards exercise later in life. Both intrinsic and extrinsic motivators, such as enjoyment, social engagement, and accomplishment, can be fostered by these early experiences and are important for maintaining consistent exercise routines as an adult. In addition to these individual motivators, the social aspect of exercise also plays an important role. Membership in sports or exercise groups can provide support, a sense of belonging, and increase motivation for regular exercise, which in the long run can contribute to better health and longevity (Stevens & Cruwys, 2020). These motivating aspects are essential for maintaining consistent exercise into adulthood. Indeed, exercise can be a more lasting and fulfilling aspect of a person's life if it strikes a balance between intrinsic fulfilment and extrinsic rewards, resulting in better physical and mental health over time (Ryan & Deci, 2000).

While numerous instruments have been created to assess exercise participation motives, one popular method for evaluating exercise motivation is the Exercise Motivations Inventory (EMI-2), which classifies the different variables that motivate people to exercise and is a widely used tool (Kim & Cho, 2022). These elements include extrinsic motives like weight control or social acknowledgement as well as intrinsic motivations like reaching personal objectives or improving one's health (Markland & Ingledew, 1997).

The purpose of this study was to investigate the connection between current exercise motivation and prior participation in organised leisure activities. We used the EMI-2 questionnaire to evaluate how prior engagement affects various motivational elements and how these motivations differ across people with varying activity histories. Gaining an understanding of this relationship could help develop customized interventions that improve exercise adherence and encourage sustained physical activity.

Methods

Participants

We included 47 female adults aged 27-57 years who were included in group recreational programs for at least 3 months and exercising at least two times a week. The participants were involved in 2 different fitness clubs and mainly attended group functional fitness programs.

Variables

The variables included demographic variables and exercise motivation which was measured by exercise motivations inventory 2 (EMI-2). The EMI-2 is a widely used tool designed to assess the different motivations that drive individuals to engage in physical activity. The EMI-2 consists of 51 items, which are grouped into 14 different subscales, covering both intrinsic and extrinsic motivators. These subscales include categories such as stress management, health pressures, enjoyment, social recognition, and appearance, allowing for a comprehensive understanding of why people choose to exercise. By evaluating these various dimensions, the EMI-2 helps researchers and fitness professionals better understand individual differences in exercise behavior and tailor interventions accordingly. This tool is useful in both clinical and recreational settings to promote adherence to exercise programs by addressing the underlying motivational factors specific to each person.

Statistical analysis

Data were analyzed using descriptive statistics (means and standard deviations). Differences between individuals who previously exercised and who did not previously exercise was determined using Mann-Whittney U test and Receiver operating characteristics curve (ROC). The ROC curve included area under the curve (AUC) and Confidence intervals (CI) for the AUC were calculated to assess the precision of the estimate. A p-value < 0.05 was considered statistically significant and SPSS statistical package 25 was used for all analysis.

Results

According to results in Table 1, there is a difference in motivation variables according to prior participation in organized recreational activities in majority of the variables. Only social recognition and weight management subscales were not significantly different.

Table 1. Descriptive statistics and differences in motivation variables according to prior participation in organized recreational activities

	Pleviously exercised (n=25)		**Previously did not exercise (n=23)**		**Mann-Whittney U test**		
Variable	Mean	SD	Mean	SD	U	Z	p
Stress Management	3.44	0.91	1.99	1.65	142.50	2.98	0.003

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Revitalisation	4.37	0.88	2.91	2.20	167.00	2.48	0.01
Enjoyment	4.11	0.81	2.45	1.99	148.50	2.86	0.004
Challenge	3.67	1.03	2.15	1.91	155.50	2.71	0.01
Social Recognition	1.31	1.20	0.91	1.17	231.50	1.15	0.25
Affiliation	2.80	1.25	1.80	1.73	197.00	1.86	0.06
Competition	2.47	1.20	1.24	1.40	143.50	2.96	0.003
Health Pressures	2.45	1.39	1.30	1.44	160.00	2.62	0.01
Ill-Health Avoidance	4.17	0.91	2.68	2.16	183.00	2.15	0.03
Positive Health	4.65	0.45	3.01	2.28	178.50	2.24	0.03
Weight Management	3.40	1.23	2.30	1.93	203.00	1.73	0.08
Appearance	2.88	0.92	1.75	1.55	161.00	2.60	0.01
Strength and Endurance	4.12	0.79	2.40	2.02	149.50	2.84	0.005
Nimbleness	4.27	0.73	2.55	2.07	150.50	2.82	0.005

Note: SD- standard deviation

The receiver operating characteristics curve results on differences in motivation variables according to prior participation in organized recreational activities are presented in Table 2. It is visible that stress management, enjoyment, competition, strength and endurance, and nimbleness are the most significant variables where individuals with previous participation in organized recreational activities had higher results than the ones without prior participation. This is additionally visually presented in Figure 1.

Table 2. Receiver operating characteristics curve results on differences in motivation variables according to prior participation in organized recreational activities

	AUC	**SE**	**95% CI Lower Bound**	**95% CI Upper Bound**
Stress Management	0.62	0.09	0.44	0.80
Revitalisation	0.55	0.09	0.37	0.74
Enjoyment	0.60	0.09	0.42	0.79
Challenge	0.59	0.10	0.39	0.78
Social Recognition	0.46	0.09	0.27	0.64
Affiliation	0.49	0.10	0.30	0.67
Competition	0.64	0.09	0.46	0.82
Health Pressures	0.59	0.10	0.41	0.78
Ill-Health Avoidance	0.51	0.10	0.32	0.70
Positive Health	0.52	0.10	0.34	0.71
Weight Management	0.47	0.09	0.29	0.65
Appearance	0.57	0.10	0.38	0.76
Strength and Endurance	0.60	0.10	0.40	0.80
Nimbleness	0.60	0.10	0.41	0.79

Legend: AUC - Area Under the Curve; SE - Standard Error; CI – Confidence Interval

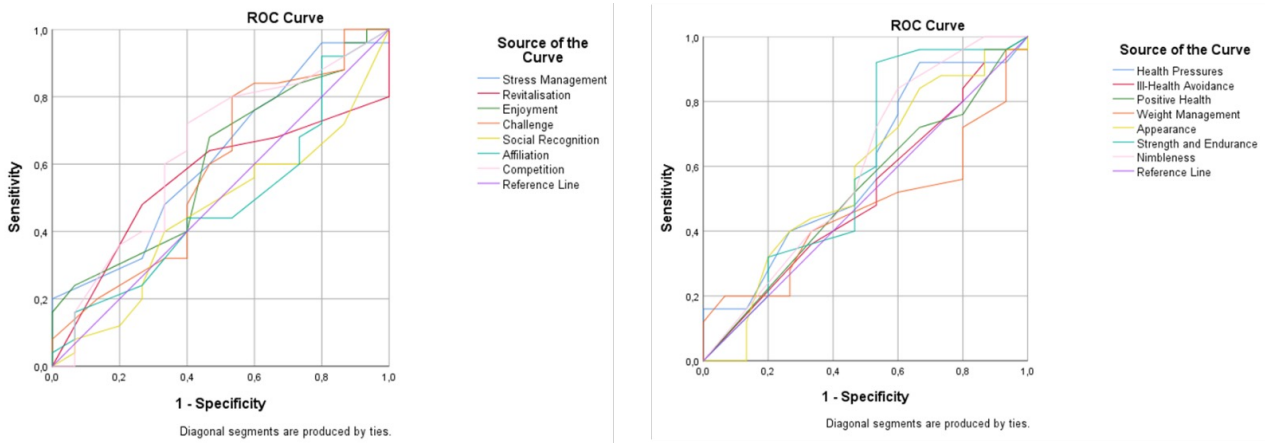

Figure 1. Receiver operating characteristics curve on differences in motivation variables according to prior participation in organized recreational activities

Discussion

The aim of this study was to investigate the influence of past participation in organized recreational activities and the current motivation for exercise in adult women. According to this aim, the most significant result is that there is a significant influence of previous exercises experience on various motivational factors. Specifically, women who previously participated in organized recreational activities demonstrated higher motivation in areas such as stress management, revitalization, enjoyment, challenge, appearance, strength and endurance, and health and fitness. These findings suggest that previous participation in structured physical activities can have a lasting impact on individuals' motivation to exercise in adulthood, which is consistent with previous research indicating the positive influence of early participation in sports and physical activity on exercise motivation in adulthood (Batista et al., 2019).

A possible explanation for the connection between past participation in organized recreational activities and the current motivation for exercise is that early positive experiences with physical activity can lead to the development of intrinsic motivation, such as enjoyment of exercise and a sense of competence (Teixeira et al., 2012). Additionally, individuals who had prior participation in organized physical activity also have highly developed physical literacy which leads to understanding the value and benefits of physical activity, fostering current and future exercise participation. Indeed, a study on Croatian adolescents revealed that adolescents who were involved in out-of-school organized activities had higher physical literacy levels, and one of the constructs which builds this concept is motivation (Sunda et al., 2022).

It is important to note that social recognition subscale was the least significant variable when it comes to differences in motivation variables according to prior participation in organized recreational activities. Indeed, one study which investigated differences in motives between sport participants and non-sport fitness participants noted that sport participants had higher interest and social recognition motives, while non-sport fitness participants had higher body-related and enjoyment motives (Ingledew & Markland, 2008). This is actually logical as sports participants are mostly motivated by rewards and social accomplishments in terms of glory and fame. On the other side, individuals exercising in fitness centers do not have the aim of competing and gaining social approval but are exercising for their self and their own health.

Conclusions

The most significant result from this study is that women who previously participated in organized recreational activities demonstrated higher motivation. A possible explanation for the connection between past participation in organized recreational activities and the current motivation for exercise is that early positive experiences with physical activity can lead to increased enjoyment in exercise and a sense of competence. Also, the social recognition was not influential variable which means that individuals with prior engagement in organized recreational activities are not driven by social approval but other more intrinsic motives.

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UDK 796.015.1:616-001

Application of training with blood flow restriction during the recovery after anterior cruciate ligament injury - A brief literature review

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Introduction

After an LCA injury, the patient is not able to perform certain activities, and the rehabilitation process itself after surgery does not allow early aggressive strengthening to protect the graft. A common approach to training aimed at increasing muscle mass and strength involves performing exercises against a large external load, ~70-85% of a single maximum repetition (1-RM). In contrast to this traditional approach, the so-called ischemic or occlusive training (''Blood Flow Restriction'': BFR) is increasingly used in recovery after injuries. BFR training is a technique that combines exercises against low external load with complete occlusion (restriction) of venous blood flow and partial occlusion of arterial blood flow and has the potential to accelerate the return of quadriceps muscle strength in the early period of rehabilitation/recovery.

The occlusive method combines exercises against low external load with restriction of venous blood flow by means of a pneumatic cuff or elastic bands placed proximal to the target muscle, and is typically used in situations where training with a high external load should be avoided. In order to understand this method, it is important to understand two terms related to the occlusion itself. These are arterial occlusive pressure (AOP) and limb occlusion pressure (LOP). AOP refers to the specific pressure at which the flow of arterial blood is completely blocked in the extremity due to the action of external compression and is an important item when it comes to the occlusive method of training. In some studies, LOP is used, which is the minimum pressure needed to completely prevent the flow of venous blood from the extremities, while allowing arterial blood to continue to flow. AOP is generally larger than LOP because it specifically targets arterial flow, while LOP takes into account the total vascular resistance in the extremity, including arteries and veins.

Although the BFR method has its place in practice and research, it is still a novelty in our region. The aim of this paper is to present the basic characteristics of occlusive training with a review of the current recommendations for its application in order to achieve the best possible results during recovery. The specific objective relates to the question of when and to what extent occlusive training should be applied after an injury to the anterior cruciate ligament of the knee, as well as possible limitations or contraindications.

Methods

The literature search was performed using the keywords: ACLR, BFR, occlusion training, ACL rehabilitation, in Pubmed, SCIndex and Google Scholar databases. 21 papers met the criteria for inclusion in the review: time range 2000-2024; ACL; effects on muscle hypertrophy.

Results and discussion

To better understand the effects of BFR, it is necessary to look at the percentage of occlusive pressure, which plays an important role in increasing muscle strength and size, reducing pain, better joint function, and muscle activation. Determining the AOP or LOP is crucial because it helps establish the optimal level of restraint needed to achieve the desired effects of the workout without causing too much risk or discomfort. AOP depends on the size and material of the cuff, but also the circumference of the affected limb.

Various variants of cuffs are mentioned in BFR research: single-chamber and multi-chamber cuffs, cuffs with automatic pressure regulation, manual pneumatic cuffs (e.g. non-automatically regulated), cuffs with different contours and flat cuffs, elastic cuffs, nylon cuffs (Rolnick et al., 2023). The greater versatility and availability of devices with self-regulating technology, the responsiveness and speed at which the device can sense and adjust the pressure, is becoming an important variable in assessing the impact of this function. Currently, there appears to be only one study (Jacobs et al., 2023) in which cuff autoregulation was directly examined as the primary variable in research design, and the results showed a 3-fold reduction in risk in terms of adverse events compared to a non-autoregulated cuff. In addition, during the four sets of exercises until failure, the group with the autoregulated cuff performed more repetitions (higher training volume) compared to the group with the non-autoregulated cuff (~199 reps vs. ~161 reps, $p < 0.001$) with less painful muscle tenderness (3± 2.2 vs. 4± 2.6, $p < 0.001$). The authors concluded that the function of autoregulation has a beneficial effect on multiple levels (Jacobs et al., 2023).

Research indicates that in addition to the above characteristics, the shape of the cuff also affects the amount of pressure necessary to determine the AOP. The contour shapes of the cuff are longer at the top and shorter at the bottom, creating a tight fit at the extremities due to differences in diameter. Contour cuffs are also produced with a variable contour shape. This design allows for an even more secure fit to the limb because the attachment can take into account small differences in the size and shape of the limb. Nevertheless, the difference in the proximal and distal diameter of the contour cuff slightly reduces the AOP (~25.4 ± 16.1 mmHg measured by Doppler ultrasound) compared to the flat cuff. The occlusive stimulus may be different, as flat cuffs are more likely to apply asymmetrical pressures to the limb given the proximal-distal difference in limb circumference. In individuals in whom we want to minimize the pressure response during BFR exercise, the use of a contour cuff may be desirable to adapt to the conical shape of the extremities, especially in the lower extremities.

Wide BFR cuffs restrict arterial blood flow at a lower pressure than narrow BFR cuffs. In addition, it has been shown that occlusive pressures in the cuff should be largely based on the circumference of the thigh and not on the pressures previously used in the literature (Loenneke et al., 2012). An interesting finding was that the leg circumference measurement model predicted the cuff pressure necessary to restrict arterial blood flow as well or better than the leg composition measurement model (amount of muscle, fat, bone density...). This suggests that measuring the circumference of the extremity, rather than the composition of the limb, would be adequate for determining occlusive pressure in the cuff. By comparing the factors that affect the restriction of arterial blood

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flow between narrow and wide cuffs, regression models show that the size and composition of the extremities have a greater effect on the pressure at which arterial blood flow is restricted by the use of wide cuffs compared to narrow cuffs (Loenneke et al., 2012). The position of the cuff is usually at the most proximal part of the limb that is affected. In the case of multi-chamber cuffs, it has been shown that the air bubble makes better occlusion of blood flow if it is located on the inside of the artery, less pressure in the cuff is required to achieve a similar or the same AOP than when the air bubble is on the outside of the artery (Rolnick et al., 2023).

Preliminary findings show that LL-BFR (30% 1RM) leads to similar muscle activation as high-intensity workouts without BFR (80% 1-RM). However, the results of the research are inconsistent due to differences in intervention protocols, especially in those in which weight-bearing exercises are performed that use four sets until failure instead of just one series (Forelli et al., 2024). In a study by Lixandrao et al. (2015), it was shown that increasing osslusion pressure was more effective for muscle hypertrophy only when applied at low intensities, e.g. 20% 1-RM and that there were no significant benefits when working at higher intensities, e.g. 40% 1-RM. Weight training with an 80% occlusion pressure yields better results when exercising at a lower intensity than BFR at a higher load intensity (40% and above) (Lihandrao et al., 2015). Li et al., (2023) compared the impact of BFR with 40% AOP and 80% AOP on the recovery of individuals with LCA reconstruction. Participants were divided into three groups (control, 40% AOP and 80% AOP). All participants underwent varying levels of occlusive training, combined with standard quadriceps rehabilitation for 8 weeks. They exercised twice a week, four sets per workout: the first set was 30 repetitions and the remaining sets were 15 repetitions, with 30-second rest periods between sets. Assessments included scaled maximal isokinetic knee extension strength at 60°/s and 180°/s, the sum of the thickness of the affected rectus femoris and vastus intermedius, Y-balance test performance, and International Knee Documentation Committee questionnaire responses before and after the intervention. After 8 weeks, the group that did BFR with 80% AOP had significantly better results than the group that worked with 40% AOP, both in the quadriceps peak torque to body weight at 60°/s and 180°/s angular velocitys, as well as the sum of the thickness of the rectus femoris and vastus intermedius. In other words, a combination of BFR and low-intensity quadriceps strengthening exercises can significantly improve the strength and cross-section of this muscle after LCA reconstruction and can help them reduce the difference between the injured and uninjured leg as well as improve the condition of the knee joint (Li et al., 2023). In a study done by Kubota et al., (2011) it was shown that a pressure of only 50mmHg reduced the strength losses associated with immobilization, indicating that BFR alone even without exercise is useful for maintaining muscle function during the resting period after surgery (Kubota et al., 2011)

The size of the external load and the training intensity

When it commes to training programming, among the main variables to be controlled are external load and intensity. In the traditional type of training, achieving muscle hypertrophy and increasing strength involves performing exercises against a high external load ~70-85% 1-RM. LL-BFR at an external load of only 20% of 1-RM, resulted in significant improvements in muscle strength and hypertrophy. The greatest effects were observed when the volume of training was 2-3 times a week. It should also be noted that the effects were almost twice as high in the group that did workouts without BFR but with an 80% 1-RM load (Vanwye et al., 2017). The pressure applied during exercise can also be dictated to some extent by the relative load lifted during training. For most individuals, exercising with a load equivalent to 20-40% of 1-RM with BFR is likely to maximize muscle growth and strength (Lihandrao et al., 2015; Counts et al., 2016). However, when the loads used are closer to the lower end (e.g. ~20% 1-RM), more pressure may be required (~80% AOP) to induce muscle growth, but further research is needed to justify this claim. Also, pressure during occlusion is second to exercise intensity when it comes to intensifying interventions, where 40% 1-RM is used as part of the BFR protocol (Lihandrao et al., 2015). Patterson et al., (2019) suggest using loads between 20% and 40% of 1-RM because this range of loads consistently led to muscle adaptation when combined with BFR (Patterson et al., 2019). In the research of Kubota et al. (2011) and related to the examination of the effects of the application of BFR in the initial phase of recovery after LCA reconstruction, the subjects were not even exposed to additional external load and as a result had less loss in muscle strength (Kubota et al., 2011). Also in the research done by Okoroha et al. (2023) in preoperative rehabilitation, they did not use external load, but only exercises with BFR, and this had a positive effect on improving strength and increasing the subjective experience of the exerciser up to the sixth week after LCA reconstruction (Okoroha et al., 2023).

Duration of intervention

The current literature suggests that the minimum duration of intervention to observe a significant difference in increases in muscle strength and hypertrophy is from 6 to 12 weeks and from 12 to 24 weeks (Colombo et al., 2024). Despite this suggestion, BFR has its benefits even when used for as little as two weeks in terms of reducing the impact of hypotrophy after LCA reconstruction, increasing the patient reported outcomes, and improving strength (Kubota et al., 2011; Okoroha et al., 2023). Taking into account the evidence from a review paper by Loenneke et al., (2012b), the same authors proposed a progressive model of occlusive training that may be effective in rehabilitation from the beginning all the way to the return to to high-intensity training (Loenneke et al., 2012b ; Hughes et al., 2017). The proposed progression model for the use of occlusive training in early rehabilitation to high-intensity training involves a four-step approach:

1. Bed rest condition with BFR;
2. low-intensity walking with BFR
3. Low-load resistance training with BFR
4. Low-load in combination with high-load resistance training

The importance of the use of BFR in the preoperative phase of treatment and the impact on postoperative recovery

When it comes to the preoperative phase (the so-called prehabilitation) and the impact of the BFR training method on its outcome, the results show that there is no benefit in the use of this intervention compared to the standard approach to exercise. Two studies conducted a two-week training plan and compared the results between, BFR groups and groups without BFR (Tramer et al., 2023; Okoroha et al., 2023). Even tho the protocol led to improvements in quadriceps strength in both groups, no difference was found between the groups in quadriceps circumference, strength, or patient reported outcomes (PRO's). The prerehabilitation protocol with BFR that subjects did at home was found to be feasible, affordable, and well tolerated by patients (Tramer et al., 2023; Okoroha et al., 2023). On the other hand, when looking at the impact of prerehabilitation on rehabilitation after LCA reconstruction, the outcomes are different. In a study done by Okoroha et al., (2023) the aim is to evaluate the postoperative isometric

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quadriceps strength in patients who underwent LCA surgery with a perioperative BFR program. Prehabilitation lasted 2 weeks, 5 times a week. Subjects in the BFR group used (single-chamber cuffs - "smart tool plus") and instructions to place them on 80% of the LOP. After surgery, all subjects, regardless of the type of prehabilitation, underwent the same postoperative rehabilitation protocol. Over the course of the study, participants were tested a total of six times: 1) on their first visit to the clinic; 2) on the day of the operation; 3) the first postoperative examination; (a) after 6 weeks; (5) after three months and (6) after six months. Six weeks postoperatively, the BFR group showed significantly greater strenght compared to the control group (symmetry index: 57% ± 24% vs. 40% ± 18%; P = .029), and the BFR group had significantly better Patient-Reported Outcomes Measurment Information System-Physical Function (42.69 ± 5.64 vs. 39.20 ± 5.51; P = .001) and the results on the IKDC questionnaire (58.22 ± 7.64 vs. 47.05 ± 13.50; P = .011). In contrast, the control group showed a significant drop in the peak torque generation of the operative versus nonoperative leg, i.e. lower symmetry index. There were no significant difference in strength or PROs at three or six months postoperatively. It should also be noted that the use of BFR training method in the prerehabilitation protocol led to an improvement in strength and increased PROs at 6 weeks after surgery. No differences were found in strength or PROs at three and six months between the groups (Okoroha et al., 2023).

Effects of the application of occlusive training

Two studies looked at muscle atrophy after surgery by measuring the cross-section of the thigh muscles. The use of BFR method was associated with a higher cross-sectional ratio of the knee extensors on operated compared to the healthy leg (Ohta et al., 2003), as well as lower hypotrophy expressed as a cross-section of the knee flexor and extensor (P<0.05) (Takarada et al., 2000b). In terms of pain, compared to training with a higher load, the occlusive training method has proven to be better (García-Rodríguez et al., 2024). Hughes et al. (2019a) observed significant improvements in pain in the group of subjects who exercised with BFR during training (P< 0.05; d= 2.5), but also 24 hours after training (P < 0.01; d=3.1) compared to the control group (Hughes et al., 2019a). In an earlier study, the same authors examined acute responses to BFR training and traditional training. The results showed that in both the healthy and LCA groups, training with LL-BFR (30% 1-RM) caused significantly more muscle pain than high-load training (70% 1-RM) without BFR (Hughes et al., 2018). In terms of knee pain, LL-BFR administered after LCA surgery caused significantly less pain compared to high-load training without BFR. On the KOOS scale (Knee injury and Osteoarthritis Outcome Score, where 0 represents extreme pain and 100 scores without pain, the BFR group reported significantly better scores compared to the control group (67 ± 10% vs. 39 ± 14%; P< 0.01) (Hughes et al., 2019b). When it comes to joint functionality, using the KOOS scale of lower limb function and the Lysholm scale. After eight weeks of training, the group that used BFR achieved higher values in all measures (P < 0.01), demonstrating greater functionality (Hughes et al., 2019b).

Conclusion

The application of the BFR method of training has proven to be effective in the fight against muscle hypotrophy after injury and surgery, and has its application in maintaining muscle strength. In patients who cannot be subjected, i.e. exposed to traditional training due to pain, discomfort, uncertainty, this method has proven to be effective. The duration of the intervention should be individualized, and the result largely depends on factors such as the size and shape of the cuff, arterial and local occlusive pressure, the intensity of the external load, the volume of training and, finally, the duration of the intervention itself. The BFR training method is effective until the moment when it needs to be replaced with a traditional type of training with a higher external load. Despite the fact that it has proven to be effective even when it lasts longer than 12 weeks, if the conditions are met for performing the traditional type of training with a higher external load, then it should be switched to it. Although BFR has positive effects, the magnitude of these effects is not like that of a traditional type of training with a higher external load. We recommend that BFR be used only in the early stages of rehabilitation when the patient is not actually able to perform the traditional form of training with a higher external load. Also, the greatest effects are observed when BFR is used 2-3 times a week due to its intensity. Arterial occlusive pressure of 80% has been shown to be better, and side effects that are very rare can be further avoided by the use of automatically regulated cuffs. The use of wider cuffs can reduce or eliminate discomfort in patients due to higher pressures in the cuff because the surface area is larger and because wider cuffs require less pressure to achieve the same level of circulatory occlusion. The advantage of this approach is that the exerciser performs exercises with a low external load of ~20-30% of 1-RM, but with a large number of repetitions per set (15-30) and short rest intervals between sets (30 seconds).

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UDK 796.015.1:616-001

Primena treninga uz okluziju krvotoka u oporavku nakon povrede prednje ukrštene veze kolena - Kratak pregled literature

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Uvod

Nakon povrede LCA pacijent nije u mogućnosti da izvodi određene aktivnosti, a sam proces rehabilitacije nakon operacije ne dozvoljava rano agresivno jačanje kako bi se zaštitio graft. Uobičajeni pristup u treningu usmerenom na povećanje mišićne mase i jačine podrazumeva izvođenje vežbi protiv velikog spoljašnjeg opterećenja, približno 70-85% od jednog maksimalnog ponavljanja (1-RM). Za razliku od ovog, tradicionalnog, pristupa, u oporavku nakon povreda sve češće se primenjuje tzv. ishemijski, odnosno okluzivni trening (eng. ''Blood Flow Restriction'': BFR). Okluzivni trening je tehnika koja kombinuje vežbe protiv malog spoljašnjeg opterećenja sa potpunom okluzijom (ograničenjem) venskog krvotoka i delimičnom okluzijom arterijskog krvotoka i ima potencijal da ubrza povratak jačine mišića kvadricepsa u ranom periodu rehabilitacije/oporavka.

Okluzivni metod kombinuje vežbe protiv malog spoljašnjeg opterećenja sa okluzijom (ograničenjem) venskog krvotoka pomoću pneumatske manžetne ili elastičnih guma koje se postavljaju proksimalno od ciljanog mišića, a tipično se koristi u situacijama kada treba izbegavati trening sa velikim spoljašnjim opterećenjem. Radi razumevanja ovog metoda, važno je da se razumeju dva pojma koja se odnose na samu okluziju. To su arterijski okluzivni pritisak (AOP) i okluzioni pritisak u ekstremitetu (eng. Limb occlusion pressure; LOP). AOP se odnosi na specifični pritisak pri kojem je protok arterijske krvi potpuno blokiran u ekstremitetu usled dejstva spoljašnje kompresije i to je bitna stavka kada je reč o okluzivnoj metodi treninga. U nekim istraživanjima se koristi LOP koji predstavlja minimalan pritisak koji je potreban da se u potpunosti spreči protok venske krvi iz ekstremiteta, dok se omogućava nastavak protok arterijske krvi. AOP je generalno veći od LOP jer specifično cilja arterijski protok, dok LOP uzima u obzir ukupni vaskularni otpor u ekstremitetu, uključujući arterije i vene.

Iako BFR metoda ima svoje mesto u praksi i istraživanjima, na našim prostorima još uvek predstavlja novinu. Cilj ovog rada je prikaz osnovnih karakteristika okluzivnog treninga uz osvrt na aktuelne preporuke za njegovu primenu radi postizanja što boljih rezultata tokom oporavka. Specifični cilj se odnosi na pitanje kada i u kojoj meri treba primenjivati okluzivni trening nakon povrede prednje ukrštene veze kolena, ali i moguća ograničenja ili kontraindikacije.

Metode

Pretraga literature je izvršena pomoću ključnih reči: ACLR, BFR, occlusion training, ACL rehabilitation, u Pubmed, SCIndeks i Google Scholar bazama podataka. 21 rad je ispunilo kriterijum za uključivanje u pregled literature: vremenski opseg 2000-2024; ACL; efekti na hipertrofiju mišića.

Rezultati i diskusija

Da bi se bolje razumeli efekti BFR, potrebno je osvrnuti se na procenat okluzivnog pritiska koji igra važnu ulogu u povećanju jačine i veličine mišića, smanjenju bola, boljoj funkciji zgloba i samoj aktivaciji mišića. Određivanje AOP ili LOP je ključno jer pomaže pri uspostavljanju optimalnog nivoa ograničenja potrebnog za postizanje željenih efekata treninga bez izazivanja prevelikog rizika ili nelagodnosti. AOP zavisi od veličine, materijala manžetn, ali i obima zahvaćenog uda.

Vrsta manžetne

U istraživanjima BFR pominju se razne varijante manžetni: jednokomorne i višekomorne manžetne, manžetne sa automatskom regulacijom primenjenog pritiska, ručne pneumatske manžetne (npr. neautomatski regulisane), manžetne sa različitim konturama i ravne manžetne, elastične manžetne, manžetne od najlona (Rolnick et al., 2023). Veća raznovrsnost i dostupnost uređaja koji poseduju tehnologiju autoregulacije, odziv i brzina kojom uređaj može da oseti i podesi pritisak, postaje važna varijabla u proceni uticaja ove funkcije. Trenutno, čini se da ima samo jedno istraživanje (Jacobs et al., 2023) u kome je direktno ispitana autoregulacija manžetne kao primarna varijabla u dizajnu istraživanja, a rezultati su pokazali smanjenje rizika za 3 puta u pogledu neželjenih događaja u poređenju sa neautoregulisanom manžetnom. Pored toga, tokom četiri serije vežbi do otkaza, grupa sa autoregulisanom manžetnom izvela je više ponavljanja (veći obim treninga) u odnosu na grupu sa neautoregulisanom manžetnom (~199 ponavljanja naspram ~161 ponavljanje, $p< 0.001$) uz manju bolnu osetljivost mišića (3± 2.2 vs. 4± 2.6, $p< 0.001$). Autori su zaključili da funkcija autoregulacije ima povoljan uticaj na više nivoa (Jacobs et al., 2023).

Istraživanja ukazuju da pored gore navedenih karakteristika i oblik manžetne utiče na veličinu pritiska neophodnog za određivanje AOP. Konturni oblici manžetne su duži na vrhu i kraći na dnu, stvarajući prisno pristajanje na ekstremitetima zbog razlika u prečniku. Konturne manžetne se proizvode i sa promenljivim oblikom konture. Ovakav dizajn uređaja omogućava još sigurnije pristajanje uz ekstremitet jer aparat za pričvršćivanje može da uzme u obzir male razlike u veličini i obliku ekstremiteta. Bez obzira na to, razlika u proksimalnom i distalnom prečniku konturne manžetne blago smanjuje AOP (~25,4 ± 16,1 mmHg mereno dopler ultrazvukom) u poređenju sa ravnom manžetnom. Okluzivni stimulus može biti drugačiji pošto je veća verovatnoća da će ravne manžetne primeniti asimetrične pritiske na ekstremitet s obzirom na proksimalno-distalnu razliku u obimu udova. Kod pojedinaca kod kojih zbog odgovora na pritisak tokom BFR vežbe kod kojih se želi smanjivanje pritiska na minimum, upotreba konturne manžetne može biti poželjna za prilagođavanje konusnom obliku ekstremiteta, posebno u donjim ekstremitetima.

Široke BFR manžetne ograničavaju arterijski protok krvi pri nižem pritisku od uskih BFR manžetni. Pored toga, pokazalo se da okluzivni pritisci u manžetni treba u velikoj meri da se zasnivaju na obimu butine, a ne na pritiscima koji su ranije korišćeni u literaturi (Loenneke et al., 2012a). Interesantan nalaz je bio da je model merenja obima nogu predvideo pritisak u manžetni neophodan da ograniči protok arterijske krvi podjednako dobro ili bolje od modela merenja sastava/kompozicije noge (količina mišića, masti, gustina kostiju...). Ovo sugeriše da bi merenje obima ekstremiteta, a ne sastava

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ekstremiteta, bilo adekvatno za određivanje okluzivnog pritiska u manžetni. Upoređujući faktore koji utiču na ograničenje protoka arterijskog krvotoka između uskih i širokih manžetni, regresioni modeli pokazuju da veličina i sastav ekstremiteta imaju veći uticaj na pritisak pri kojem dolazi do ograničenja arterijskog krvotoka korišćenjem širokih manžetni u odnosu na uske manžetne (Loenneke et al., 2012a). Pozicioniranje manžetne je obično na najproksimalnijem delu ekstremiteta koji je zahvaćen. Ako je reč o višekomornim manžetnama, pokazalo se da vazdušni mehur pravi bolju okluziju krvotoka ako se nalazi sa unutrašnje strane arterije, manji pritisak u manžetni je potreban da bi se postigao sličan ili isti AOP nego kada je vazdušni mehur sa spoljne strane arterije (Rolnick et al., 2023).

Preliminarni nalazi pokazuju da LL-BFR (30% 1RM) dovodi do slične aktivacije mišića kao i treninzi sa visokim intenzitetom bez okluzije krvotoka (80% 1-RM). Međutim, rezultati istraživanja nisu konzistentni zbog razlika u protokolima intervencija, posebno kod onih u kojima se izvode vežbe sa opterećenjem u kojima se koriste četiri serije do otkaza umesto samo jedne serije (Forelli et al., 2024). U istraživanju koje su radili Lixandrao i sar., (2015) pokazalo se da je povećanje okuzivnog pritiska efikasanije za mišićnu hipertrofiju samo kada se primenjuje uz niske intenzitete npr. 20% 1-RM i da nije bilo značajnih benefita kada se radi sa većim intenzitetima npr. 40% 1-RM. Trening sa opterećenjem uz okluziju krvotoka od 80% daje bolje rezultate kada se vežba sa nižim intenzitetom nego BFR uz veći intenzitet opterećenja (40% i više) (Lihandrao et al., 2015) . Li i sar., (2023) uporedili su uticaj BFR sa 40% AOP i 80% AOP na oporavak osoba sa rekonstrukcijom LCA. Ispitanici su bili podeljeni u tri grupe (kontrolna, 40% AOP i 80% AOP). Svi ispitanici su bili podvrgnuti različitim nivoima okluzivnog treninga, u kombinaciji sa standardnom rehabilitacijom kvadricepsa u trajanju od 8 nedelja. Vežbali su dvaput nedeljno, 4 serije po treningu: prva serija je bila 30 ponavljanja a u preostalim serijama po 15 ponavljanja, sa pauzama od 30sekundi između serija. Procedura testiranja je uključila maksimalnu izokinetičku jačinu ekstenzora kolena pri ugaonoj brzini od 60° i 180°stepeni/sekundi, zbir debljine zahvaćenog rektus femorisa i vastus intermediusa, rezultat na Y-balans testu, i skor na upitniku o funkciji kolena i fizičkoj aktivnosti (eng. International Knee Documentation Committee, IKDC) koji su sprovedeni pre i posle intervencije. Nakon 8 nedelja, grupa koja je radila BFR sa 80% AOP imala je značajno bolje rezultate nego grupa koja je radila sa 40% AOP, kako u maksimalnom momentu sile kvadricepsa tako i u zbiru debljine rektus femorisa i vastus intermediusa. Drugim rečima, kombinacija BFR i malog intenziteta vežbi za jačanje kvadricepsa može znatno poboljšati jačinu i poprečni presek ovog mišića nakon rekonstrukcije LCA i može im pomoći da se smanji razlika između povređene i nepovređene noge kao i da poboljša stanje zgloba kolena (Li et al., 2023). U istraživanju koje je radio Kubota i sar., (2011) pokazalo se da je pritisak od samo 50mmHg smanjio gubitke u jačini povezane sa imobilizacijom, što ukazuje da je sam BFR čak i bez vežbanja koristan za održavanje mišićne funkcije tokom perioda mirovanja nakon operacije (Kubota et al., 2011).

Veličina spoljašnjeg opterećenja i intenzitet treninga

Prilikom programiranja treninga među glavnim varijablama koje se kontrolišu su spoljašnje opterećenje i intenzitet. Kod tradicionalnog tipa treningu postizanje hipertrofije mišića i povećanje jačine podrazumeva izvođenje vežbi protiv velikog spoljašnjeg opterećenja približno 70-85% 1-RM. LL-BFR pri spoljašnjem opterećenju od samo 20% 1-RM, rezultirao je značajnim poboljšanjem mišićne snage i hipertrofije. Najveći efekti su primećeni kada je obim treninga bio 2-3 puta nedeljno. Takođe treba naznačiti da su efekti bili skoro duplo veći u grupi koja je radila treninge bez okluzije krvotoka ali sa opterećenjem od 80% 1RM (Vanwye et al., 2017). Pritisak koji se primenjuje tokom vežbanja takođe može u izvesnoj meri biti diktiran relativnim opterećenjem podignutim tokom treninga. Za većinu pojedinaca vežbanje sa opterećenjem koje odgovara 20-40% 1-RM uz okluziju krvotoka će verovatno maksimizirati rast i jačinu mišića (Lihandrao et al., 2015; Counts et al., 2016). Međutim, kada su korišćena opterećenja bliža donjoj granici (npr. približno 20% 1-RM), možda će biti potreban veći pritisak (približno 80% AOP) da bi se izazvao rast mišića, ali potrebna su dalja istraživanja da bi se opravdala ova tvrdnja. Takođe, pritisak prilikom okluzije je na drugom mestu u odnosu na intenzitet vežbanja kada je reč o intenzivnijim intervencijama gde se koristi 40% 1-RM u sklopu BFR protokola (Lihandrao et al., 2015). Patterson i sar. (2019) predlažu da se koriste opterećenja između 20% i 40% 1-RM jer je ovaj opseg opterećenja dosledno dovodio do adaptacije mišića kada se kombinuje sa BFR (Patterson et al.,, 2019). U istraživanju Kubota i sar. (2011) a odnosilo se na ispitivanje efekata primene BFR u početnoj fazi oporavka nakon rekonstrukcije LCA, ispitanici nisu ni bili izlagani dodatnom spoljašnjem opterećenju i kao rezultat su imali manje gubitke u jačini mišića (Kubota et al., 2011). Takođe u istraživanju koje su uradili Okoroha i sar. (2023) u preoperativnoj rehabilitaciji nisu koristili spoljašnje opterećenje već samo vežbe uz okluziju krvotoka i to je imalo pozitivan uticaj na poboljšanje snage i povećanja subjektivnog doživljaja vežbača do šeste nedelje nakon rekonstrukcije LCA (Okoroha et al., 2023).

Trajanje intervencije

Trenutni podaci iz literature sugeriše da je minimalno trajanje intervencije za uočavanje značajne razlike u povećanju mišićne jačine i hipertrofije od 6 do 12 nedelja i od 12 do 24 nedelje (Colombo et al., 2024). I pored te sugestije BFR ima svoje benefite čak i kada se koristi u trajanju od samo dve nedelje u pogledu smanjenja uticaja hipotrofije nakon rekonstrukcije LCA, povećanju subjektivnog doživljaja vežbača i poboljšanju jačine (Kubota et al., 2011; Okoroha et al., 2023). Uzimajući u obzir dokaze iz preglednog rada Loenneke et al., (2012b), isti autori su predložili progresivni model okluzivnog treninga koji može biti efikasan u rehabilitaciji od početka pa sve do povratka na vežbe sa velikim opterećenjem (Loenneke et al., 2012b ; Hughes et al., 2017). Predloženi model progresije za korišćenje okluzivnog treninga u ranoj rehabilitaciji do treninga sa velikim intenzitetom obuhvata pristup u četiri koraka:

1. Samo okluzija tokom perioda odmora u krevetu;
2. Okluzija u kombinaciji sa vežbama hodanja niskog intenziteta
3. Okluzija u kombinaciji sa vežbama sa malim opterećenjem (LL-BFR);
4. LL-BFR u kombinaciji sa vežbanjem visokog intenziteta

Značaj primene BFR u preoperativnoj fazi lečenja i uticaj na postoperativni oporavak

Kada je reč samo o preoperativnoj fazi (tzv. prehabilitacija) i uticaju BFR metode treninga na njen ishod, rezultati pokazuju da nema benefita u korišćenju ove intervencije u odnosu na standardni pristup vežbanju. U dva istraživanja sproveden je dvonedeljni plan treninga i poredili su se rezultati između, BFR grupa i grupa bez BFR (Tramer et al., 2023 ; Okoroha et al., 2023). I ako je protokol doveo do poboljšanja u jačini kvadricepsa u obe grupe, između grupa nije pronađena razlika u obimu kvadricepsa, jačini ili subjektivnom doživljaju vežbača. Utvrđeno je da je protokol prehabilitacije sa BFR-om koji su ispitanici radili kod kuće izvodljiv, pristupačan i da ga pacijenti dobro podnose (Tramer et al., 2023 ;

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Okoroha et al., 2023). Sa druge strane kada se gleda uticaj prehabilitacije na rehabilitaciju nakon rekonstrukcije LCA ishodi su drugačiji. U studiji koju su radili Okoroha i sar., (2023) cilj je da evaluiraju postoperativnu snagu kvadricepsa u izometriji kod pacijenata koji su imali operaciju LCA a koristili su okluzivni metod treninga u preoperativnoj rehabilitaciji (prehabilitaciji). Prehabilitacija je trajala 2 nedelje, 5 puta nedeljno. Ispitanici u BFR grupi koristili su (jednokomorne manžetne- "smart tool plus") i uputstvo da ih postave na 80% LOP. Nakon operacije, svi ispitanici, nezavisno od vrste prehabilitacije podvrgnuti su istom protokolu postoperativne rehabilitacije. Tokom trajanja istraživanja, ispitanici su testirani ukupno šest puta: 1) pri prvoj poseti klinici; 2) na dan operacije; 3) prvi postoperativni pregled; 4) nakon šest nedelja; 5) nakon tri meseca i 6) nakon šest meseci. Šest nedelja postoperativno, BFR grupa je pokazala značajno veću jačinu u poređenju sa kontrolnom grupom (indeks simetrije: 57% ± 24% naspram 40% ± 18%; P = .029), a BFR grupa je imala značajno bolji subjektivni osećaj (42,69 ± 5,64 naspram 39,20 ± 5,51; P = ,001) i rezultate na IKDC upitniku (58,22 ± 7,64 naspram 47,05 ± 13,50; P = ,011). Za razliku od njih, kod kontrolne grupe je uočen značajan pad u maksimalnom momentu sile operisane u odnosu na neoperisanu nogu, tj. niži indeks simetrije. Nije bilo značajnih razlika u snazi ili subjektivnom doživljaju vežbača na tri ili šest meseci postoperativno. Takođe treba napomenuti da je primena BFR metode treninga u protokol prehabilitacije dovela do poboljšanja snage i povećanja subjektivnom doživljaju vežbača do šeste nedelje nakon operacije. Nisu pronađene razlike u jačini ili subjektivnom doživljaju vežbača nakon tri i šest meseci između grupa (Okoroha et al., 2023).

Efekti primene okluzivnog trening

Dva istraživanja proučavala su atrofiju mišića nakon operacije, merenjem poprečnog preseka mišića natkolenice. Upotreba okluzivnog metoda treninga je bila povezana sa većim odnosom poprečnog preseka ekstenzora kolena operisane u poređenju sa zdravom nogom (Ohta et al., 2003), kao i manjom hipotrofijom izraženom kao poprečni presek fleksora i ekstenzora kolena (P<0.05) (Takarada et al., 2000b). Što se tiče bola, u poređenju sa treningom sa većim opterećem, okluzivni metod treninga se pokazao kao bolji (García-Rodríguez et al., 2024). Hughes i sar., (2019a) su kod grupe ispitanika koja je vežbala uz okluziju krvotoka primetili značajna poboljšanja u toku samog treninga (P< 0.05; d= 2.5), ali i 24 sata nakon treninga (P < 0.01 ; d=3.1) u poređenju sa kontrolnom grupom (Hughes et al., 2019a). U ranijem istraživanju, isti autori su ispitali akutne odgovore na trening sa BFR i tradicionalni trening. Rezultati su pokazali da i u grupi zdravih ispitanika i u grupi onih sa operacijom LCA trening sa LL-BFR (30% 1-RM) izaziva značajno veći bol u mišićima nego trening sa velikim opterećenjem (70% 1-RM) bez BFR (Hughes et al., 2018). Što se tiče bola u kolenu, LL-BFR primenjen nakon operacije LCA je izazvao značajno manji bol u odnosu na trening sa velikim opterećenjem bez BFR-a. Na KOOS skali (eng. Knee injury and Osteoarthritis Outcome Score), na kojoj 0 predstavlja ekstremnu bol a 100 skor bez bola, BFR grupa je prijavila značajno bolje rezultate u poređenju sa kontrolnom grupom (67 ± 10% naspram 39 ± 14% ; P< 0.01) (Hughes et al., 2019b). Kada je reč o funkcionalnosti zgloba koristeći KOOS skalu funkcije donjih ekstremiteta i Lysholm skalu. Posle osam nedelja treniranja, grupa koja je koristila BFR je ostvarila više vrednosti u svim merama (P < 0.01), pokazujući veću funkcionalnost (Hughes et al., 2019b).

Zaključak

Primena BFR metode treninga se pokazala kao efikasna u borbi protiv hipotrofije mišića nakon povrede i operacije, a ima i svoju primenu i u održavanju mišićne jačine. Kod pacijenata koje nije moguće podvrgnuti tj. izložiti tradicionalnom treningu usled bolova, nelagodnosti, nesigurnosti, ovaj metod se pokazao kao efikasan. Trajanje intervencije bi trebalo da bude individualno zasnovano, a rezultat u velikoj meri zavisi od faktora poput veličine i oblika manžetne, arterijskog i lokalnog okluzivnog pritiska, intenziteta spoljašnjeg opterećenja, obima treninga i na kraju, trajanja same intervencije. BFR metod treninga je efikasan sve do trenutka kada ga je potrebno zameniti sa tradicionalnim tipom treninga sa većim spoljašnjim opterećenjem. I pored toga što se pokazao kao efikasan čak i kada traje duže od 12 nedelja, ako se ostvare uslovi za izvođenje tradicionalnog tipa treninga sa većim spoljašnjim opterećenjem onda treba preći na njega. Iako BFR ima pozitivne efekte, veličina tih efekata ipak nije kao kod tradicionalnog tipa treninga sa većim spoljašnjim opterećenjem. Preporučujemo da se BFR koristi samo u ranoj fazi rehabilitacije kada pacijent zapravo i nije u mogućnosti da izvodi tradicionalni vid treninga sa većim spoljašnjim opterećenjem. Takođe najveći efekti su zapaženi kada se BFR koristi 2-3 puta nedeljno zbog svog intenziteta. Arterijski okluzivni pritisak od 80% se pokazao kao bolji, neželjeni efekti koji su jako retki se dodatno mogu izbeći upotrebnom automatski regulisanih manžetni. Primena širih manžetni može kod pacijenata umanjiti ili eliminisati nelagodnost usled većih pritisaka u manžetni jer je veća površina i jer je kod širih manžetni potreban manji pritisak da bi se ostvario isti nivo okluzije krvotoka. Prednost ovog pristupa je što vežbač izvodi vežbe sa malim spoljašnjim opterećenjem ~20-30% od 1-RM, ali sa velikim brojem ponavljanja po seriji (15-30) i kratkim intervalima odmora između serija (30 sekundi).

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UDK 796.015.1:616-001

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UDK 793.3:612.766

The effect of push-up rhythm and tempo on repetition count to failure, work output, and power - Pilot study

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Introduction

Work and power are among the fundamental indicators of performance in sports and physical activity (Haff & Triplett, 2015). Power represents the ability of muscles or muscle groups to generate force, while work reflects the amount of energy the body expends during physical activity. These two components are crucial for understanding and improving athletic performance, as well as for evaluating physical progress in athletes and recreational exercisers. Analyzing these parameters not only allows for training optimization but also provides a better understanding of the biomechanical and physiological processes that influence physical capacity (Schoenfeld, 2010).

Changing the tempo during push-ups and other exercises can be an important factor for muscle activation and performance improvement. Some studies suggest that different tempos and rhythms can significantly affect muscle activation, oxygen consumption, and overall training efficiency (Kearney et al., 2019). Faster exercise execution can contribute to increased metabolic stress, while a slower tempo can emphasize muscle tension and time under load, which is important for hypertrophy and endurance. The optimal rhythm depends on the training goal, individual abilities, and the nature of the exercise.

Push-ups are a practical, easily applicable multi-joint upper-body exercise that does not require expensive equipment and are therefore recommended as one of the best practical exercises (Lee, 2008). They are beneficial for developing upper-body muscle strength and endurance, particularly targeting the chest muscles, triceps, and anterior deltoids. Due to their simplicity and lack of need for additional equipment, they are suitable for both beginners and experienced exercisers. However, despite their popularity, few studies have systematically examined how different factors, such as tempo and rhythm, affect push-up performance.

Previous research has shown that execution tempo can significantly influence muscle activation and overall work during strength exercises (Wilk et al., 2020). Studies analyzing the effects of slow execution have indicated greater muscle tension and increased muscle fiber activation, while faster movements are more often associated with higher metabolic demands (Wilk et al., 2020; Schoenfeld, 2010). LaChance and Hortobagyi (1994) demonstrated that different execution tempos in pull-ups, as well as push-ups, which is more relevant to this study, affect performance. Specifically, a faster tempo significantly increases the maximum number of repetitions, as well as the work performed and power output. However, further research is needed for more conclusive findings on this topic.

The aim of this pilot study is to examine the impact of different push-up rhythms and tempos on the number of repetitions until muscle failure, work performed, and power output. The results could contribute to a better understanding of the relationship between different tempos and rhythms of exercises and physiological responses, which may have practical significance for training program design and individualization.

Methods

Subject sample

The sample of participants consisted of 9 male students from FSVF, with an average height of 183.6±7.2 cm and a weight of 80.3±10.2 kg. All students were healthy and had no injuries to the upper body musculoskeletal system that could affect the study results in the previous six months. Participants were informed about the procedures to be used and signed a written informed consent form before the start of the study. The study protocol adhered to the principles of the Declaration of Helsinki

Study design

In this study, an experimental design was used. The study was designed to examine the impact of different tempo and rhythm on the maximum number of push-ups performed, work done, and power. All measurements were conducted over four sessions, organized on four consecutive days. Body height was measured using an anthropometer (Seritex anthropometer model 100), while body mass and composition were assessed using bioelectrical impedance analysis (InBody 720) for each participant before the first session. In all five sessions, participants will perform the maximum number of push-ups at different tempos or rhythms.

Testing procedure

Before each session, participants performed a five-minute warm-up consisting of preparatory exercises. They were then given instructions on the exact tasks and workload for the session. Before the first session, participants' body height and composition were measured. Participants performed the maximum number of push-ups at different tempos controlled by a metronome (90 bpm, 60 bpm, 60 bpm [1:2], and 60 bpm [2:1]) across four separate sessions, with a 24-hour rest between each. Participants stopped performing push-ups as soon as they fell out of sync with the metronome. The order of tempo and rhythm conditions was randomized for each participant. Based on the collected data, work (A) and power (P) were subsequently calculated according to LaChance and Hortobagyi (1994).

Statistical analysis

Descriptive statistics, specifically the mean and standard deviation, were used to analyze the basic characteristics of the participants. To examine differences in the number of push-ups performed, work done, and power, a one-way analysis of variance (ANOVA) was applied, with Bonferroni used as a post-hoc test. The Kolmogorov-Smirnov test was used to assess the normality of data distribution.

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Results

The research results indicated that there were no statistically significant differences between different tempos and rhythms in the maximum number of repetitions (F=2.794, p=0.056) or work done (F=1.853, p=0.158). However, statistically significant differences were found in power output (F=31.157, p=0.000). Bonferroni post-hoc test results showed statistically significant differences between all groups, except between the 60 bpm (1:2) and 60 bpm (2:1) conditions, where no significant differences were observed (p=1.000).

Table 1. Mean Values of Maximum Push-Ups, Work Done, and Power Across Different Tempos and Rhythms

Frequency	Maximal repetitions	A (J)	P (W)
90bpm (1:1)	25.7 ± 7.6	6444.6 ± 2249.5	182 ± 34.9**
60bpm (1:1)	23 ± 7.8	5850.8 ± 2424.9	127 ± 31.5**
60bpm (1:2)	17 ± 5.5	4365.1 ± 1839	79 ± 16.2**
60bpm (2:1)	17.8 ± 8.6	4502.3 ± 2430.8	80.3 ± 16.4**

** $p < 0.01$ indicates a statistically significant difference.

Disscusion

Different tempo and rhythm of push-up execution can significantly influence muscle activation and performance during strength training. This study demonstrated that varying tempo and rhythm do not lead to significant differences in the maximum number of repetitions and work done but do have a significant effect on power output ($p < 0.05$). The highest power was achieved when performing push-ups at a tempo of 90 bpm (1:1), while the lowest power values were recorded at tempos of 60 bpm (1:2) and 60 bpm (2:1).

Controlling the tempo and rhythm of exercises can be a key factor in optimizing strength training. Research has shown that varying tempo can affect muscle activation, oxygen consumption, and the overall training effect (Kearney et al., 2019; Wilk et al., 2020). A faster tempo typically leads to greater power output and muscle contraction speed, while a slower tempo increases time under tension, which can contribute to hypertrophy and muscular endurance (Schoenfeld, 2010). Numerous studies have examined the impact of different tempo and rhythm on muscle strength and hypertrophy. Regarding hypertrophy, studies have shown that slower execution of exercises leads to greater muscle growth. Specifically, exercises performed with a 3-second concentric and 3-second eccentric contraction had significantly greater effects compared to those performed with a 1-second concentric and 1-second eccentric contraction (Tanimoto & Ishii, 2006; Watanabe et al., 2013; Usui et al., 2016).

When discussing the development of power and explosiveness, particularly vertical and horizontal jumps, research has shown that exercises with shorter contraction durations yield better results (Morrissey et al., 1998; Bottaro et al., 2007; Usui et al., 2016). Understanding these mechanisms allows for better application in sports practice and the individualization of training according to the athlete's goals.

However, there are only a few studies with a research objective similar to ours. Our results partially confirm the initial hypothesis that different tempos and rhythms significantly affect power output but not work done or the maximum number of repetitions. When compared to previous research, our findings align with those of LaChance and Hortobagyi (1994), who also demonstrated that a faster tempo contributes to greater power output. However, while previous studies have shown that a slower tempo can increase overall metabolic stress and muscle activation, our study did not find significant differences in total work across different tempos. Future research should focus on a deeper analysis of the biomechanical and physiological responses to various tempo regimes.

As this is only a pilot study, one of its limitations is the relatively small sample size (n=9). Additionally, the study was conducted only on male participants, raising the question of whether similar results would be obtained in female subjects. Future studies could include a larger sample, different age groups, and training levels, as well as additional biomechanical and physiological parameters.

The results of this study indicate that push-up tempo significantly affects power output but not the maximum number of repetitions or work done. If the goal is to increase power, a faster tempo should be used during exercises. Trainers and athletes can utilize this information to adjust training regimens based on specific goals.

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UDK 796.322.015.8

Development trend of attacking performance indicators in elite men's handball teams at the EHF Champions League final tourtournament

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Introduction

Modern handball represents a very complex competitive sport activity, which is largely determined by individual technical-tactical indicators of the game and the interaction of individuals within the team. The game is becoming faster, with numerous changes in movement speed, and the individual and group technical-tactical activities of players in attack have become the main indicators of success in handball (Skarbalius et al., 2018). During the game, there is a high variability in movements, conditioned by numerous factors of the players' physical fitness, and all the mentioned indicators that affect team success vary during the competitive activity of a team. The role of the coach in creating the training process and managing the competitive activities of the handball team is of increasing importance. Silva (2008) defines the role of the coach as crucial in the evolution of the game, stating that tactical changes in the game are initiated by handball coaches, which has led to changes in the structure of the game.

All changes in the structure of handball from the perspective of technique and tactics can be observed through different phases of the game. To achieve success and a better understanding of the game, Daza et al. (2017) state that the dominant indicators of competitive activity should be equally represented in all phases of the game and should be properly represented and combined during the competition. In this regard, the analysis of competitive activity is an essential condition for achieving top results in sport, including handball. Meletakos et al. (2011) note that based on the analysis of competitive activity in handball, it is possible to identify indicators that distinguish winning teams from those that lose matches. During the analysis, data is collected that opens the possibility of comparing indicators between players and teams. Such comparisons can help identify differences between indicators that may influence the final outcome of the match or competition (Vuleta et al., 2012). To observe all aspects of the game, Vuleta et al. (2015) propose a hierarchical structure of factors to be analyzed in players. On the first level are aspects of physical fitness and morphological characteristics. On the next level is the knowledge of the game and the ability to perform basic technical-tactical elements of the game. On the third level is the efficiency and proper selection of actions taken during certain periods of the game, while the fourth level addresses the impact of individual player activity on the final outcome of the match.

We may witness significant changes in the structure of handball. As Meletakos et al. (2011) point out, there has been a constant increase in the number of attacks and shooting efficiency at major handball competitions. On the other hand, Ohnjec et al. (2008) mention in their research that, at the Women's World Senior Championship, the final result of the match was directly linked to the shooting efficiency from six meters and from the wing positions. Some authors emphasize the efficiency of positional attacks as a key factor for achieving victory, particularly highlighting its importance in the final stages of a match (Skarbalius et al., 2018). Furthermore, other researches mention attacking indicators such as: goals from six meters, total number of goals, total number of shots, shots from nine meters, wing shots, counterattack shots, and assists (Almeida et al., 2019; Milanović et al., 2018).

Despite the large number of studies analyzing the technical-tactical parameters of attacks in handball, there is an insufficient number of those that can indicate the trend of their changes in a specific competition cycle. For this reason, this paper will present and analyze results based on which conclusions will be drawn to allow for a better understanding of how the choice of shot can influence the success of teams in a competition. In this way, the system for monitoring technical-tactical parameters of attacking play could be improved, which can significantly impact the advancement of the training and competition process.

This study aims to determine the trend of changes in the technical-tactical parameters of attacks in top men's handball teams at the final four tournament of the EHF Champions League, in order to define the most sensitive parameters in relation to the final standings of teams.

Method

This research is of a transversal type. The sample of the research consisted of the results of 8 top men's club teams that participated in the final tournament of the EHF Champions League in 2022 and 2023. All data (variables) were taken from the official website of the European Handball Federation (https://www.eurohandball.com). The main criterion for the analysis was the final ranking of the teams in the tournament, from first to fourth place.

In this research, 10 variables were analyzed and divided into three groups: quantitative, qualitative, and structural technical-tactical indicators of the game in attack. These are: the total number of shots from 9-meter, the total number of shots from 6-meter, the total number of shots from the wing position, the total number of penalty throw (7-meter), total number of shots, efficiency of 9-meter shots, efficiency of 6-meter shots, shooting efficiency from the wing position, the shooting efficiency from a penalty throw (7-meter) and the total shooting efficiency.

For the purposes of this research, the following methods were used: analysis of competitive activity – notational analysis, statistical analysis, and logical-causal analysis. Descriptive statistics and distribution parameters were performed for all variables. To determine the effect of change, one-way analysis of variance was applied, and for trend analysis of change, linear regression analysis was used. In accordance with the subject, aim, and tasks of the research, all data were processed using Microsoft Office Excel 2019 software.

Results

Table 1 presents the cumulative results of descriptive statistics for the technical-tactical parameters of the attack at the men's Champions League final tournaments in 2022 and 2023.

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In the columns of Table 1, in relation to the teams' rankings, results for all monitored variables are shown, divided into two main groups: the number of attempts and shooting efficiency. For all monitored variables, the following are presented: the average (AVG), standard deviation (SD), maximum result (Max), minimum result (Min), and the coefficient of variation (cV).

By analyzing the data from Table 1, it is found that, on average, the highest number of shots taken from 6-meter was by the first-place (52) and third-place teams (52.5), while the highest average shooting efficiency from this distance was recorded by the second-place teams (77.9%) and third-place teams (77.4%). The second-place teams took the highest number of shots on average (38.5) from 9-meter, while the first-place teams had the highest average shooting efficiency from this distance (54.3%), but with only 17 attempted shots. The first-place teams took the most shots on average (16.5) from the wing position, while the highest shooting efficiency from this position was achieved by the second-place teams (76.8%) and fourth-place teams (76.3%). The first-place teams had the highest number of penalty shots on average (16.5), as well as the highest average shooting efficiency (85.1%). The third-place teams had the highest total number of shots attempted in a match (109.5), and the first-place teams had the highest overall shooting efficiency (67.9%).

Table 1. Cumulative results of descriptive statistics for the technical-tactical parameters of the attack at the Men's Champions League final four tournaments 2022 and 2023

	6m	6m %	9 m	9m %	wing	wing %	7m	7m %	shots	% shots
I	52	74,2	17	54,3	16,5	66,2	16,5	85,1	104	67,9
II	38,5	77,9	38,5	38	10,5	76,8	11,5	78	99,5	63,2
III	52,5	77,4	32	50,4	13,5	66,5	10,5	56,8	109,5	65,2
IV	46,5	69,9	33,5	46,3	10,5	76,3	9,5	51,4	103	60,7
AVG	47,4	74,9	30,3	47,3	12,8	71,5	12,0	67,8	104,0	64,3
SD	6,5	3,7	9,3	7,0	2,9	5,9	3,1	16,3	4,1	3,1
Max	52,5	77,9	38,5	54,3	16,5	76,8	16,5	85,1	109,5	67,9
Min	38,5	69,9	17,0	38,0	10,5	66,2	9,5	51,4	99,5	60,7
cV%	13,7	4,9	30,6	14,8	22,5	8,2	25,9	24,0	4,0	4,7

6m - total number of shots from 6-meter; **6m %** efficiency of 6-meter shots; **9m** - total number of shots from 9-meter; **9m %** - efficiency of 9-meter shots; **wing** - total number of shots from the wing position; **wing %** - shooting efficiency from the wing position; **7m** - total number of penalty throw; **7m %** - shooting efficiency from the penalty throw; **shots** - total number of shots; **% shots** - total shooting efficiency; **AVG** - average; **SD** - standard deviation; **cV** - coefficient of variation; **Max**- maximum result; **Min** - minimum result.

The aim of this study was to check the trend of changes in the analyzed qualitative technical-tactical attacking indicators in relation to the final ranking of men's teams at the final four tournament of the EHF Champions League in 2022 and 2023.

Figure 1 presents the trend of change in the average value of the total shooting efficiency, which represents the ratio between the number of attempted and successful shots expressed as a percentage, at the final four tournaments of the EHF Champions League for men in 2022 and 2023 in relation to the teams' rankings. On average, the highest total shooting efficiency percentage was recorded by the first-place teams (67.91%), while the lowest was by the fourth-place teams (60.68%).

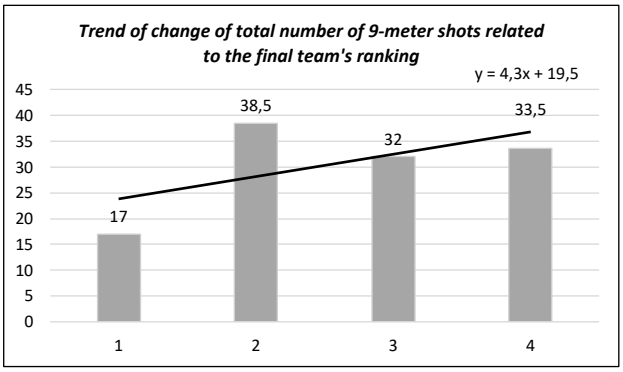

Figure 1. Trend of change in the average total shooting efficiency in relation to the teams' final rankings at the Men's final four tournaments of the EHF Champions League in 2022 and 2023.

The results of this study confirmed a statistically significant trend of change for this monitored variable (F=4.18; p=0.005). The total shooting efficiency percentage decreased, on average, by 1.96% from the first-place to the fourth-place team. Figure 1 shows a negative trend in the change of the average total shooting efficiency percentage in relation to the teams' rankings.

The aim of the research also included verifying the trend of changes in the analyzed structural technical-tactical attacking indicators in relation to the ranking of men's teams at the final four tournament of the EHF Champions League in 2022 and 2023.

Figure 2 presents the trend of change in the average of the total number of 9-meter shots at the final tournaments of the EHF Champions League for men in 2022 and 2023 in relation to the teams' rankings. The highest average number of shots on goal from 9-meter was made by the second-place teams (38.5), while the fewest shots were made by the first-place teams (17).

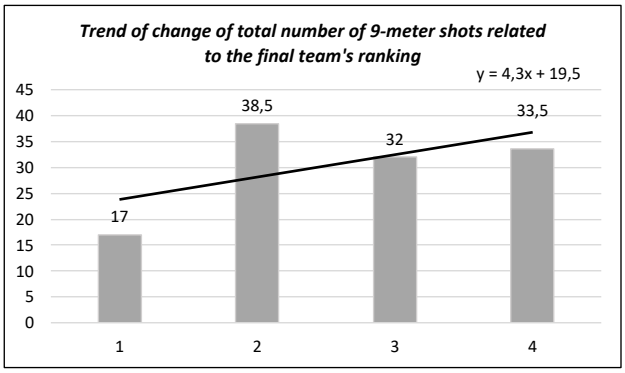

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Figure 2. Trend of change in the average number of 9-meter shots in relation to the teams' final rankings at the Men's final four tournaments of the EHF Champions League in 2022 and 2023.

The results of this study confirmed a statistically significant trend of change for this monitored variable (F=2.88; p=0.048), and it was found that the average number of shots taken from 9-meter increased by an average of 4.3 shots per team from the first-place to the fourth-place team. Figure 2 shows a positive trend in the change of the average number of shots taken from 9-meter line.

Figure 3 presents the trend of change in the average number of penalty throws (7-meter shots) taken at the final four tournaments of the EHF Champions League for men in 2022 and 2023 in relation to the final teams' rankings. The highest average number of penalty shots was made by the first-place teams (16.5), while the fewest shots were made by the fourth-place teams (9.5).

The results of this study confirmed a statistically significant trend of change for this monitored variable (F=10.08; p=0.001), and it was found that the average number of penalty shots decreased by an average of 2.2 shots per team from the first-place to the fourth-place team. Figure 3 shows a negative trend in the change of the average number of penalty shots taken.

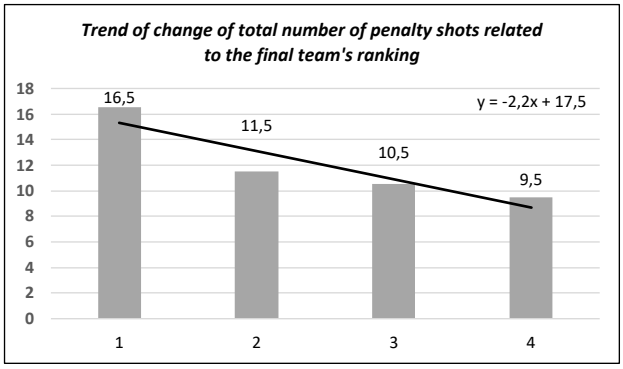

Figure 3. Trend of change in the average number of penalty shots taken in relation to the teams' final rankings at the final four tournaments of the EHF Champions League for men in 2022 and 2023.

Figure 4 presents the trend of change in the average penalty shot efficiency, which represents the ratio between the number of attempted and successful penalty shots expressed as a percentage, at the Men's final four tournaments of the EHF Champions League in 2022 and 2023 in relation to the teams' final rankings. The highest average penalty shot efficiency was achieved by the first-place teams (85.11%), while the lowest efficiency percentage for penalty shots was recorded by the fourth-place teams (51.43%).

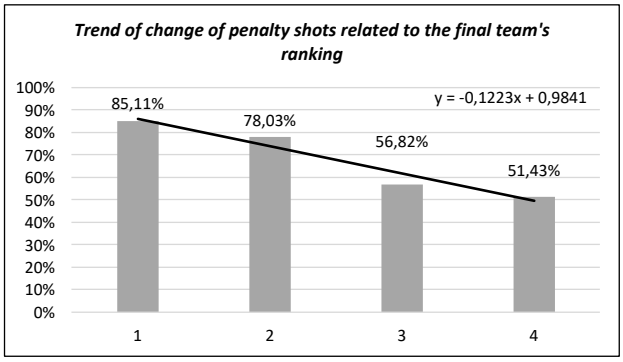

Figure 4. Trend of change in the average penalty shot efficiency in relation to the teams' final rankings at the Men's final four tournaments of the EHF Champions League in 2022 and 2023.

The results of this study confirmed a statistically significant trend of change for this monitored variable (F=32.79; p=0.000), and it was found that the average penalty shot efficiency decreased by 12% from the first-place to the fourth-place team. Figure 4 shows a negative trend in the change of penalty shot efficiency.

Discussion

This research identified a statistically significant trend of change in four out of the ten examined variables. A statistically significant trend of change in relation to the teams' rankings at the final tournaments of the EHF Champions League for men in 2022 and 2023 was found in the analyzed qualitative and structural attacking indicators.

The results of this study confirmed a statistically significant negative trend in the change of the overall shooting efficiency percentage at the final tournaments of the EHF Champions League for men in 2022 and 2023 in relation to the teams' rankings (F=4.18; p=0.005). The overall shooting efficiency percentage decreased by an average of 1.96% from the first-place to the fourth-place team.

Overall shooting efficiency is a discriminative technical-tactical parameter of attacking play in the context of team rankings at major handball competitions, as emphasized by other authors (Almeida, 2019; Bilge, 2012; Ohnjec et al., 2008). Results supporting this finding are also mentioned in the research by Jovanović (2022), who examined the trend of changes in the shooting efficiency of the top handball national teams at European Championships from 2010 to 2018. The same author states that the top four ranked teams have statistically significantly higher overall shooting efficiency compared to lower-ranked teams at these competitions.

Overall shooting efficiency is clearly a discriminative technical-tactical parameter in attacking play at top handball competitions for women as well. In the research by Kragulj (2016), who examined the trend of changes in the efficiency of play of top women's handball teams at World Championships from 2009 to 2015, it is also stated that more successful teams have statistically significantly higher overall shooting efficiency compared to lower-ranked teams at those competitions.

This study also confirmed a statistically significant positive trend in the change of the number of 9-meter shots (F=2.88; p=0.048), and it was found that the average number of shots taken from 9-meter line increased by 4.3 shots per team from the first-place to the fourth-place team. The lower number of those shots by higher-ranked teams may indicate that teams with a higher level of technical-tactical proficiency organize their attacks more patiently and efficiently, not frequently finding themselves in situations where they need to take shots from beyond the free-throw line compared to lower-ranked teams.

Additionally, the higher number of 6-meter shots observed in higher-ranked teams may indicate that more successful teams search for technical-tactical solutions in attack that provide a more secure position for scoring a goal, i.e., a position that potentially ensures higher efficiency of the executed shot. Similar results have been recorded by other authors, who concluded that 9-meter shots can play a decisive role in determining the final ranking of teams in major handball competitions (Almeida, 2019; Milanović, 2018).

The higher number of 9-meter shots recorded in lower-ranked teams may indicate greater efficiency in the defense of higher-ranked teams. It is well known that a great

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deal of attention is currently paid to defense in handball, especially at the highest level. Numerous authors have pointed out that, in recent years, there has been a negative trend in the total number of goals scored, with a steady increase in shot efficiency, particularly in higher-ranked teams (Jovanović, 2022; Kragulj, 2016). All of this indicates that a high defensive efficiency is necessary for a high ranking in major handball competitions. In this regard, we can conclude that lower-ranked teams at the final four tournaments of the EHF Champions League had a higher number of 9-meter precisely because they faced efficient defensive systems and failed to secure safer positions for scoring goals, such as the 6-meter shot.

The results of this study confirmed a statistically significant negative trend in the change of the average number of penalty shots (7-meter throws) taken at the EHF Men's Champions League final four tournaments in 2022 and 2023, in relation to the placement of teams ($F=10.08$; $p=0.001$). It was found that the average number of penalty shots taken decreased by 2.2 shots per team from the first-place to the fourth-place team.

The aforementioned results support the fact that higher-ranked teams, on average, had a greater number of penalty shots, which may indicate more efficient organization of their attacks. According to the rules of handball, a penalty shot is awarded when a clear goal-scoring situation is prevented. It can be concluded that lower-ranked teams more frequently prevented such goal-scoring situations, which also indicates a lower level of their defensive efficiency. Similar findings are mentioned by other authors. Gomez et al. (2010) concluded that teams with higher rankings in competitions have more efficient offensive strategies, which inevitably bring them into more clear goal-scoring situations. This, in turn, leads defensive players into situations where they unlawfully prevent such goal-scoring situations, resulting in a higher number of referee decisions for penalty shots. The same author also points out that these findings can be explained by psychological factors. Namely, in their defensive opposition to higher-ranked teams, lower-ranked teams may face psychological pressure, which can result in recklessness and a greater number of defensive mistakes, leading to a higher number of decisions to award a penalty shot.

The results of this study confirmed a statistically significant negative trend in the change of the average penalty shot efficiency, which represents the ratio between the number of attempted and successful penalty shots expressed as a percentage at the EHF Men's Champions League final four tournaments in 2022 and 2023, in relation to the placement of teams ($F=32.79$; $p=0.000$). It was determined that the average penalty shot efficiency decreased by 12% from the first-place to the fourth-place team.

Higher-ranked teams, on average, demonstrated significantly higher penalty shot efficiency compared to lower-ranked teams. A penalty shot represents an attacking action where the attacker directly faces the goalkeeper of the opposing team without interference from other defensive players. During the execution of a penalty shot, the attacker has enough time to focus their attention on the ultimate goal, which increases the likelihood of scoring. In contrary, all other shots in handball are executed under competitive pressure and direct opposition from defensive players, which can reduce the precision and effectiveness of the shot. Additionally, penalty shots are taken under static and relatively stable conditions, allowing the shooter to properly position themselves and prepare for the shot.

The higher penalty shot efficiency in higher-ranked teams may indicate better player selection in more successful teams, meaning that the players executing these shots possess higher technical and tactical skills, better psychological stability, make timely and good decisions, and likely have greater playing experience, which helps them handle such competitive situations. Similar findings can be found in the research of Lago-Penas et al. (2010), who analyzed individual parameters of competitive activity in top-level handball teams. They note that higher-ranked teams usually have players with a high level of technical-tactical skills and enough competitive experience, which can lead to better penalty shot execution. These teams have players who handle psychological pressure better, which also leads to better stability and higher efficiency when executing this shot.

Further support for the findings of this research can be found in other authors' works, which emphasize that higher penalty shot efficiency can be explained by the fact that higher-ranked teams have players with better technique and individual tactics, more playing experience, better shot selection strategies, greater variability, and minimal tactical awareness in choosing the shooting technique (Gomez et al., 2010; Lago-Penas et al., 2010; Rein et al., 2013).

Conclusion

The results of this research have shown that the following qualitative and structural indicators, as technical-tactical parameters of attack in top-level men's handball teams, can influence the definition of the most sensitive indicators in relation to the placement of teams in major handball competitions: overall shooting efficiency percentage, total number of shots taken outside the 9-meter line, total number of penalty shots (seven-meter shots), and penalty shot efficiency percentage.

Identifying key attacking indicators to define parameters in relation to placement is of great importance for the further development of the training process in handball. In this regard, this study confirmed the connection between qualitative and structural attacking indicators as a discriminative factor for team placement.

The process of establishing a hierarchical structure of factors becomes highly significant for applying the results of such analyses in the context of training and competitions when setting a high goals in sports. Determining the factors that influence the game can aid in the development and improvement of training process, both for coaches and players (Wagner et al., 2014). In this way, the collected data can be viewed in the context of evaluating each player's competitive activity in different phases of the game, as well as their contribution to achieving the team result. This can allow coaches to make an appropriate tactical plan and strategy for the competition in order to achieve the desired goals.

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UDK 796.611

Center of pressure oscillations in spontaneous body posture in adolescents and adults

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Introduction

The fact that human beings are able to maintain vertical posture is in itself a miracle. One would have hard time imagining a mechanical system that is less stable in the field of gravity. Sometimes during analysis of control of the vertical posture, the human body is modeled as an inverted pendulum (Figure 1), which is not easy to equilibrate, especially in the presence of external perturbations and changes in its orientation with respect to the field of gravity. However, the problem is much more complicated because of the presence of a number of joints along the axis of the pendulum (Latash, 2008).

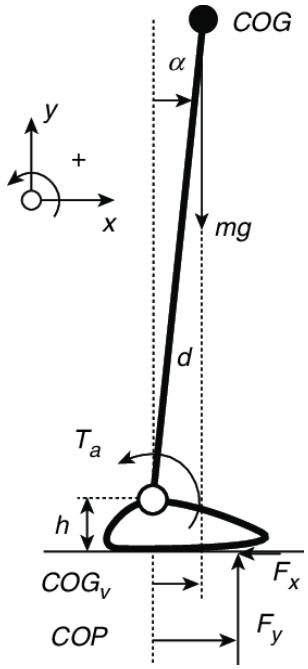

Figure 1. Single inverted pendulum model for the representation of a human standing. COG, center of gravity; COGv, COG vertical projection in relation to the ankle joint; COP, center of pressure in relation to the ankle joint; m, g, bodymass, acceleration of gravity; Fx, Fy, horizontal and vertical components of the resultant ground reaction force; Ta, torque at the ankle joint; d, distance between the COG and ankle joint; h, height of the ankle joint to the ground; α, angle of the body (Duarte, 2011).

In physics, stability of a mechanical system in the field of gravity requires that the projection of its center of mass fall within the area of support (Latash, 2008). The area of support for a human being is relatively small (of the order of approximately 120 cm2), requiring fine-tuning of interaction between movements in different joints along the body in order to maintain the equilibrium. The sense of balance is one of the least prominent in our consciousness. Humans become aware of it only in extreme situations when balance is seriously endangered. The nervous system integrates visual, vestibular, and somatosensory information regarding the position of the body and its segments to maintain an upright posture (Jeong et al., 2011). Vision provides one of the most reliable sources of information for the human brain. When visual information comes into conflict with information of another modality, people tend to "believe" their eyes, not the other source of information. The system for postural control is also strongly dependent upon visual information. For example, all possible indexes of postural stability become worse if the subject is standing with eyes closed. This means that the body is constantly in motion, which is called postural sway (Røgind, 2003).

The spontaneous body posture test involves monitoring the oscillations of the center of pressure (COP), providing insights into the sensitivity of postural control, which integrate various neurological and biomechanical mechanisms (Figure 2). Changes occurring after the age of 60 reduce the sensitivity of postural control (Wang, 2024; Michalska et al., 2021; Hegeman et al., 1995; Sheldon, 1963). Establishing normative values for a healthy population within a specific age group holds significant practical importance in the field of health. Since spontaneous posture disorders can signal the onset or progression of various diseases, gaining insight into how the variables that regulate spontaneous posture manifest in a healthy population is essential (Mancini et al., 2012; Ruhe et al., 2011). During natural bipedal stance with eyes open, studies have reported a decrease in postural sway with increasing age (Newell et al., 1997). When standing with eyes closed, adolescents exhibit greater postural sway compared to when their eyes are open (Newell et al., 1997; Gebel et al., 2019). Additionally, postural sway decreases with age even in the eyes-closed condition (Newell et al., 1997; Wolff et al., 1998). Most of the studies to date have been concerned with the comparison of COP symptoms between different age groups. Thus, the aim of this study is to examine differences in spontaneous posture with eyes open and closed between adolescents and adults by monitoring variables that integrate COP oscillations in both directions and to explain these differences by correlation of spontaneous posture variables with age.

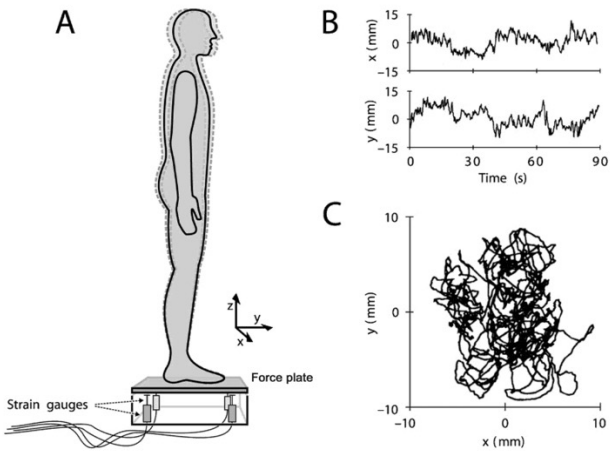

Figure 2. Change of the center of pressure (COP) calculated through the force plate. (A) Stand statically on the force plate for the postural sway test. The dotted line of the humanoid outline indicates spontaneous sway. The force plate is usually arranged with strain gauges at the four corners below the supporting plate, which can calculate the ground reaction force and COP trajectory. (B) COP time series in medio-lateral (x) and anterio-posterior (y) directions. (C) The trajectory of COP (Chen et al., 2021).

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Method

The sample consisted of 67 healthy subjects without recent injuries, divided into two age categories (Lachman, 2001): 35 adolescents (13-18 years) and 32 middle-aged adults (40-60 years). Two tests of spontaneous posture were conducted: one with eyes open (EO) and one with eyes closed (EC). With instruction to remain as still as possible on a force platform (MuscleLab, Ergotest Technology AS, Langesund, Norway) for 30 seconds, the subjects maintained their regular upright posture with their feet parallel, arms next to the body and hip-width apart. Before the test began, the subjects took a deep breath in and out to calm their breathing, while simultaneously adopting into their natural upright posture through single circular motion in the shoulder joints. The sample rate was 200 Hz, and further, no filter was used as an analog-to-digital converter. The test order was randomized across the participants.

Verbal encouragement to the participants, peaceful conditions without noise and artificial lighting were standardized. The monitored variables were the total area of the COP movement (ACOP), the mean COP distance (MCPD), the COP path length (LCOP), and the COP path velocity (VCOP). Repeated measures ANOVA was used to compare differences, with additional post-hoc T-test with Bonferroni correction if a statistically significant effect of a factor or interaction was observed, while the Pearson correlation coefficient was applied to examine associations between variables. Data was analyzed using IBM SPSS Statistics (version 26, IBM, Armonk, NY, USA). Statistical significance was set at ≤ 0.05.

Results

The normality of the data was assessed using the Shapiro-Wilk test, and all identified outliers were excluded from further statistical analysis. All data showed a normal distribution ($p > 0.05$).

Table 1 presents the results of the repeated measures ANOVA, including the main effects of the factors and their interaction. For all of the variables the Time x Group interaction was statistically significant ($p \pm 0.05$), except for VCOP that showed tendency towards statistical significance ($p = 0.08$).

Table 2 provides descriptive statistics for spontaneous body sway variables, along with the results of post-hoc T-tests comparing differences between the two groups and test conditions.

Table 1. ANOVA: Influence of condition, group and their interaction. Presented are F-values and their statistical significance.

Variable	Test	Group	Test x Group
ACOP	F = 19.07 p < 0.01	F = 18.39 p < 0.01	F = 6.49 p < 0.05
MCPD	F = 20.02 p < 0.01	F = 9.07 p < 0.01	F = 7.96 p < 0.05
LCOP	F = 66.57 p < 0.01	F = 25.93 p < 0.01	F = 3.96 p = 0.05
VCOP	F = 73.01 p < 0.01	F = 22.69 p < 0.01	F = 3.10 p = 0.08

Table 2. Descriptive statistics of spontaneous body sway variables and post-hoc T-tests. (mean ± standard deviaton).

Variable		EO	EC	Post-hoc
ACOP [mm^2]	Adolescents Adults **Post-hoc**	83.6 ± 38.0 50.4 ± 28.3 p < 0.01	136.1 ± 89.0 64.2 ± 36.0 p < 0.01	p < 0.01 p = 0.22
MCPD [mm]	Adolescents Adults **Post-hoc**	3.6 ± 1.1 3.2 ± 1.1 p = 0.19	4.7 ± 1.6 3.4 ± 1.0 p < 0.01	p < 0.01 p = 0.26
LCOP [mm]	Adolescents Adults **Post-hoc**	362.9 ± 92.7 247.4 ± 54.7 p < 0.01	503.0 ± 188.7 332.6 ± 100.5 p < 0.01	p < 0.01 p < 0.01
VCOP [mm/s]	Adolescents Adults **Post-hoc**	12.0 ± 3.1 8.4 ± 2.2 p < 0.01	16.3 ± 5.8 11.2 ± 3.3 p < 0.01	p < 0.01 p < 0.01

Adolescents exhibited higher levels of oscillation indicators at EC compared to EO ($p < 0.05$), whereas adults exhibited mentioned differences only for LCOP and VCOP ($p < 0.05$). Adults exhibited smaller oscillation indicators compared to adolescents ($p < 0.05$), except for MCPD at EO.

Table 3 shows the Pearson's correlation coefficients between spontaneous body sway variables and age.

Table 3. Pearson's correlations between sway variables and age. * marks statistical significance ($p < 0.05$).

	ACOP	MCPD	LCOP	VCOP
EO	-0.39*	-0.09	-0.55*	-0.52*
EC	-0.45*	-0.38*	-0.45*	-0.38*

Age is moderately correlated with all oscillation indicators ($r = -0.38$–0.55, $p < 0.05$), except MCPD at EO ($p > 0.05$).

Discussion

The aim of this study was to examine differences in spontaneous posture with eyes open and closed between adolescents and adults by monitoring variables that integrate COP oscillations in both directions and to explain these differences by correlation of spontaneous posture variables with age. Adolescents and adults both exhibited more stable spontaneous posture at EO condition, with adults demonstrating greater stability compared to adolescents, suggesting greater proficiency in maintaining stable, upright posture. Age showed a moderate correlation with nearly all oscillation indicators, indicating that postural control remains relatively robust and sensitive until later life.

Adolescents exhibited higher levels of oscillation indicators at EC compared to EO, whereas adults exhibited mentioned differences only for LCOP and VCOP. Adults exhibited smaller oscillation indicators compared to adolescents, except for MCPD at EO, which on the one hand indicates that adults are more capable of maintaining a stable, upright posture, while on the other hand it indicates specific sensori-motor adaptations caused by aging, the cause and consequences of which should be further investigated. Age is moderately correlated with almost all oscillation indicators, indicating that postural control does not decrease in sensitivity until late life. The results of this study are in line with the previous findings (Newell et al., 1997; Wolff et al., 1998).

The theoretical significance of this study is reflected in its contribution to the overall understanding of the problem

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of spontaneous posture between different age groups. The practical importance is reflected in the appreciation of differences between different ages in terms of the maturation of mechanisms responsible for maintaining upright posture and balance. Data from this study could potentially contribute to the creation of normative values for different age groups. Considering that spontaneous posture disorder can indicate the onset or progression of numerous diseases, and the sample in this study consists exclusively of healthy subjects, it is crucial to gain insight into how variables controlling spontaneous posture manifest in a healthy population (Mancini et al., 2012; Ruhe et al., 2011). Further studies in this derection could focus on spontaneous posture of young adults in order to fill the gap between age groups used in this study.

Conclusion

Adolescents and adults both exhibited more stable spontaneous posture at EO, with adults demonstrating greater stability compared to adolescents. Given that oscillations decrease with age, it can be concluded that postural control is influenced by maturation. Data from this study could potentially contribute to the creation of normative values for different age groups. Further studies in this direction could focus on spontaneous posture of young adults in order to fill the gap between age groups used in this study.

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UDK 796.012.1: 614.84

Relationship between basic physical abilities and task-specific performance in firefighters

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Introduction

Firefighting is among the most demanding and high-risk professions, requiring rapid decision-making and effective action in dynamic and hazardous situations. Their primary mission is to protect lives, property, and the environment, often under time pressure and the stress of potential civilian endangerment (Perroni et al., 2014; Samardžić et al., 2024). Key responsibilities include rapid deployment to fire sites, equipment handling, climbing, forced entry into confined spaces, operating fire hoses, and rescuing victims. These tasks are frequently performed under extreme conditions, such as high temperatures and exposure to toxic fumes, further complicated by the use of heavy protective gear (Walker et al., 2016; Skinner et al., 2020). Consequently, well-developed general and specific physical abilities are essential for the successful execution of these tasks, ensuring the safety of firefighters, their colleagues, and civilians (Michaelides et al., 2011).

Insufficient physical fitness among firefighters poses a serious professional challenge, as it is associated with reduced work capacity and an increased risk of injuries. Research highlights a significant correlation between the level of physical fitness and the speed of intervention during firefighting operations (Rhea et al., 2004; Michaelides et al., 2008), as well as between high levels of physical fitness and a lower risk of injuries (Knapik et al., 2001). Therefore, the implementation of individualized training programs, tailored in terms of intensity, specificity of exercises, volume, and duration, is recommended to enhance the occupational performance of all firefighters (Perroni et al., 2015).

During interventions, firefighters perform highly demanding tasks that require specific agility, strength, and endurance, as well as skills for the efficient use of equipment under challenging conditions (Plat et al., 2010; Perroni et al., 2014; Skinner et al., 2020). Given these demands, training programs must simultaneously optimize various aspects of physical fitness, including agility for maneuvering, strength for carrying equipment and rescuing individuals, and anaerobic endurance for working at high intensities. Additionally, exercises aimed at improving equipment handling skills are essential to adequately prepare firefighters for specific tasks in real-world intervention scenarios (Michaelides et al., 2011; Dobson et al., 2013; Chizewski et al., 2021; Samardžić et al., 2024).

To ensure adequate occupational competencies, physical abilities are assessed during the selection process, education, and professional careers (Lockie et al., 2022). The purpose of these assessments is to determine the level of specific abilities that are crucial for the successful performance of professional tasks. All individuals performing the same tasks in identical positions should meet uniform physical fitness standards, which should not be based on factors such as gender or age, but solely on the demands of the specific job (Jackson & Wilson, 2013; Janković et al., 2020). In this context, training programs and assessments should focus on improving and identifying appropriate work-related abilities that ensure professional competence. Standards and norms should be defined according to job requirements to identify individuals who meet the relevant criteria (Lockie et al., 2018; Koropanovski et al., 2022; Janković & Koropanovski, 2024). Understanding the relationship between physical abilities and the demands of specific tasks may influence the proper definition of physical fitness standards and norms. The aim of this study is to examine the relationship between basic physical abilities and task-specific performance among firefighters.

Methods

Sample Description

The study included 85 members of the Emergency Situations Sector of the Ministry of Internal Affairs of the Republic of Serbia – Police Department in Kraljevo, with an average age of 40.2 ± 8.6 years (range: 24–52 years; height: 184.9 ± 5.6 cm; weight: 98.6 ± 13.4 kg). All participants were informed about the purpose and methodology of assessing their physical abilities. The research was conducted in accordance with the ethical standards outlined in the Declaration of Helsinki (Williams, 2008).

Assessment of Physical Abilities

1. The assessment of basic physical abilities (BPA) was conducted using a standardized battery comprising four tests. The repetitive strength of trunk flexor muscles was evaluated through a trunk flexion with rotation test performed over 30 seconds. The strength of arm extensor muscles was measured using the «push-up» test (PU), where participants performed push-ups from a front support position for 10 seconds. The repetitive strength of arm flexor muscles was assessed using the pull-up test (PLU) on a fixed bar, where participants performed pull-ups in a hanging position with an overhand grip and hands shoulder-width apart. Aerobic endurance was measured using the Cooper running test, in which participants ran on a circular athletic track upon a given signal. The objective was to cover the maximum possible distance within 12 minutes, expressed in meters (Dimitrijević et al., 2014; Koropanovski et al., 2022).

2. For occupational abilities required in firefighting tasks, two tests were applied (Stajkovac, 2024). The first test, Specific Run Test (SRT), assesses speed, endurance, and maneuverability during a 100-meter run while wearing full firefighting gear. This test includes overcoming obstacles and handling fire hoses, with execution time measured from the start to the connection of the nozzle. The second test, Stair Endurance Test (SET), evaluates stair climbing under a 40 kg load. Participants, equipped with firefighting gear and a breathing apparatus, ascend to the fourth floor, with stair skipping and handrail support permitted to enhance movement. The test concludes with an audio signal upon reaching the target location.

Statistical methods of data analysis

In the initial phase of data analysis, basic descriptive

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statistics were calculated, including measures of central tendency, dispersion, and data distribution. To explore the relationship between basic physical abilities and specific agility test results, Pearson correlation analysis and linear regression (backward method) were applied. The criterion for statistical significance was set at the 95% confidence level, with $p<0.05$ (Hair et al., 1998). All statistical analyses were performed using SPSS Statistics for Windows, Version 20.0.

Results

In the study of general and specific abilities of members of the Emergency Situations Sector, descriptive statistics provide a foundational insight into the participants' performance and a basis for further statistical analysis. Table 1 presents the results for all participants, highlighting noticeable variability in the observed parameters.

Table 1. Basic descriptive parameters

Variable	Min	Max	Mean	SD	Skew.	Kurt.
SU (No.)	12	38	24.6	5.1	0.244	0.269
PU (No.)	5	15	9.8	2.6	0.289	0.736
PLU (No.)	1	12	5.1	2.7	0.473	0.638
RUN (m)	1700	3200	2200.5	284.3	0.753	0.642
STR (s)	21	42	33.9	5.8	0.323	0.931
SET (s)	14	39	22.7	5.9	1.168	0.752

The results of the Pearson correlation analysis (Table 2) indicate a significant relationship between specific tests (SRT and SET) and the observed basic physical abilities. The strongest correlations were found between PU and STR (-0.761) and RUN and STR (-0.708), which, according to the classification by Schober et al. (2018), fall into the category of very strong correlations. Other correlations were assessed as moderate, suggesting that better basic physical ability results are associated with shorter execution times in specific tests. The weakest association was observed between the specific tests themselves.

Table 2. Results of Pearson Correlation Analysis

	SU	PU	PLU	RUN	SRT
SRT	0.614**	0.761**	0.671**	0.708**	/
SET	0.570**	0.487**	0.496**	0.486**	0.406**

Table 3 presents the results of the regression analysis examining the influence of BPA on SRT performance. The analysis includes three models. Model 1, incorporating all four variables, identifies PU as the most significant predictor (B=–0.968, p=0.001). Model 2, which excludes SU, confirms the significance of PU (B=–1.003, p=0.000) and introduces RUN as a moderately significant predictor (B=–0.005, p=0.042). Model 3 further enhances the impact of PU (B=–1.165, p=0.000) and RUN (B=–0.006, p=0.010) on SRT performance. Other variables do not demonstrate a statistically significant contribution to the prediction of results. Consequently, the relationship between BPA and SRT can be represented by the following formula: SRT=58.389–1.165×PU–0.006×RUN

Table 3. Results of Regression Analysis of the Impact of Basic Abilities on SRT

Model		Unstandardized Coefficients		Standardized Coefficients	T	Sig.
		B	Std. Error	Beta		
1	(Constant)	56.499	3.822		14.781	0.000
	PU	0.968	0.271	-0.444	-3.569	0.001
	SU	0.086	0.117	-0.076	-0.735	0.464
	PLU	0.287	0.242	-0.134	-1.185	0.239
	RUN	0.004	0.002	-0.212	-1.737	0.086
2	(Constant)	56.156	3.783		14.844	0.000
	PU	-1.003	0.266	-0.460	-3.770	0.000
	PLU	0.326	0.236	-0.152	-1.382	0.171
	RUN	0.005	0.002	-0.239	-2.069	0.042
3	(Constant)	58.389	3.440		16.976	0.000
	PU	-1.165	0.240	-0.534	-4.850	0.000
	RUN	0.006	0.002	-0.291	-2.640	0.010

Table 4 presents the results of the regression analysis defining the influence of BPA on SET performance. Model 1, incorporating all four BPA variables, identifies SU as a significant predictor (B=–0.449, p=0.005).

Model 2 excludes RUN and further confirms the significance of SU, with no other variable showing a statistically significant contribution. In Model 3, SU and PLU remain, with an even stronger impact of SU (B=–0.499, p=0.000), while PLU shows a tendency toward significance (B=–0.462, p=0.079). The results suggest that among the observed BPAs, abdominal muscle strength has the most pronounced influence on SET performance. Combined with PLU, the predictive capability for success can be represented by the following formula: SET=37.359–0.499×SU–0.462×PLU.

Table 4. Results of Regression Analysis of Basic Abilities on SET

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Model		Unstandardized Coefficients		Standardized Coefficients	T	Sig.
		B	Std. Error	Beta		
1	(Constant)	39.260	5.104		7.692	0.000
	PU	-0.167	0.362	-0.075	-0.461	0.646
	SU	-0.449	0.157	-0.388	-2.868	0.005
	PLU	-0.325	0.323	-0.149	-1.006	0.317
	RUN	-0.001	0.003	-0.048	-0.301	0.765
2	(Constant)	38.008	2.933		12.959	0.000
	PU	-0.214	0.324	-0.096	-0.660	0.511
	SU	-0.464	0.148	-0.400	-3.130	0.002
	PLU	-0.348	0.313	-0.159	-1.112	0.269
3	(Constant)	37.359	2.753		13.568	0.000
	SU	-0.499	0.138	-0.431	-3.630	0.000
	PLU	-0.462	0.260	-0.211	-1.780	0.079

Discussion

The results indicate a significant relationship between specific tests and the observed basic physical abilities. Strong correlations were identified between PU and SRT, as well as between RUN and SRT. These correlations suggest that greater repetitive strength of arm extensors and better aerobic endurance contribute to improved efficiency in performing the SRT. In contrast, the weakest correlation was observed between the specific tests themselves (r=0.406), highlighting their complementary nature. Correlations between SET and all observed BPA components were moderate, ranging from 0.486 to 0.570. The slightly lower correlations may be attributed to the specific characteristics of the SET, which primarily requires anaerobic endurance and the ability to move under the load of equipment. Therefore, it can be assumed that repetitive strength and aerobic endurance have a lesser impact on this test.

Regression analysis highlights the importance of specific BPA components in predicting performance on specific tests. PU emerged as the most significant predictor for SRT, with RUN contributing to a lesser extent, while SU was the key predictor for SET, with PLU showing a tendency toward significance. These results suggest that repetitive strength of arm extensors and aerobic endurance contribute the most to SRT performance, while it can be assumed that the repetitive strength of trunk flexors plays a significant role in the success of the SET. Based on the regression analysis results, it is possible to predict the outcomes of the SRT and SET with a high degree of reliability.

In comparison with previous studies, it has been confirmed that the development of BPA can contribute to the efficiency of tests assessing specific abilities. The structure of tasks in specific tests determines which BPA components are emphasized. For example, speed, agility, along with anaerobic and aerobic endurance, influence better performance in tasks involving running, while speed strength, repetitive strength, and maximal strength play a key role in overcoming obstacles, neutralizing attackers, or assisting the injured (Janković, 2023). These findings align with the study by Lockie et al. (2018), who identified significant correlations between BPA and performance on tests of specific professional tasks. Their research demonstrated that pull-ups, push-ups, and a 2.4 km run significantly contribute to performance in tasks such as climbing over barriers, efficiency on a specific obstacle course, and a 500-yard run. In our study, PU, PLU, and RUN showed the strongest correlations with SRT, while SU was most strongly associated with SET. These similar findings underscore the importance of basic physical preparedness, particularly various types of strength and endurance, for the successful execution of specific tasks.

Physical activity forms the foundation for maintaining work-related abilities at an adequate level, as confirmed by the findings of Strating et al. (2010). Their research showed that older participants and those with fewer hours of physical activity per week achieved poorer results on the Physical Competency Test. Similar conclusions were drawn in the study by Jackson and Wilson (2013), which found that younger candidates performed better on the Gender-Neutral Timed Obstacle Course. These findings further emphasize the importance of optimal physical fitness and regular exercise for achieving better results. It can be assumed that participants in better physical condition achieve superior performance across all tests, which explains the statistically significant relationships observed in the results.

In line with the presented results, this study highlights the need for the development and implementation of training programs that account for the individual abilities and characteristics of participants to reduce the range of results and achieve more consistent professional preparedness (Rhea et al., 2004; Perroni et al., 2015). Simultaneously, it is essential to conduct continuous evaluations of all relevant professional abilities and consider potential improvements to the tests to ensure their validity in assessing both basic and specific physical abilities.

Conclusion

The results of this study confirm the importance of continuous development of BPA for enhancing efficiency in the specific tasks performed by members of the Emergency Situations Sector. The strong and moderate correlations between BPA and specific occupational performance tests, as well as the regression analysis, indicate the potential for predicting specific test outcomes based on BPA test results.

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However, certain limitations must be considered. The sample was restricted to male participants, which may limit the generalizability of the findings, and morphological status was not analyzed, despite detailed information on body composition potentially providing deeper insights. Additionally, BPA were assessed exclusively using tests currently employed within the sector, which limits the scope of the study.

According to the presented limitations, future research should include a broader and more diverse sample, a detailed analysis of body composition, and additional tests to evaluate anaerobic endurance, maximal and explosive strength, as well as agility. Longitudinal monitoring of participants could further provide a more precise understanding of the impact of training programs on their performance.

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UDK 796.035:796.012.1-055.2

Effects of a 6-Week step aerobic training program on motor abilities and body composition in women participating in recreational activities

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Introduction

The role of structured physical activity in promoting health and reducing the risk of chronic diseases is well-established. Aerobic exercises, in particular, have been widely recognized for their ability to improve cardiovascular health, enhance functional capacity, and contribute to psychological well-being across various populations (Nelson et al., 2007). Within this context, step aerobics, as a choreographed exercise involving rhythmic stepping on an elevated platform (Karageorghis, 2016; Melillo, 1991) has gained reputation due to its accessibility, engagement, and its capacity to simultaneously target cardiovascular endurance, muscular strength, and flexibility (Pickett et al., 1990; Lim, 1990). Previous research has explored the effects of step aerobics on physical fitness, with a notable emphasis on elderly populations. For instance, Hallage et al. (2010) conducted an important study examining the effects of a 12-week step aerobics program on functional fitness in elderly women. The findings demonstrated significant improvements in cardiovascular endurance, lower body strength, and reductions in body fat, particularly in waist circumference (Chien et al., 2000). Similarly, Mori et al. (2006) highlighted enhancements in aerobic capacity, balance, and power of the lower extremities among older adults participating in home-based step aerobics training. These studies collectively emphasize the effectiveness of step aerobics in promoting physical fitness and reducing the risk of age-related functional decline. Step aerobics also lowers the risk of cardiovascular diseases as found in the study by Barha et al., (2021). Despite the robust findings concerning elderly populations, research on the impact of step aerobics in younger adult populations, particularly recreationally active women, remains limited. This gap in the literature warrants further investigation, especially given the growing concern over cardiovascular disease in countries like North Macedonia, where sedentary lifestyles contribute to high mortality rates from cardiovascular-related conditions (Global Burden of Disease, 2019).

This study is designed to investigate the effects of a 6-week step aerobics training program on motor abilities, specifically lower extremity strength, core stability, and endurance, as well as body composition parameters, including fat mass, muscle mass, and key anthropometric measures (waist, hip, and thigh circumferences). Although previous research has demonstrated improvements in motor abilities such as strength, agility, and endurance through various forms of aerobic training (Masliak et al., 2015), there is a lack of data regarding the specific impact of step aerobics on body composition and anthropometric measures in this demographic. This study, therefore, aims to provide a deeper understanding of how a structured 6-week step aerobics program affects both motor abilities and body composition in recreationally active women. In doing so, it aims to contribute to the growing body of literature on aerobic training's role in promoting overall health and fitness beyond the elderly population. The research seeks to evaluate whether step aerobics as an intervention can enhance these physical fitness components in recreationally active women, thereby filling a critical gap in the literature on step aerobics' efficacy across different age groups and activity levels. Moreover, the findings of this study will provide valuable insights for fitness trainers, fitness and health enthusiasts and gyms, helping them tailor more effective training programs aimed at improving overall fitness. This is particularly relevant in the context of North Macedonia, where knowledge and application of step aerobics remain limited. By demonstrating the benefits of step aerobics on both motor abilities and body composition, this research will contribute to the promotion of aerobic fitness and support the development of more comprehensive fitness strategies.

Methods

Design and procedure

This articleis part of a larger study comparing the effects of 2 training protocols on motor abilities and body composition in recreational women of different ages. The study focuses on changes in motor abilities (lower extremity and trunk muscle strength) and body composition (fat and muscle tissue percentage) in women participating in recreational activities members of the Synergy fitness center in Skopje. The study was conducted in a sports facility designed with active architecture principles (Stefanovska Cvetkovska, I. 2024), promoting accessibility and supporting an environment conducive to physical activity.

Participants

A total of 12 participants (average age $\bar{x}$= 40.9 years), were included in the study. Participants needed to be active but not involved in any other form of physical activity to meet the inclusion criteria. The exclusion criteria encompassed any cardiovascular, metabolic, or orthopedic conditions that might hinder training. One participant was excluded from the experiment due to incomplete testing procedures. Assessments of motor abilities and anthropometric measures were conducted at three control points (initial, control, and final). After three weeks (9 sessions, day 20), each participant repeated the testing procedure. The final testing took place after completing the six-week experimental program (18 sessions in total, day 43). To successfully complete the experiment, participants were required to avoid additional systematic training, complete all sessions and tests, not to be active athletes, have no injuries, and be in overall good health (verified through a pre-conducted questionnaire). The study was approved in advance by the Ethics Committee of the Faculty of Physical Education, Sport and Health at the University of Ss. Cyril and Methodius, with decision number 0201-1373/4.3 from 16.12.2022 verifying that it is in accordance with the Declaration of Helsinki.

Motor Abilities measurements

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To assess motor abilities, all participants underwent individual testing using a modified battery of tests adapted from Robert Wood (2008, 2010). Seven standardized tests were applied to evaluate different aspects of motor performance. These tests included:

YMCA 3-Minute Step Test (YMCA) – designed to assess cardiovascular endurance, Standing Long Jump (SLJ) – to measure explosive lower body power, Sit-Ups for 30 seconds (SU30S) – assessing core endurance, Sit-Ups To Failure (SU) – to measure core strength endurance, Plank Hold to Failure (PLANK) – evaluating core stability and endurance, Wall Sit Hold (WALL) – assessing static lower body strength endurance, and Push-Ups to Failure (PUSH) – assessing upper body muscular endurance.

Anthropometric Characteristics and Body Composition measurements

Anthropometric measures and body composition parameters were also collected as part of the study. Body Height (BH) and key circumferential measures, including Waist Circumference (WC), Hip Circumference (HC), and Thigh Circumference (TC), were measured using a standardized protocol. Anthropometric measurements followed the guidelines outlined by the International Society for the Advancement of Kinanthropometry (ISAK).

These were performed by trained professionals to ensure accuracy and consistency. For the assessment of body composition, the study utilized the OMRON BF511 body composition monitor, which provides measurements of the Total Body Mass (TBM), Percentage of Muscle Mass (PMM), Percentage of Subcutaneous Fat Tissue (PSFT), and Percentage of Visceral Fat (PVF). The device employs bioelectrical impedance analysis (BIA) to estimate body composition based on the body's resistance to a small electrical current. In addition to these metrics, Basal Metabolic Rate (BMR) and Body Mass Index (BMI) were calculated as part of the comprehensive analyses.

Training Program

Participants were given exercise instructions and information on healthy habits, with no specific dietary recommendations. Exercise intensity was weekly adjusted for an optimal gradual increase, and a Polar H9 heart rate monitor was used to monitor heart rate during each training session for all participants. Exercise took place three times a week, lasting 55-60 minutes each session, following the recommendations of the American College of Sports Medicine (Ferguson, B, 2014). Subjects were asked to rate their perceived exertion 10 minutes after every training session using the Borg scale Borg, G. (1998). The training sessions, were divided into three parts. The warm-up phase, with 120-134 BPM, emphasized moderate-intensity exercises focusing on the entire body with an emphasis on lower extremities. The main part, at 122-155 BPM, featured high-intensity exercises divided into three 10-minute sections targeting lower extremities, abdominal muscles and the trunk, and abdominal muscles, upper back, shoulders, and arms. The cool down included a 10-minute recovery period. Exercise intensity, based on heart rate, ranged from 65-85% of individual MAXHR, estimated using the formula 208 - (0.7 × age) developed by Tanaka, H., Monahan, K. D., & Seals, D. R. (2001). All the trainings were held in a well-designed sports facility. Incorporating universal design principles in sports facilities fosters an environment where individuals of all abilities can participate in physical activities, enhancing overall user experience (Stefanovska Cvetkovska, I. 2024).

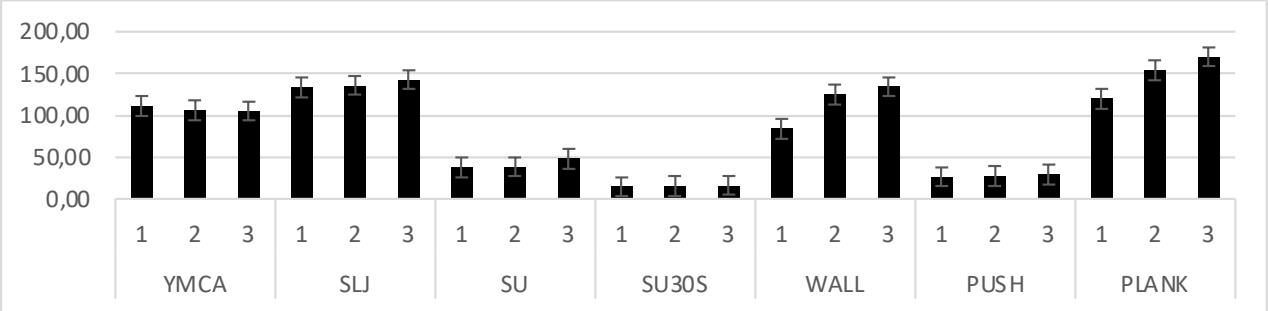
Statistical Analysis

For all variables, basic descriptive statistics were calculated, including the mean (X), standard deviation (S-d). The normality of data distribution was assessed using the Kolmogorov-Smirnov (K-S) and (S-W) Shapiro-Wilk tests and all the variables followed a normal distribution. To evaluate differences within the group at three measurement points, repeated measures ANOVA was employed.

LSD post hoc test was used to determine the differences between the arithmetic means in three control points. For all analyses, the level of statistical significance was set at $p < 0.05$. Data were processed using the statistical software SPSS (V22, SPSS Inc., Chicago).

Results

Figure 1. Comparison among the initial, control and final measurements for the tests assessing the motor abilities



Based on the obtained results, we can conclude that the Standing Long Jump (SLJ) test demonstrated improvement in lower extremity power, with a mean increase from 133.30 cm at baseline to 142.80 cm post-intervention (table 1), reflecting a significant gain of 7.13% ($p < 0.05$). The Wall Sit Hold (WALL) test showed one of the most substantial improvements, with a 58.98% increase in duration, from 84.60 seconds to 134.50 seconds ($p < 0.05$), indicating enhanced lower body muscular endurance. Additionally, core strength improved significantly, as shown by the Plank Hold (PLANK) test, which saw a 41.87% increase ($p < 0.05$), emphasizing the program's positive effects on abdominal and trunk muscles. Upper body strength, while showing percentage improvements, did not exhibit statistically significant changes.

Table 1. Summarized repeated measures ANOVAs and post hoc from the results for the motor abilities in the Step Aerobic Group

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Test	Control Point	Mean	SD	Sig.	Control points comparison	Percentage Difference (%)
YMCA	1	111.10	12.60		1-2	-4.59
	2	106.00	8.77	0.13	2-3	-0.57
	3	105.40	7.92		1-3	-5.13
SLJ	1	133.30	14.43		1-2	2.1*
	2	136.10	15.47	0.00+	2-3	4.92*
	3	142.80	16.29		1-3	7.13**
SU	1	38.30	24.19		1-2	1.83
	2	39.00	24.56	0.00+	2-3	22.82**
	3	47.90	24.12		1-3	25.07*
SU30S	1	15.30	2.45		1-2	1.31
	2	15.50	2.27	0.10	2-3	7.74
	3	16.70	1.95		1-3	9.15
WALL	1	84.60	36.49		1-2	47.16**
	2	124.50	51.24	0.01+	2-3	8.03**
	3	134.50	54.15		1-3	58.98**
PUSH	1	27.00	10.98		1-2	4.07
	2	28.10	10.65	0.29	2-3	4.63
	3	29.40	10.06		1-3	8.89
PLANK	1	119.90	70.47		1-2	28.36*
	2	153.90	87.80	0.01+	2-3	10.53*
	3	170.10	82.87		1-3	41.87**

Notes: M=arithmetic mean; SD = standard deviation; * = Post Hoc tests significance at error level $p < 0.05$; **Post Hoc tests significance at error level < 0.01; + = repeated measures ANOVA significance at error level $p < 0.05$

The Push-Ups (PUSH) test results increased from 27.00 repetitions to 29.40 repetitions, but the change was not statistically significant ($p < 0.05$). In terms of body composition (table 2), the Waist Circumference (WC) showed a significant reduction of 8.89%, from 83.20 cm to 75.80 cm ($p < 0.05$), indicating a decrease in abdominal fat. The Visceral Fat Percentage (PVF) also decreased by 8.70% ($p < 0.05$), reflecting the efficacy of the step aerobics program in targeting fat deposits, especially in the abdominal region. However, there were no significant changes in Total Body Mass (TBM), which remained relatively stable throughout the intervention. Similarly, Percentage of Muscle Mass (PMM) and Percentage of Subcutaneous Fat Tissue (PSFT) did not show statistically significant changes.

These results highlight the importance of structured physical activity in driving improvements in physical fitness and body composition underscoring the effectiveness of the step aerobics program in producing significant changes in motor abilities and body composition, particularly in the areas of lower body strength and abdominal fat reduction.

Table 2. Summarized repeated measures ANOVAs and post hoc from the results for the body composition variables in the Step Aerobic Group

Test	Control Point	Mean	SD	Sig.	Control points comparison	Percentage Difference (%)
TBM	1	63.53	14.44		1-2	-0.25
	2	63.37	14.61	0.57	2-3	-0.58
	3	63.22	14.16		1-3	-0.49
PMM	1	28.7	3.2		1-2	1.25
	2	29.06	3.03	0.65	2-3	-0.41
	3	28.94	2.67		1-3	0.84
PSFT	1	30.64	8.75		1-2	-1.93
	2	30.05	8.45	0.53	2-3	0.93
	3	30.33	7.83		1-3	-1.01

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BMI	1	22.28	4.35		1-2	-0.18
	2	22.24	4.37	0.58	2-3	-0.27
	3	22.18	4.3		1-3	-0.45
PVF	1	4.6	2.22		1-2	0
	2	4.6	2.12	0.13	2-3	-8.7
	3	4.2	1.87		1-3	-8.7
WC	1	83.2	13.57		1-2	-6.01*
	2	78.2	14.3	0.07	2-3	-3.07*
	3	75.8	16.12		1-3	-8.89*
HC	1	95.75	10.94		1-2	0.89
	2	96.6	9.03	0.59	2-3	-0.41
	3	96.2	8.15		1-3	0.47
TC	1	56.95	7.25		1-2	-2.99
	2	55.25	4.53	0.27	2-3	1.9
	3	56.3	4.37		1-3	-1.14

Notes: M=arithmetic mean; SD = standard deviation; * = Post Hoc tests significance at error level $p < 0.05$; **Post Hoc tests significance at error level < 0.01; + = repeated measures ANOVA significance at error level $p < 0.05$

Discussion

The results of this study demonstrate that the six-week step aerobics training program significantly improved lower body and core strength, as indicated by the substantial gains in the WALL and PLANK tests. These findings are consistent with previous research by Kravitz et al. (1993), which highlights the role of dynamic movements in step aerobics in enhancing lower body strength. The significant improvement in core strength (as measured by the PLANK test) underscores the effectiveness of this type of aerobic training for targeting trunk muscles, which are often neglected in traditional aerobic programs. In contrast, upper body strength did not show statistically significant improvements over the six-week period. This could be attributed to the nature of step aerobics, which places greater emphasis on lower body and core movements, with less focus on upper body engagement. To achieve significant gains in upper body strength, longer training durations or supplementary upper-body-focused exercises may be necessary.

Regarding body composition, the significant reductions in visceral fat and waist circumference reflect the impact of aerobic exercise on fat distribution, particularly in the abdominal region. These findings align with studies by Hallage et al. (2010) and Masliak et al. (2015), which demonstrated similar reductions in waist circumference and body fat after prolonged aerobic training. However, the lack of significant changes in other anthropometric measures, such as body mass and subcutaneous fat percentage, may be explained by the relatively short duration of the intervention and the relatively low number of participants.

Similarly, the study conducted by Kraemer et al. (2001) showed a 5% reduction in the percentage of body fat after a 12-week programmed exercise, further confirming the assumption that step aerobics can directly influence significant changes in body composition, but that an extended time period is necessary.

Additionally, the age of the participants could have influenced the outcomes, as older adults may have a more efficient energy metabolism, resulting in fewer changes in body composition over short durations. This could suggest that younger participants, with a higher basal metabolic rate, may experience greater changes in body composition over a longer intervention period such as 8, 10, and 12 weeks (Kin-Isler & Kosar, 2006; Sillanpää et al., 2009; Hallage et al., 2010) may positively influence motor abilities in healthy adult women.

Although the results from the anthropometric measurements are statistically insignificant, it can be assumed that the group that practiced step aerobics experienced a reduction in body fat, similar to the findings of Keating, S. E., et al. (2014). Such a training program can be practiced and may have positive effects on the health, body composition, and motor abilities in overweight adult females participating in recreatinoal physical activities (Miyamoto-Mikami, et, all., 2015).

Overall, while the study demonstrates clear benefits of step aerobics on lower body strength and abdominal fat reduction, future research should consider longer durations and higher number of participants across different age groups to capture more significant changes in body composition and upper body strength in recreationally active women. Furthermore, the addition of other aerobic exercises may complement step aerobics to provide a more comprehensive fitness improvement for recreationally active woman.

Conclusion

This study was set out to see the impact of a 6-week step aerobic training program on women practicing recreational physical activities, focusing on both motor abilities and body composition changes. Our findings revealed significant improvements in motor abilities, including enhanced strength, agility, and endurance, demonstrating the efficacy of step aerobics in enhancing physical fitness among participants.

Statistical analysis showed significant enhancements in specific motor abilities tests such as the Standing Long Jump (SLJ), Sit Ups (SU), and Plank Hold (PLANK), indicating improved lower body strength, core strength, and endurance. For instance, the SLJ test saw a mean increase from 133.30cm to 142.80cm, and the SU test results improved from an initial mean of 38.30 to 47.90, highlighting the program's effectiveness in improving strength and muscular endurance. However, changes in body composition weren't observed. While there was a notable decrease in waist circumference, indicating a positive reduction in abdominal fat, other

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anthropometric measures such as Total Body Mass (TBM), Percentage of Muscle Mass (PMM), and Percentage of Subcutaneous Fat Tissue (PSFT) showed minimal changes. This suggests that while step aerobics can be effective in specific fat reduction areas, its impact on overall body composition might require longer durations or complementary exercise modalities.

These findings contribute to the growing body of literature affirming the benefits of step aerobics and provide a practical reference for fitness professionals designing exercise programs. Future research could explore longer training durations, the inclusion of dietary interventions, and the comparison with other exercise modalities to fully clarify step aerobics' impact on motor abilities, body composition and overall health.

The results of the present study demonstrated that 6 weeks of SA training reduced WC and increased the strength, agility, and cardio respiratory fitness of women practicing recreational activities. Therefore, it is suggested that step aerobic training should be used as an effective strategy to promote improvements in the functional fitness of healthy women of different ages. Its low operational cost, easy applicability, high attendance rate, and the fact that it can be performed by many individuals of different fitness levels at the same time make this modality viable to be implemented. The results given in this study can be used by fitness facilities, group fitness trainers and fitness enthusiasts as well as healthy lifestyle promoters.

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UDK 796.853.23.159.9

The impact of rapid weight loss on judo athletes performance: Physiological and psychological consequences

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Introduction

In combat sports such as judo, weight categorization plays a crucial role in competition tactics and preparation. Athletes often seek to compete at the upper range of a lower weight category, which may provide a competitive advantage. Rapid Weight Loss (RWL) is defined as a reduction of 5% or more of total body mass within less than seven days prior to competition (Artioli et al., 2010; Franchini et al., 2012). Although widespread, this practice is controversial due to its potential adverse effects on athletes' overall health.

The most common methods of RWL used by athletes include fluid restriction, caloric restriction, high-volume training, prolonged exercise, training in heated environments, use of rubber suits, saunas, and, in some cases, prohibited substances such as diuretics and laxatives. Research indicates that RWL leads to a decline in both aerobic and anaerobic performance. Impairments in aerobic capacity are primarily associated with dehydration, reduced plasma volume, increased heart rate, electrolyte imbalances, impaired thermoregulation, and depleted muscle glycogen stores. Conversely, the reduction in anaerobic performance is often linked to decreased buffering capacity, glycogen depletion, and disturbances in hydro-electrolytic balance (Franchini et al., 2012).

Moreover, RWL and repeated weight cycling negatively affect physical health, particularly endocrine and renal function. These processes often result in hormonal disturbances and kidney stress, which diminish performance capacity and may lead to long-term health consequences (Uddin et al., 2022). Studies demonstrate that judokas who undergo RWL of 5% or more of body mass prior to competition are physiologically depleted even before competing. Roklicer et al. (2020) confirmed that athletes subjected to RWL and intense training experience significant skeletal muscle damage, limiting their ability to perform at peak level during competition.

RWL also significantly affects athletes' psychological states, often resulting in fatigue, mood disturbances, and negative profiles of mood states (Hiraoka et al., 2019). Some studies highlight detrimental effects on cognitive functions such as short-term memory, mood, and decision-making processes. Although rehydration may restore certain cognitive functions, the temporary reduction in memory, focus, and anticipation induced by RWL represents a substantial risk. This is particularly concerning in combat sports, where quick decisions and responses are essential (Caglar et al., 2025). High-level performance in judo requires an integrated approach combining physical conditioning, technical skills, tactical knowledge, and psychological variables (Santos et al., 2015).

Method

This study applied a descriptive analysis of previous research examining the effects of rapid weight loss on the physiological and psychological performance of judo athletes. Electronic databases including PubMed, Google Scholar, and ResearchGate were searched for relevant articles. Only original research articles published in peer-reviewed journals between 2005 and 2024 were included. There were no restrictions regarding sex or age of participants.

Results

Impact of RWL on Physiological Performance

Fortes et al. (2017) investigated the effects of RWL on judokas' performance using the Special Judo Fitness Test (SJFT). Results indicated that judokas subjected to RWL did not show improvements in SJFT index values, while the control group exhibited an increase. Additionally, the experimental group demonstrated fewer throws during SJFT and higher heart rates compared to the control group.

A study examining cardiac biomarkers during RWL and high-intensity sport-specific testing revealed significant increases in heart rate and alterations in cardiac biomarkers, while left ventricular systolic function remained unchanged. Biomarker changes observed in the sport-test-only group were primarily attributed to muscle damage (Milovančev et al.,2024).

Markers of muscle damage such as myoglobin (Mb), creatine kinase (CK), and aldolase (ALD) increased during RWL. Serum myoglobin rose above reference values during the last two days of RWL. CK levels also exceeded reference values, while ALD increased within normal limits. Hematocrit and hemoglobin levels showed changes by the final day but remained within reference ranges (Roklicer et al., 2020).

Athletes who lost 5% or more of body mass within seven days showed reduced maximal oxygen uptake (VO_2max) and greater perceived fatigue during endurance tests. This is attributed to depleted glycogen stores, which reduce energy availability. Elevated lactate concentrations following submaximal and maximal exertion suggest impaired lactate metabolism due to reduced buffering capacity (Artioli et al., 2010). Anaerobic capacity was also compromised, evident in decreased maximal power output during short, high-intensityefforts.

Ceylan et al. (2022) showed that RWL induced significant dehydration among judokas. Even after 15 hours of recovery and 5% body mass regain, hydration status was not fully restored, whereas the control group maintained stable hydration throughout.

Impact of RWL on Psychological Performance

Numerous studies have demonstrated that RWL in judokas not only affects physiological parameters but also has serious psychological consequences. Degotte et al. (2006) found that rapid food restriction elevated cortisol levels, the stress hormone, contributing to tension, irritability, and anxiety. Judokas reported lower motivation and greater emotional instability, which hindered competition preparation. Aggressive

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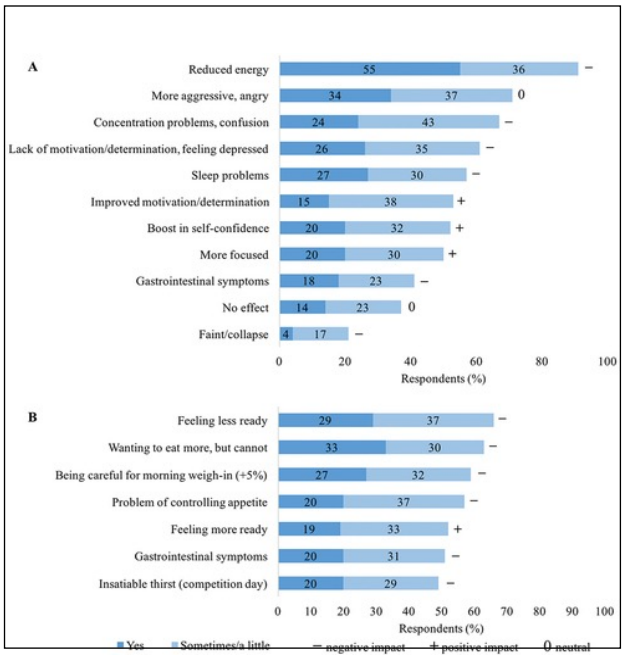
dieting was also associated with increased pre-competition anxiety, reducing focus and confidence.

The combination of physical exhaustion and psychological stress induced by RWL impairs recovery and increases risk of mental fatigue, which may negatively affect long-term athletic careers (Isacco et al., 2020). Athletes undergoing restrictive diets reported depressive symptoms, including fatigue, exhaustion, and impaired decision-making ability.

Štangar et al. (2022) analyzed subjective reports of RWL effects. Negative effects included reduced energy (55%), aggression and anger (34%), concentration problems and confusion (24%), and sleep disturbances (27%). Positive effects such as increased motivation and confidence were reported less frequently. Other common issues included perceived lack of readiness (29%), excessive thirst (29%), appetite control difficulties (37%), and gastrointestinal problems (31%). These findings highlight the significant psychological and physiological toll of RWL on athletes.



Conclusion

RWL is a common practice among judokas competing in weight-class sports. Although it may offer short-term competitive advantages, the evidence strongly indicates negative consequences for both physiological and psychological performance.

Physiologically, RWL reduces aerobic and anaerobic capacities, elevates heart rate, induces dehydration, decreases muscle mass, and disrupts electrolyte balance. Athletes subjected to RWL show lower performance in sport-specific tests such as the SJFT. Elevated biomarkers of muscle damage point to potential long-term health risks.

Psychologically, RWL worsens mood, increases anxiety, reduces motivation, and fosters emotional instability. Elevated cortisol levels complicate mental preparation and impair decision-making during competition. Although partial recovery is possible after rehydration, RWL remains a high-risk strategy for both health and performance.

Future research should aim to identify safer and more effective weight-management strategies that preserve athletes' health while allowing optimal preparation for competition.

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UDK 796.853.23.159.9

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UDK 796:37:159.942-053.5

Anxiety in older school-aged students during physical and health education classes

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Introduction

Anxiety is defined as worry, fear, insecurity, and tension, and represents an unpleasant emotion characterized by the arousal of the nervous system (Weinberg & Gould, 2007).

Anxiety in physical education classes is characterized by feelings of worry, tension, fear, and increased physiological arousal related to the teaching process (Barkoukis, 2007). Many students perceive physical and health education as enjoyable, but there are also those who show a negative attitude toward this subject.

Among the most significant factors influencing the occurrence of anxiety in physical education classes are instruction that is not based on students' previous experiences, a performance-oriented motivational climate, the teacher's attitude toward students, and the methods of evaluation. Research has shown that a decline in sports performance is associated with exercise and evaluation under high pressure conditions (Molina, Chorot, Valiente, & Sandin, 2014), particularly in students with high sensitivity to anxiety (Molina, Sandin, & Chorot, 2014). Regarding gender equity, most studies show that boys tend to have a more positive attitude than girls (Danthony, Mascret & Cury, 2020).

Anxiety during evaluation in physical education classes is more pronounced than in evaluation from other subjects due to assessments being conducted in front of the teacher and peers (Barkoukis et al., 2012). A poor grade in physical education can cause anxiety as it highlights some form of physical inadequacy, which can negatively affect students who have a low self-image.

The aim of the research is to investigate the differences between male and female students of older school ages regarding anxiety in physical and health education classes.

Method

The study was cross-sectional and conducted in primary schools in Jagodina during the first semester of the 2024/2025 school year. The sample consisted of 200 seventh and eighth-grade students, divided into two sub-samples based on gender: 105 boys and 95 girls. To assess the state of anxiety in physical and health education classes, the Physical Education State Anxiety Scale (PESAS) (Barkoukis et al., 2005; Barkoukis, 2007) adapted for use in Serbian (Orlić, Ilić, & Lazarević, 2012) was utilized, along with an additional questionnaire constructed for the study.

Descriptive statistics (frequency, percentage, mean, standard deviation, minimum, and maximum) were applied to process the obtained data. The t-test for independent samples and the $\chi 2$ test were used to examine gender differences. The data were processed using the SPSS-26 software package.

Results

Based on the sample of respondents and the dependent and independent variables, Table 1 shows the basic characteristics of the sample.

Table 1. Sample characteristics

Variables	Categories	Sample size (N)	%
Participant gender	Male	105	52,5
	Female	95	47,5
Grade of participants	Seventh	121	60,5
	Eight	79	39,5
Physical education mark	Satisfactory	3	1,5
	Good	19	9,5
	Excellent	178	89
Practising sport	Engaged	141	70,5
	Not engaged	59	29,5
Engagement in leisure-time physical activities	Not engaged	33	16,5
	Engaged 1-2 times a week	22	11
	Engaged 3 times a week	42	21
	Engaged more than 3 times a week	103	51,5

From table 1, we can conclude that a significant number of respondents engage in sports, with 70.5% involved, and more than half, 51.5%, are physically active outside of physical and health education classes.

Table 2. Descriptive statistic of the PESAS' Items

Scale item	N	Min	Max	Mean	SD
I find it difficult to remember information about the tasks presented.	200	1	5	1,74	0,959

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I feel as though I am short of breath.	200	1	5	1,63	0,978
I am concerned about making errors during task execution.	200	1	5	2,12	1,233
I find it difficult to focus on the Physical Education task presented.	200	1	5	1,43	0,823
I feel discomfort when I breathe.	200	1	5	1,51	0,868
When performing the tasks, I feel uneasy about potential mistakes.	200	1	5	1,74	1,053
I find it difficult to memorise information regarding the tasks presented.	200	1	5	1,60	0,925
I feel dizzy.	200	1	5	1,47	0,924
I worry a lot about the physical tests.	200	1	5	1,65	1,093
I find it difficult to remember Physical Education tasks I already know.	200	1	5	1,59	0,922
I sense a feeling of pressure on my chest.	200	1	5	1,49	0,868
I am concerned about failing when performing the tasks.	200	1	5	1,75	1,097
Irrelevant thoughts disturb my thinking.	200	1	5	1,80	1,156
My body is aching.	200	1	5	1,65	0,986
I think about the consequences of possible mistakes in the test.	200	1	5	1,84	1,194
I have difficulty understanding the pattern of such complex tasks.	200	1	5	1,61	0,986
I feel as if something is choking me.	200	1	5	1,31	0,745
I worry that I will perform badly.	200	1	5	1,82	1,242

The average results of the scale items ranged from 1.31 with a standard deviation of 0.745 to 2.12 with a standard deviation of 1.233.

Table 3. Independet samples t-test comparing males and females

Scale item	**F**	**t**	**df**	**p**
I find it difficult to remember information about the tasks presented.	2,225	0,269	198	0,788
I feel as though I am short of breath.	2,312	-1,846	198	0,66
I am concerned about making errors during task execution.	5,677	-0,352	198	0,723
I find it difficult to focus on the Physical Education task presented.	8,983	1,609	198	0,101
I feel discomfort when I breathe.	0,992	-1,311	198	0,191
When performing the tasks, I feel uneasy about potential mistakes.	0,615	-1,036	198	0,301
I find it difficult to memorise information regarding the tasks presented.	0,667	0,692	198	0,490
I feel dizzy.	6,232	-1,831	198	0,072
I worry a lot about the physical tests.	0,613	-0,611	198	0,542
I find it difficult to remember Physical Education tasks I already know.	0,002	0.041	198	0,967
I sense a feeling of pressure on my chest.	2,434	-1,130	198	0,260
I am concerned about failing when performing the tasks.	0,628	-0,612	198	0,541
Irrelevant thoughts disturb my thinking.	4,754	0,611	198	0,538
My body is aching.	0,071	-0,322	198	0,748
I think about the consequences of possible mistakes in the test.	2,497	-1,388	198	0,167
I have difficulty understanding the pattern of such complex tasks.	0,877	0,348	198	0,729
I feel as if something is choking me.	8,912	-1,724	198	0,091
I worry that I will perform badly.	0,312	-755	198	0,451

To explore the differences between male and female students of older school ages regarding anxiety in physical and health education classes, an independent samples t-test was conducted. As seen in Table 3, there is no statistically significant difference between male and female students regarding anxiety in physical and health education classes. Based on the values obtained from Levene's test for equality of variances and the corresponding significance indicators, we can conclude that there are no statistically significant differences between respondents of different genders regarding the scale items.

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Table 4. Independet samples t-test comparing students who practising sports

Scale item	F	t	df	p
I find it difficult to remember information about the tasks presented.	8,874	-2,023	198	0,045
I feel as though I am short of breath.	5,801	-3,969	198	0,000
I am concerned about making errors during task execution.	5,678	-2,670	198	0,042
I find it difficult to focus on the Physical Education task presented.	8,646	-2,222	198	0,029
I feel discomfort when I breathe.	11,086	-2,494	198	0,015
When performing the tasks, I feel uneasy about potential mistakes.	5,038	-1,998	198	0,049
I find it difficult to memorise information regarding the tasks presented.	0,722	-1,326	198	0,186
I feel dizzy.	9,462	-2,903	198	0,032
I worry a lot about the physical tests.	17,172	-2,697	198	0,009
I find it difficult to remember Physical Education tasks I already know.	11,724	-2,378	198	0,020
I sense a feeling of pressure on my chest.	5,882	-1,346	198	0,182
I am concerned about failing when performing the tasks.	12,273	-2,777	198	0,007
Irrelevant thoughts disturb my thinking.	4,754	0,611	198	0,538
My body is aching.	4,823	-2,559	198	0,012
I think about the consequences of possible mistakes in the test.	2,140	-1,661	198	0,098
I have difficulty understanding the pattern of such complex tasks.	11,657	-2,533	198	0,027
I feel as if something is choking me.	4,742	-1,362	198	0,177
I worry that I will perform badly.	11,805	-1,464	198	0,147

Table 4 shows that based on the results from Levene's test for equality of variances and the corresponding significance indicators, there is a statistically significant difference between respondents who participate in some sports outside of physical education classes in 12 out of 18 items. We can conclude that there are no statistically significant differences among respondents when answering the scale items (e.g., "I find it difficult to remember information related to the presented tasks," "I feel something pressing in my chest," "Irrelevant thoughts interfere with my thinking," "I think about the consequences of possible mistakes on the test," "I feel like something is choking me," and "I worry that I will perform poorly on the task"), for which no statistically significant differences were obtained (F=0.722; t=-1.326; p=0.186, F=5.882; t=-1.346; p=0.182, F=4.754; t=0.611; p=0.538, F=2.140; t=-1.661; p=0.098, F=4.742; t=-1.362; p=0.177, F=11.805; t=-1.464; p=0.147).

Table 5. Pearson's χ2 values depending on the engagement in leisure-time physical activities

Scale item	X2	df	P
I find it difficult to remember information about the tasks presented.	14,517	12	0,269
I feel as though I am short of breath.	40,710	12	0,000
I am concerned about making errors during task execution.	35,000	12	0,000
I find it difficult to focus on the Physical Education task presented.	31,150	12	0,002
I feel discomfort when I breathe.	22,245	12	0,035
When performing the tasks, I feel uneasy about potential mistakes.	30,865	12	0,002
I find it difficult to memorise information regarding the tasks presented.	35,775	12	0,000
I feel dizzy.	27,798	12	0,006
I worry a lot about the physical tests.	35,618	12	0,000
I find it difficult to remember Physical Education tasks I already know.	36,483	12	0,000
I sense a feeling of pressure on my chest.	17,169	12	0,143
I am concerned about failing when performing the tasks.	40,571	12	0,000
Irrelevant thoughts disturb my thinking.	29,467	12	0,003
My body is aching.	31,433	12	0,002
I think about the consequences of possible mistakes in the test.	29,607	12	0,003
I have difficulty understanding the pattern of such complex tasks.	43,747	12	0,000

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I feel as if something is choking me.	14,816	12	0,252
I worry that I will perform badly.	43,582	12	0,000

In view of Table 5, and based on the obtained values of Pearson's χ2 and the associated significance indicators, we can conclude that there are statistically significant differences among students engaging in recreational physical activities, except for the items where the values of Pearson's χ2 are greater than the threshold at the significance level of 0.05 (X2=14.517 df=12 p=0.269; X2=17.169 df=12 p=0.143; and X2=14.816 df=12 p=0.252) for the scale items (e.g., "I find it difficult to remember information related to the tasks I need to do," "I feel something pressing in my chest," and "I feel like something is choking me").

Table 6. Values of Pearson's χ2 depending on the grade

Scale item	**X2**	**df**	**P**
I find it difficult to remember information about the tasks presented.	3,719	8	0,923
I feel as though I am short of breath.	12,020	8	0,150
I am concerned about making errors during task execution.	7,088	8	0,527
I find it difficult to focus on the Physical Education task presented.	2,568	8	0,958
I feel discomfort when I breathe.	5,101	8	0,747
When performing the tasks, I feel uneasy about potential mistakes.	5,350	8	0,720
I find it difficult to memorise information regarding the tasks presented.	10,353	8	0,241
I feel dizzy.	54,206	8	0,000
I worry a lot about the physical tests.	29,500	8	0,000
I find it difficult to remember Physical Education tasks I already know.	19,403	8	0,013
I sense a feeling of pressure on my chest.	33,963	8	0,000
I am concerned about failing when performing the tasks.	32,499	8	0,000
Irrelevant thoughts disturb my thinking.	24,975	8	0,002
My body is aching.	12,145	8	0,145
I think about the consequences of possible mistakes in the test.	9,057	8	0,338
I have difficulty understanding the pattern of such complex tasks.	19,102	8	0,014
I feel as if something is choking me.	33,382	8	0,000
I worry that I will perform badly.	20,626	8	0,008

There is no statistically significant difference among respondents concerning their grades in physical and health education at the end of the previous school year. Table 6 presents the results of the Pearson's χ2 values in relation to the grades at the end of the previous school year, where it was observed that there is no statistically significant difference, except for 9 items whose Pearson's χ2 values are below the threshold (X2=54.206; df=8; P=0.000, X2=29.500; df=8; P=0.000, X2=19.403; df=8; p=0.013, X2=33.963; df=8; p=0.000, X2=32.499; df=8; p=0.000, X2=24.975; df=8; p=0.002, X2=19.102; df=8; p=0.014, X2=33.382; df=12; p=0.000, X2=20.626; df=12; p=0.000).

Conclusion

It is very important for teachers to recognize and reduce anxiety in students and to mitigate factors in teaching that could potentially cause anxiety so that students do not experience feelings of incompetence, low self-esteem, or low achievement in physical education, leading them to avoid physical and health education classes and physical activity in general.

Although our sample did not highlight statistically significant differences between male and female students of older school ages regarding anxiety in physical and health education classes, many other studies have. Therefore, it is essential for physical and health education teachers to have a better understanding of their students' characteristics (e.g., gender differences, grades in this subject, methods of evaluation, involvement in sports, and the frequency of engaging in physical activities outside of physical and health education classes) to help reduce anxiety in physical and health education.

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UDK 796:37:159.942-053.5

Anksioznost učenika starijeg školskog uzrasta na časovima fizičkog i zdravstvenog vaspitanja

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Uvod

Anksioznost se definiše kao bojazanost, strah, nesigurnost i napetost i predstavlja neprijatnu emociju koju karakteriše pobuđenost nervnog sistema (Weinberg & Gould, 2007).

Anksioznost u nastavi fizičkog vaspitanja predstavlja osećanje brige, napetosti, straha i porasta fiziološke pobuđenosti organizma koja je u vezi s procesom nastave (Barkoukis, 2007). Mnogi učenici fizičko i zdravdtveno vaspitanje doživljavaju kao zabavu, ali ima i onih koji prema ovom nastavnom predmetu pokazuju negativan stav.

Među najznačajnijim faktorima koji utiču na javljanje anksioznosti u nastavi fizičkog vaspitanja spada nastava koja nije zasnovana na prethodnom iskustvu učenika, motivaciona klima orijentisana na postignuće, način odnosa nastavnika prema učenicima i način ocenjivanja. Pokazalo se da je pad sportskog performansa povezan sa vežbanjem i ocenjivanjm u uslovima visokog pritiska (Molina, Cho rot, Valiente, & Sandin, 2014), posebno kod učenika kod kojih je visoka osetljivost na anksioznost (Molina, Sandin, & Chorot, 2014). Što se tiče rodne ravnospavnosti većina istraživanja pokazuje da dečaci imaju pozitivniji stav od devojčica (Danthony, Mascret & Cury,2020).

Anksioznost u nastavi fizičkog vaspitanja tokom ocenjivanja je izraženija nego tokom ocenjivanja iz drugih nastavnih predmeta jer se ocenjivanje izvodi pred nastavnikomm i drugovima iz odeljenja (Barkoukis et al., 2012). Loša ocena iz fizičkog vaspitanja može se smatrati izazivanjem anksioznosti jer ističe neki oblik fizičke nesposobnosti, što može loše uticati na učenike koji imaju lošu sliku o sebi.

Cilj istraživanja je da se istraže razlike između učenika i učenica starijeg školskog uzrasta u pogledu anksioznosti na časovima fizičkog i zdravstvenog vaspitanja.

Metod

Istraživanje je bilo transverzalnog karaktera i realizovano je u osnovnim školama Jagodine u prvom semestru školske 2024/2025. Uzorak ispitanika je obuhvatio 200 učenika sedmog i osmog razreda, koji je bio podeljen na dva subuzorka u odnosu na pol i to: subuzorak od 105 učenika i 95 učenica. Za ispitivanje stanja anksioznosti na časovima fizičkog i zdravstvenog vaspitanja korišćen je instrument Physical Education State Anxiety Scale (PESAS) (Barkoukis et al, 2005, Barkoukis, 2007) adaptiran za primenu na srpskom jeziku (Orlić, Ilić, & Lazarević, 2012) i konstruisan je dodatni upitnik. Za obradu dobijenih podataka od statističkih procedura primenjena je deskriptivna statistika (frekvenca, procenat, aritmetička sredina, standardna devijacija, minimum i maksimum). Za ispitivanje polnih razlika korišćen je t-test za nezavisne uzorke i $\chi 2$ test. Podaci su obrađeni u programskom paketu SPSS-26.

Rezultati

Polazeći od od uzorka ispitanika i zavisnih i nezavisnih varijabli, u Tabeli 1. prikazane su osnovne karakteristike uzorka.

Tabela 1. Uzorak ispitanika

Variable	Kategorije	Broj ispitanika (N)	%
Pol ispitanika	Muški	105	52,5
	Ženski	95	47,5
Razred ispitanika	Sedmi	121	60,5
	Osmi	79	39,5
Ocena iz fizičkog i zdravstvenog vaspitanje	Tri	3	1,5
	Četiri	19	9,5
	Pet	178	89
Bavljenje sportom	Bavim se	141	70,5
	Ne bavim se	59	29,5
Učestalost bavljenja fizičkim aktivnostima van nastave fizičkog i zdravstvenog vaspitanja	Ne bavim se	33	16,5
	1 do 2 puta nedeljno	22	11
	3 puta nedeljno	42	21
	Više od tri puta nedeljno	103	51,5

Uvidom u tabelu 1. možemo konstatovati da se dosta ispitanika bavi sportom, 70,5% i da više od polovine, 51,5% ispitanika je fizički aktivno i van nastave fizičkog i zdravstvenog vaspitanja.

Tabela 2. Deskriptivna statistika stavki skale

Stavke skale	N	Min	Max	Mean	SD
Teško mi je da se setim informacije u vezi zadataka koje treba da uradim.	200	1	5	1,74	0,959

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Osećam se kao bez daha	200	1	5	1,63	0,978
Zabrinut/a sam da ne napravim greške tokom izvođenja zadatka.	200	1	5	2,12	1,233
Teško mi je da se usresredim na postavljeni zadatak u fizičkom vaspitanju	200	1	5	1,43	0,823
Osećam nelagodnost pri disanju.	200	1	5	1,51	0,868
Kada izvodim zadatke osećam se uznemireno zbog mogućih grešaka.	200	1	5	1,74	1,053
Teško mi je da zapamtim informacije u vezi sa prikazanim zadacima.	200	1	5	1,60	0,925
Osećam vrtoglavicu.	200	1	5	1,47	0,924
Mnogo brinem kada su u pitanju testovi fizičkih sposobnosti.	200	1	5	1,65	1,093
Teško mi je da se setim zadataka fizičkog vaspitanja koje znam od ranije	200	1	5	1,59	0,922
Imam osećaj da me nešto pritiska u grudima.	200	1	5	1,49	0,868
Prilikom izvođenja zadataka brinem da neću uspeti u tome.	200	1	5	1,75	1,097
Nevažne misli remete mi razmišljanje.	200	1	5	1,80	1,156
Osećam bol u telu.	200	1	5	1,65	0,986
Razmišljam o posledicama mogućih grešaka na testu.	200	1	5	1,84	1,194
Imam poteškoće da razumem složene zadatke.	200	1	5	1,61	0,986
Osećam se kao da me nešto guši.	200	1	5	1,31	0,745
Brinem da ću loše izvesti zadatak	200	1	5	1,82	1,242

Prosečni rezultati stavki skale kretali su se od 1,31 sa standardnom devijacojom 0,745 do 2,12 sa standardnom devijacijom 1,233.

Table 3. T-test za nezavisne uzorke, razlike po polu

Stavka	**F**	**t**	**df**	**p**
Teško mi je da se setim informacije u vezi zadataka koje treba da uradim.	2,225	0,269	198	0,788
Osećam se kao bez daha.	2,312	-1,846	198	0,66
Zabrinut/a sam da ne napravim greške tokom izvođenja zadatka.	5,677	-0,352	198	0,723
Teško mi je da se usresredim na postavljeni zadatak u fizičkom vaspitanju.	8,983	1,609	198	0,101
Osećam nelagodnost pri disanju.	0,992	-1,311	198	0,191
Kada izvodim zadatke osećam se uznemireno zbog mogućih grešaka.	0,615	-1,036	198	0,301
Teško mi je da zapamtim informacije u vezi sa prikazanim zadacima.	0,667	0,692	198	0,490
Osećam vrtoglavicu.	6,232	-1,831	198	0,072
Mnogo brinem kada su u pitanju testovi fizičkih sposobnosti.	0,613	-0,611	198	0,542
Teško mi je da se setim zadataka fizičkog vaspitanja koje znam od ranije.	0,002	0.041	198	0,967
Imam osećaj da me nešzo pritiska u grudima.	2,434	-1,130	198	0,260
Prilikom izvođenja zadataka brinem da neću uspeti u tome.	0,628	-0,612	198	0,541
Nevažne misli remete mi razmišljanje.	4,754	0,611	198	0,538
Osećam bol u telu.	0,071	-0,322	198	0,748
Razmišljam o posledicama mogućih grešaka na testu.	2,497	-1,388	198	0,167
Imam poteškoće da razumem složene zadatke.	0,877	0,348	198	0,729
Osećam se kao da me nešto guši.	8,912	-1,724	198	0,091
Brinem da ću loše izvesti zadatak.	0,312	-755	198	0,451

Polazeći od cilja istraživanja se istraže razlike između učenika i učenica starijeg školskog uzrasta u pogledu anksioznosti na časovima fizičkog i zdravstvenog vaspitanja urađen je t-test za nezavisne uzorke.

Iz tabele 3. može se videti da ne postoji statistički značajna razlika između učenika i učenica starijeg školskog uzrasta u pogledu anksioznosti na časovima fizičkog i zdravstvenog vaspitanja. Na osnovu dobijenih vrednosti Leveneovog testa jednakosti varijanse i odgovarajućih pokazatelja značajnosti, možemo zaključiti da ne postoje statistički značajne razlike između ispitanika različitih polova kada odgovaraju po stavkama skale.

Tabela 4. T-test za nezavisne uzorke, razlika u bavljenju sportom

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Stavka	F	t	df	p
Teško mi je da se setim informacije u vezi zadataka koje treba da uradim.	8,874	-2,023	198	0,045
Osećam se kao bez daha.	5,801	-3,969	198	0,000
Zabrinut/a sam da ne napravim greške tokom izvođenja zadatka.	5,678	-2,670	198	0,042
Teško mi je da se usresredim na postavljeni zadatak u fizičkom vaspitanju.	8,646	-2,222	198	0,029
Osećam nelagodnost pri disanju.	11,086	-2,494	198	0,015
Kada izvodim zadatke osećam se uznemireno zbog mogućih grešaka.	5,038	-1,998	198	0,049
Teško mi je da zapamtim informacije u vezi sa prikazanim zadacima.	0,722	-1,326	198	0,186
Osećam vrtoglavicu.	9,462	-2,903	198	0,032
Mnogo brinem kada su u pitanju testovi fizičkih sposobnosti.	17,172	-2,697	198	0,009
Teško mi je da se setim zadataka fizičkog vaspitanja koje znam od ranije.	11,724	-2,378	198	0,020
Imam osećaj da me nešzo pritiska u grudima.	5,882	-1,346	198	0,182
Prilikom izvođenja zadataka brinem da neću uspeti u tome.	12,273	-2,777	198	0,007
Nevažne misli remete mi razmišljanje.	4,754	0,611	198	0,538
Osećam bol u telu.	4,823	-2,559	198	0,012
Razmišljam o posledicama mogućih grešaka na testu.	2,140	-1,661	198	0,098
Imam poteškoče da razumem složene zadatke.	11,657	-2,533	198	0,027
Osećam se kao da me nešto guši.	4,742	-1,362	198	0,177
Brinem da ću loše izvesti zadatak.	11,805	-1,464	198	0,147

U tabeli 4. na osnovu dobijenih vrednosti Leveneovog testa jednakosti varijanse i odgovarajućih pokazatelja značajnosti, možemo zaključiti da postoji statistički značajna razlika između ispitanika koji se bave nekim sportom van časova fizičkog vaspitanja u 12 od 18 stavki. Možemo zaključiti da ne postoji statistički značajna razlika između ispitanika kada odgovaraju po stavkama skale (teško mi je da zapamtim informacije u vezi sa prikazanim zadacima, imam osećaj da me nešzo pritiska u grudima, nevažne misli remete mi razmišljanje, razmišljam o posledicama mogućih grešaka na testu, osećam se kao da me nešto guši i brinem da ću loše izvesti zadatak.), za koje nisu dobijene statistički značajne razlike (F=0,722; t= -1,326; p=0,186, F=5,882; t= -1,346; p=0,182, F=4,754; t=0,611; p=0,538, F=2,140; t= -1,661; p=0,098, F=4,742; t= -1,362; p=0,177, F=11,805; t= -1,464; p=0,147).

Tabela 5. Pirsonove vrednosti χ2u zavisnosti od bavljenja fizičkim aktivnostima u slobodno vreme

Stavka	X2	df	P
Teško mi je da se setim informacije u vezi zadataka koje treba da uradim.	14,517	12	0,269
Osećam se kao bez daha.	40,710	12	0,000
Zabrinut/a sam da ne napravim greške tokom izvođenja zadatka.	35,000	12	0,000
Teško mi je da se usresredim na postavljeni zadatak u fizičkom vaspitanju.	31,150	12	0,002
Osećam nelagodnost pri disanju.	22,245	12	0,035
Kada izvodim zadatke osećam se uznemireno zbog mogućih grešaka.	30,865	12	0,002
Teško mi je da zapamtim informacije u vezi sa prikazanim zadacima.	35,775	12	0,000
Osećam vrtoglavicu.	27,798	12	0,006
Mnogo brinem kada su u pitanju testovi fizičkih sposobnosti.	35,618	12	0,000
Teško mi je da se setim zadataka fizičkog vaspitanja koje znam od ranije.	36,483	12	0,000
Imam osećaj da me nešzo pritiska u grudima.	17,169	12	0,143
Prilikom izvođenja zadataka brinem da neću uspeti u tome.	40,571	12	0,000
Nevažne misli remete mi razmišljanje.	29,467	12	0,003
Osećam bol u telu.	31,433	12	0,002
Razmišljam o posledicama mogućih grešaka na testu.	29,607	12	0,003
Imam poteškoče da razumem složene zadatke.	43,747	12	0,000
Osećam se kao da me nešto guši.	14,816	12	0,252
Brinem da ću loše izvesti zadatak.	43,582	12	0,000

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Uvidom u tabelu 5. i na osnovu dobijenih vrednosti Pirsonovog χ2 i pripadajućih pokazatelja značajnosti možemo zaključiti da postoje statistički značajne razlike između učenika rekreativnog bavljenja fizičkim aktivnostima osim za stavke čije su vrednosti Pirsonovog χ2 veće od graničnih na nivou značajnosti 0,05 (X2=14,517 df=12 p=0,269; X2=17,169 df=12 p=0,143 i X2=14,816 df=12 p=0,252) kod stavki skala (teško mi je da se setim informacije u vezi zadataka koje treba da uradim, imam osećaj da me nešto pritiska u grudima i osećam se kao da me nešto gušio).

Tabela 6. Vrednosti Pirsonovog χ2 koeficijenta u zavisnosti od razreda

Stavka	**X2**	**df**	**P**
Teško mi je da zapamtim informacije o predstavljenim zadacima.	3,719	8	0,923
Osećam se kao da mi nedostaje daha	12,020	8	0,150
Brinem se zbog grešaka tokom izvršavanja zadatka.	7,088	8	0,527
Teško mi je da se fokusiram na zadatak iz fizičkog vaspitanja koji mi je predstavljen.	2,568	8	0,958
Osećam nelagodnost kada dišem.	5,101	8	0,747
Prilikom obavljanja zadataka, osećam se nelagodno zbog mogućih grešaka.	5,350	8	0,720
Teško mi je da zapamtim informacije u vezi sa predstavljenim zadacima.	10,353	8	0,241
Vrti mi se u glavi.	54,206	8	0,000
Mnogo brinem zbog fizičkih testova.	29,500	8	0,000
Teško mi je da se setim zadataka iz fizičkog vaspitanja koje već znam.	19,403	8	0,013
Osećam pritisak u grudima.	33,963	8	0,000
Brinem se da ću neuspeti prilikom izvršavanja zadataka.	32,499	8	0,000
Nebitne misli mi ometaju razmišljanje.	24,975	8	0,002
Telo me boli.	12,145	8	0,145
Razmišljam o posledicama mogućih grešaka na testu.	9,057	8	0,338
Teško mi je da razumem obrazac tako složenih zadataka.	19,102	8	0,014
Osećam se kao da me nešto guši.	33,382	8	0,000
Brinem se da ću loše uraditi test.	20,626	8	0,008

Ne postoji statistički značajna razlika među ispitanicima u pogledu njihovih ocena iz fizičkog i zdravstvenog vaspitanja na kraju prethodne školske godine. Tabela 6 prikazuje rezultate Pirsonovog ch2 indeksa u odnosu na ocene na kraju prethodne školske godine, gde je uočeno da nema statistički značajne razlike, osim za 9 stavki čije su Pirsonove ch2 vrednosti ispod praga (X2=54,206; df=8; P=0,000, X2=29,500; df=8; P=0,000, X2=19,403; df=8; p=0,013, X2=33,963; df=8; p=0,000, X2=32,499; df=8; p=0,000, X2=24,975; df=8; p=0,002, X2=19,102; df=8; p=0,014, X2=33,382; df=12; p=0,000, H2=20,626; df=12; p=0,000).

Zaključak

Veoma je važno da nastavnici znaju da uoče i redukuju anksioznost kod učenika i da u nastavi redukuju one faktore koji potencijalno mogu izazvati anksioznost kako ne bi kod učenika došlo do doživljaja nekompetentnosti, niskog samopouzdanja, niskog postignuća u nastavi fizičkog vaspitanja i samim tim izbegavanje časova fizičkog i zdravstvenog vaspitanja i fizičke aktivnosti u celini.

Iako na nivou našeg uzorka nije uočena statistički značajna razlika između učenika i učenica starijeg školskog uzrasta u pogledu anksioznosti na časovima fizičkog i zdravstvenog vaspitanja u mnogim drugim radovima jeste pa je neophodno bolje razumevanje nastavnika fizičkog i zdravstvenog vaspitanja o karakteristikama svojih učenika (npr. polne razlike, oceni iz ovog nastavnog predmeta, načinu ocenjivanja, bavljenjem sportom i učestalošću bavljenjem fizičkim aktivnostima van časova fizičkog i zdravstvenog vaspitanja) može doprineti smanjenju anksioznosti u nastavi fizičkog i zdravstvenog vaspitanja.

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UDK 796:37:159.942-053.5

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UDK 796.035

Horticultural therapy - Occupational therapy and/or sports and recreational activity

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Introduction

Contemporary times and everyday life of people in the global society are characterized by a largely sedentary lifestyle, reduced physical activity, a significant number of hours spent in front of computer monitors, TV sets, mobile phones, many factors that cause different types of stress, all of which have a negative impact on people's health and, in general, on the reduction of people's quality of life regardless of age group and numerous social and cultural differences. In the relevant literature, the following cultural, social and economic factors that negatively affect health can be distinguished: 1. lack of physical activity; 2. stress; 3. low income and poverty; 4. inadequate medical and social care and poor availability of health and social services; 5. lack of cheap forms of recreation and absence of parks and gardens; 6. excessive smoking and alcohol, taking illegal drugs, not practicing safe sex; 7. living in areas with a high crime rate; 8. failure to implement safety measures at work; 9. poor housing conditions, humidity, cold and insufficient living space; 10. proper meals are not bought or prepared; 11. inadequate child care and inadequate socialization; 12. poor planning of transport, unavailability of means of public transport; 13. unemployment; 14. consumption of «fast food» and other types of food that are bad for health; 15. living in industrial areas with a high risk of pollution, busy roads and poor air quality; 16. social isolation and social exclusion – living on the margins of society, without the possibility of controlling one's own life; 17. long working hours, stressful or risky working conditions; 18. poor education, poor health education and lack of information about the availability of health services (Giddens & Sutton, 2021; Radenović, 2021: 163).

We will not consider all the listed factors individually, but we note that the lack of physical activity is the first on the list of factors that has the negative impact on health, and in connection with it, the lack of cheap and accessible forms of recreation and the absence of green areas, parks and gardens (Giddens & Sutton, 2021), which is extremely important information both for the sociology of sport, and when we are considering the proposal of practical application of hortitherapeutic and sociological benefits of green areas.

Horticultural therapy or garden therapy can be seen and implemented not only as a form of occupational therapy that has a wide rehabilitative application, but also as a type of physical activity, a form of recreation, sports-recreational activitiy according to the needs and wishes of the target group. Working and generally interacting with plants in gardens and on green areas reduces stress, improves people's mental, psychosocial and psychophysical abilities and has a positive effect on health and in general on increasing people's quality of life, as it is indicated by the results of various researches (Drkenda et al., 2024b: 12 -13, 148-153). Numerous studies point to the conclusion that working in the garden along with daily sports and recreational activities such as long walks can significantly contribute to the extension of people's lifespan (Dikić, 2024). Namely, we are talking about the concept of the 'blue zone', which refers to certain regions in the world where the longevity of the population has been confirmed, that is, a longer life expectancy compared to the other regions in the world. The results of numerous studies point to the conclusion that within the 'blue zone', residents practice: a plant-based diet, moderate calorie intake, low consumption of tobacco and alcohol, regular physical activity and an active social life (Dikić, 2024). Researches have confirmed that within the 'blue zone', residents move around a lot, go on foot and work in the garden, or rather, they do not have to go to the gym to achieve a certain physical activity (Dikić, 2024). In the 'blue zone', an active social life is recognized in socializing with friends over coffee or tea (Dikić, 2024), but socializing in the context of working in the garden or in the yard can also be considered, which again points to the aforementioned fact that working in the garden and gardening as a form of sports-recreational activity affects the increase in the people's quality of life.

Finally, horticultural therapy is a part of the broader concept of urban agriculture, which refers to the activity of growing and producing food in cities and which is developing due to global urbanization and the need for the development of sustainable cities. Urban agriculture is based on the principles of organic production, which implies the exclusion of the use of mineral fertilizers and pesticides, and which consequently implies uncontaminated, microbiologically tested and proper food that has no harmful effects on the health of the consumer. The production of vegetables and fruits in combination with flowers, aromatic and medicinal plants is an innovative form of food production, regardless of whether the production takes place in the yard, garden, on the balcony, roof, wall or even in the interior (Drkenda and others, 2024b: 9). All of the above points to the unequivocal conclusion that urban agriculture contributes to improving the quality of life of people in cities, and that it contributes to increasing people's longevity.

This paper discusses the main characteristics of horticultural therapy gardens, as well as the results of horticultural therapy workshops realized so far within projects in the field of horticultural therapy designed and implemented in Bosnia and Herzegovina.

Method

The method of theoretical analysis and the method of content analysis are applied in the paper. Let us also mention that during the implementation of specific educational hortitherapy workshops, action research was conducted.

Results

From 2018 to 2024, five (5) educational workshops for children of preschool age were realized in the public institution for preschool upbringing and education «Mladost» in Kakanj (Bosnia and Herzegovina) as a part of the project «Horticultural therapy for the youngest». During the workshops, children had the opportunity to plant and practice in the field of planting material production with the aim that children of the youngest age will love nature, get to know its diversity, to understand the importance of plant material production, and through play and socializing, to learn teamwork, tolerance and respect for another and different. The goals of the aforementioned project are also the social inclusion of children with developmental

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disabilities, improvement of the conditions in which preschool children stay, and improvement of environmental parameters in the area of Kakanj municipality, which is one of the most polluted in Bosnia and Herzegovina.

Let us consider in more detail the content of the conducted educational workshops. The conducted educational horticultural therapy workshops for children of preschool age belong to the type of social horticultural therapy (horticultural therapy in the community) (Drkenda et al., 2024b: 152). This type of horticultural therapy is a recreational activity that is applied in free time through various programs of gardening activities and focusing on plants, interaction with nature, indoor or outdoor programs that focus on teamwork, joint activities and integration of each individual. The program used in the preschool institution «Mladost» is a program called «Direct interaction with nature with the use of specially designed tool set for the use of sensory-stimulating green areas» (Drkenda et al., 2024b: 152). The main goal of the program is to bring nature as close as possible to the users of the program through exercises that lead to the awakening of a special sensibility towards nature and its contents. As the beneficiaries of this program, children from the «Mladost» pre-school had the first sensory-stimulating green area where most of the planned exercises took place. One of the goals of this program was to improve the integration of children with developmental difficulties into the peer group. Regarding the fact that for children with developmental disabilities it is difficult to stay in a standing or kneeling position for a long time within the participation in the classical gardening provided by the program, special tool set was created in this educational horticultural therapy workshop with the aim of facilitating access and enabling the integration of peers with difficulties in the program. The program consisted of exercises with the following content: 1. learning about nature; 2. learning about the method of plant propagation and mastering simple plant propagation techniques; 3. learning about how to use plants and their use in nutrition. Through the program, children were shown in a creative way with direct interaction with plants the specificity of each plant through the period of growth and development, with the aim of awakening a feeling of love for nature and empathy for peers (Drkenda et al., 2024b: 153-161). The program proved to be extremely effective and applicable, and the children showed great interest in all the exercises conducted within the program.

During 2021, a horticultural therapy workshop was also held for students of the University of Sarajevo. The main goal of this educational workshop was to familiarize the student population with the importance of urban agriculture for improving the quality of life and longevity of the population and to familiarize them with the potential of horticultural therapeutic gardens as a type of a 'team building' program. This educational workshop involved passive communication with plant material through its visual, sensory, auditory and tactile qualities. The workshop also had a pronounced social component, as students were enabled to interact with other people, develop cooperation skills and encourage an atmosphere in which colleagues inspire each other regardless of the different socio-demographic characteristics of each individual. Each of the participants of this educational horticultural therapy workshop brought their planted plant composition with them, learning that each individual has his/her own path of growth and development (University of Sarajevo, 2021). The results of the action research carried out during the holding of this educational horticultural therapy workshop point to the conclusion that the students showed a significant interest in acquiring knowledge in the field of urban agriculture and that they are motivated to acquire knowledge and skills related to the improvement of teamwork in the form of a specific 'team building' program that would include work in the horticultural therapeutic garden as well as certain sports and recreational activities such as chess, badminton, judo, etc.

According to the knowledge so far, the realized educational horticultural therapy workshops for children of preschool age in the public institution for preschool upbringing and education «Mladost» in Kakanj and for students of the University of Sarajevo are of pioneering character both in Bosnia and Herzegovina and in the region.

Discussion

The considered educational horticultural therapy workshops were successfully implemented, which can be a valid basis for the implementation of similar projects in the future. Regarding the horticultural therapy workshops realized in the «Mladost» preschool, the pioneering program created was intended to, through a creative and relatively inexpensive concept, using the existing resources of this preschool, come to life in the long term as a form of therapy in which peers with developmental difficulties were also integrated, with the aim that the implemented program will be accepted through the regular programs of this institution. Children of preschool age were successfully presented learning about nature through various gardening activities in a creative and attractive way, according to their age (Drkenda et al., 2024a), and in this way the main goal of the program – bringing nature closer to the users – was successfully fulfilled.

Regarding the implemented educational horticultural therapy workshop for students of the University of Sarajevo, as it is mentioned, the main goal of this program was to introduce the student population to the importance of urban agriculture for improving the quality of life and longevity of the population. This goal was successfully fulfilled considering the fact that the students showed great interest in the characteristics and benefits of the concept of urban agriculture, which they did not know much about before. The students also showed interest in participating in the creation and implementation of horticultural therapy programs that would be combined with certain sports and recreational activities through the concept of a kind of 'team building' program, so another goal of the realized educational hortitherapy workshop was fulfilled.

All of the above points to the significant potential of educational horticultural therapy workshops, which we should be aware regarding the previously mentioned benefits of horticultural therapy and urban agriculture as a broader framework. Let us remind that the results of numerous researches indicate the positive effect of horticultural therapy on people with developmental difficulties, learning difficulties, on the elderly, on people with psychological problems and illnesses, on people with social problems, on unemployed people through the acquisition of new work competencies, on victims of the different forms of violence, on people with disabilities, on chronic patients, etc. (Haller & Kramer, 2017; Drkenda et al., 2024b: 148). The positive effects of horticultural therapy have also been recorded in the area of improving sensorimotor skills, cognitive and psychosocial skills (Drkenda et al., 2024b: 148). Horicultural therapy is practiced in the world by additionally educated health professionals, through numerous models of horticultural therapeutic practice in Austria, Great Britain, Germany, and the USA (Drkenda et al., 2024b: 148).

Conclusion

The hortitherapeutic and sociological aspects in synergistic action point to the development of the quality of the

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relationship between man and nature through concrete touch, i.e. the interaction of man with different plant cultures on the green areas, with quality communication with the hortitherapist according to the age of the target group and other social and cultural characteristics of the target group. Practically, this means that, for example, children of (pre)school age who stay in the hortitherapeutic garden will learn the basic elements of planting, growing and maintaining certain plant cultures through play and desired and adequate sports and recreational activities, while, for example, adults employed in a certain company, in the hortitherapeutic garden will gain knowledge about planting, growing and maintaining plant cultures with the application of horticultural therapy - not only as a sports and recreational activity, but also as a specific type of 'team building' program. Furthermore, in the hortitherapeutic garden, people with disabilities will gain knowledge about planting, growing and maintaining plant crops with the application of horticultural therapy and adapted physical activity according to their capacities, and in this way their quality of life can be significantly improved in the long term, etc. Finally, let us underline the work in the garden as one of the elements of the 'blue zone' concept, which refers to certain regions in the world where the longevity of the population has been confirmed, i.e. a longer lifespan compared to other regions in the world. All of the above mentioned confirms the importance of horticultural therapy not only as a form of occupational therapy and/or sports-recreational activity, but also as a significant factor that improves the quality of life and longevity of people. Related to that is the importance of urban agriculture as a broader framework for the application of horticultural therapy. Considering all the mentioned characteristics of urban agriculture that point to benefits when it comes to improving people's quality of life and consequently people's longevity, educating the inhabitants of the cities of the global society about the importance of urban agriculture and horticultural therapy is crucial and represents a challenge for professionals from various fields who should come up with the most efficient and effective ways of educating the urban population and, consequently, the practical application of the acquired knowledge.

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Hortiterapija - radna terapija i/ili sportsko-rekreativna aktivnost

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Uvod

Savremeno doba i svakodnevni život ljudi u globalnom društvu karakteriše mahom sedentarni način života, smanjena fizička aktivnost, značajan broj sati provedenih ispred kompjuterskih monitora, TV prijemnika, mobilnih telefona, mnogo faktora koji izazivaju različite vrste stresa, a što sve negativno utiče na zdravlje ljudi i generalno na smanjenje kvaliteta života ljudi, bez obzira na starosnu grupu i brojne društvene i kulturološke razlike. U relevantnoj literaturi mogu se izdvojiti sledeći kulturni, društveni i ekonomski faktori koji negativno utiču na zdravlje: 1. nedostatak fizičke aktivnosti; 2. stres; 3. niska primanja i siromaštvo; 4. neodgovarajuća medicinska i socijalna briga i slaba dostupnost zdravstvenih i socijalnih usluga; 5. nedostatak jeftinih vidova rekreacije i nepostojanje parkova i vrtova; 6. prekomerno pušenje i alkohol, uzimanje nedozvoljenih lekova, neupražnjavanje bezbednog seksa; 7. život u oblastima sa visokom stopom kriminala; 8. nesprovođenje mera zaštite na radu; 9. loši uslovi stanovanja, vlaga, hladnoća i nedovoljan životni prostor; 10. ne kupuju se i ne pripremaju pravi obroci; 11. neadekvatna briga o deci i neodgovarajuća socijalizacija; 12. loše planiranje transporta, nedostupnost sredstava javnog prevoza; 13. nezaposlenost; 14. konzumiranje „brze hrane" i ostalih vrsta namirnica loših po zdravlje; 15. život u industrijskim oblastima sa visokim rizikom od zagađenja, prometnim saobraćajnicama i lošim kvalitetom vazduha; 16. društvena izolacija i društvena ekskluzija – život na marginama društva, bez mogućnosti kontrole sopstvenog života; 17. dugačko radno vreme, stresni ili rizični uslovi rada; 18. loše obrazovanje, loše zdravstveno obrazovanje i neobaveštenost o dostupnosti zdravstvenih usluga (Giddens & Sutton, 2021; Radenović, 2021: 163).

Sve pobrojane faktore nećemo pojedinačno razmatrati, no uočimo da je nedostatak fizičke aktivnosti faktor koji je na prvom mestu negativnog uticaja na zdravlje, a sa njim u vezi i nedostatak jeftinih i pristupačnih vidova rekreacije i nepostojanje zelenih površina, parkova i vrtova (Giddens & Sutton, 2021), a što je podatak od izuzetnog značaja kako za sociologiju sporta, tako i kada je predlog praktične primene hortiterapijskih i socioloških benefita zelenih površina u pitanju. Hortiterapija ili vrtna terapija se može posmatrati i realizovati ne samo kao oblik radne terapije koji ima široku rehabilitacijsku primenu, već i kao jedna vrsta fizičke aktivnosti, oblik rekreacije, sportsko-rekreativne aktivnosti shodno potrebama i željama ciljne grupe. Rad i uopšte interakcija sa biljkama u vrtovima i na zelenim površinama smanjuje stres, poboljšava mentalne, psihosocijalne i psihofizičke sposobnosti ljudi i pozitivno deluje na zdravlje i uopšte na povećenje stepena kvaliteta života ljudi, kako upućuju rezultati različitih istraživanja (Drkenda i drugi, 2024b: 12-13, 148-153). Brojna istraživanja upućuju i na zaključak da baš rad u bašti uz svakodnevne sportsko-rekreativne aktivnosti poput dužih šetnji može značajno doprineti produženju životnog veka ljudi (Dikić, 2024). Naime, reč je o konceptu 'plave zone' koji se odnosi na određene regione u svetu u kojima je potvrđena dugovečnost stanovništva, odnosno duži životni vek u odnosu na ostale regione u svetu. Rezultati brojnih istraživanja upućuju na zaključak da u okviru 'plave zone', stanovnici praktikuju: ishranu na biljnoj bazi, umeren unos kalorija, nisku potrošnju duvana i alkohola, redovnu fizičku aktivnost i aktivan socijalni život (Dikić, 2024). Istraživanja su potvrdila da se u okviru 'plave zone', stanovnici mnogo kreću, idu peške i rade u bašti ili vrtu, tačnije, ne moraju da idu u teretanu da bi ostvarili određenu fizičku aktivnost (Dikić, 2024). U 'plavoj zoni' aktivan socijalni život je prepoznat u druženju sa prijateljima uz kafu ili čaj (Dikić, 2024), ali se može razmotriti i druženje u kontekstu rada u bašti ili u vrtu, što ponovo upućuje na navedenu činjenicu da rad u bašti i vrtu kao oblik sportsko-rekreativne aktivnosti utiče na povećanje stepena kvaliteta života ljudi.

Najzad, hortiterapija jeste deo šireg koncepta urbane poljoprivrede koji se odnosi na aktivnost uzgoja i proizvodnje hrane u gradovima i koji se razvija usled globalne urbanizacije i potrebe za razvojem održivih gradova. Urbana poljoprivreda se zasniva na principima organske proizvodnje, što podrazumeva isključivanje korišćenja mineralnih đubriva i pesticida, a što posledično podrazumeva nekontaminiranu, mikrobiološki testiranu i ispravnu hranu koja nema štetne posledice na zdravlje konzumenta. Proizvodnja povrća i voća u kombinaciji sa cvećem, aromatičnim i lekovitim biljem jeste inovativan oblik proizvodnje hrane bez obzira na to da li se proizvodnja odvija u dvorištu, vrtu, okućnici, na balkonu, krovu, zidu ili čak u unutrašnjem prostoru (Drkenda i drugi, 2024b: 9). Sve navedeno upućuje na nedvosmislen zaključak da urbana poljoprivreda doprinosi poboljšanju kvaliteta života ljudi u gradovima, te da doprinosi povećanju dugovečnosti ljudi.

U ovom radu su razmotrene glavne karakteristike hortiterapijskih vrtova, kao i rezultati do sada realizovanih hortiterapijskih radionica u okviru projekata iz oblasti hortiterapije osmišljenih i sprovedenih u Bosni i Hercegovini.

Metod

U radu je primenjen metod teorijske analize i metod analize sadržaja. Pomenimo i to da je tokom realizacije konkretnih edukativnih hortiterapijskih radionica sprovedeno akciono istraživanje.

Rezultati

Od 2018. godine do 2024. godine je realizovano pet (5) edukativnih radionica za decu predškolskog uzrasta u javnoj ustanovi za predškolsko vaspitanje i obrazovanje «Mladost» u Kaknju (Bosna i Hercegovina) u okviru projekta «Hortiterapija za najmlađe». U okviru radionica deci je omogućena sadnja i vežba iz oblasti proizvodnje sadnog materijala sa ciljem da deca najmlađeg uzrasta zavole prirodu, upoznaju njene raznolikosti, da shvate značaj proizvodnje biljnog materijala, a kroz igru i druženje, da se nauče timskom radu, toleranciji i poštovanju prema drugom i drugačijem. Ciljevi pomenutog projekta jesu i socijalna inkluzija dece sa poteškoćama u razvoju, poboljšanje uslova u kojima borave deca predškolske ustanove, te poboljšanje ekoloških parametara na području opšine Kakanj koja je evidentirana kao jedna od najzagađenijih u Bosni i Hercegovini.

Razmotrimo detaljnije sadržaj sprovedenih edukativnih radionica. Sprovedene edukativne hortiterapijske radionice za decu predškolskog uzrasta pripadaju tipu socijalne hortiterapije (hortiterapija u zajednici) (Drkenda i drugi, 2024b: 152). Ovaj tip hortiterapije jeste rekreativna aktivnost koja se primenjuje u slobodno vreme kroz različite programe

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vrtlarskih aktivnosti i usmerenja na biljke, interakciju sa prirodom, programe u zatvorenom ili otvorenom prostoru koji se fokusiraju na timski rad, zajedničke aktivnosti i integraciju svakog pojedinca. Program korišćen u predškolskoj ustanovi "Mladost" jeste program pod nazivom "Direktna interakcija sa prirodom uz primenu specijalno dizajniranog mobilijara za primenu i senzorno-stimulativne zelene površine" (Drkenda i drugi, 2024b: 152). Osnovni cilj programa je što više približiti prirodu korisnicima programa kroz vežbe koje vode ka buđenju posebnog senzibiliteta ka prirodi i njenim sadržajima. Deca iz predškolske ustanove "Mladost" su kao korisnici ovog programa imala i prvu senzorno-stimulativnu zelenu površinu na kojoj se odvijao veći deo predviđenih vežbi. Jedan od ciljeva ovog programa bio je i poboljšanje integracije dece sa poteškoćama u razvoju u vršnjačku grupu. Da bi uzela učešća deca sa poteškoćama u razvoju kojima je teško da dugo budu u stojećem ili klečećem položaju koji se zauzima tokom klasičnog vrtlarenja predviđenog programom, u okviru ove edukativne hortiterapijske radionice kreiran je mobilijar koji je imao za cilj da olakša pristup i omogući integraciju vršnjaka sa poteškoćama u program. Program su činile vežbe sa sledećim sadržajem: 1. učenje o prirodi; 2. učenje o načinu razmnožavanja biljaka i savladavanje jednostavnih tehnika razmnožavanja biljaka; 3. učenje o načinu korišćenja biljaka i upotrebi u ishrani. Kroz program je deci na kreativan način uz neposrednu interakciju sa biljkama prikazana specifičnost svake biljke kroz period rasta i razvoja, a u cilju buđenja osećaja ljubavi prema prirodi i empatije prema vršnjacima (Drkenda i drugi, 2024b: 153-161). Program se pokazao izuzetno efikasnim i primenjivim, a deca su pokazala veliko interesovanje za sve sprovedene vežbe u okviru programa.

Tokom 2021. godine realizovana je i radionica hortiterapije za studente Univerziteta u Sarajevu. Osnovni cilj ove edukativne radionice je bio upoznavanje studentske populacije sa značajem urbane poljoprivrede za poboljšanje kvaliteta života i dugovečnosti stanovništva i upoznavanje sa potencijalima hortiterapijskih vrtova kao vrste 'team building' programa. Ova edukativna radionica je podrazumevala pasivnu komunikaciju sa biljnim materijalom kroz njegove vizuelne, čulne, auditivne i taktilne kvalitete. Radionica je imala i izraženu socijalnu komponentu, jer je studentima omogućena interakcija sa drugim osobama, razvijanje veština saradnje i podsticanje atmosfere u kojoj kolege inspirišu jedni druge bez obzira na različite sociodemografske karakteristike svakog pojedinca. Svako od učesnika ove edukativne hortiterapijske radionice je poneo svoju zasađenu biljnu kompoziciju naučivši da svaki pojedinac ima vlastiti put rasta i razvoja (Univerzitet u Sarajevu, 2021). Rezultati sprovedenog akcionog istraživanja tokom održavanja ove edukativne hortiterapijske radionice upućuju na zaključak da su studenti pokazali značajno interesovanje za sticanje znanja iz oblasti urbane poljoprivrede i da su motivisani za sticanje znanja i veština u vezi sa unapređenjem timskog rada u obliku specifičnog 'team building' programa koji bi obuhvatio rad u hortiterapijskom vrtu kao i određene sportsko-rekreativne aktivnosti poput šaha, badmintona, džudoa itd.
Prema dosadašnjim saznanjima, realizovane edukativne hortiterapijske radionice za decu predškolskog uzrasta u javnoj ustanovi za predškolsko vaspitanje i obrazovanje «Mladost» u Kaknju i za studente Univerziteta u Sarajevu su pionirskog karaktera kako u Bosni i Hercegovini, tako i u regionu.

Diskusija

Razmotrene edukativne hortiterapijske radionice su uspešno realizovane što može biti valjana baza za sprovođenje sličnih projekata ubuduće. Što se tiče hortiterapijskih radionica realizovanih u predškolskoj ustanovi "Mladost", kreiran pionirski program je bio zamišljen da kroz kreativan, a relativno jeftin koncept, korišćenjem postojećih resursa ove predškolske ustanove, dugoročno zaživi kao vid terapije u koju su bili integrisani i vršnjaci sa poteškoćama u razvoju, sa ciljem da sprovedeni program bude prihvaćen kroz redovne programe ove institucije. Deci predškolskog uzrasta je na kreativan i atraktivan način, shodno uzrastu, uspešno predstavljeno učenje o prirodi kroz različite vrtlarske aktivnosti (Drkenda i drugi, 2024a) i na taj način je osnovni cilj programa – približavanje prirode korisnicima – uspešno ispunjen.

Što se tiče realizovane edukativne hortiterapijske radionice za studente Univerziteta u Sarajevu, kako je pomenuto, osnovni cilj ovog programa je bio upoznavanje studentske populacije sa značajem urbane poljoprivrede za poboljšanje kvaliteta života i dugovečnosti stanovništva. Ovaj cilj je uspešno ispunjen s obzirom na činjenicu da su studenti pokazali izuzetno zanimanje za karakteristike i benefite koncepta urbane poljoprivrede o kome prethodno nisu mnogo znali. Studenti su pokazali interesovanje i za učestvovanje u kreiranju i realizaciji hortiterapijskih programa koji bi bili kombinovani sa određenim sportsko-rekreativnim aktivnostima kroz koncept svojevrsnog 'team building' programa, pa je tako ispunjen još jedan cilj realizovane edukativne hortiterapijske radionice.

Sve navedeno upućuje na značajan potencijal edukativnih hortiterapijskih radionica koga bi trebalo biti svestan s obzirom na prethodno pomenute benefite hortiterapije i urbane poljoprivrede kao šireg okvira. Podsetimo da rezultati brojnih istraživanja ukazuju na pozitivan učinak hortiterapije na osobe sa poteškoćama u razvoju, poteškoćama u učenju, na starije osobe, na osobe sa psihičkim problemima i oboljenjima, na osobe sa socijalnim problemima, na nezaposlene osobe kroz sticanje novih radnih kompetencija, na žrtve različitih oblika nasilja, na osobe sa invaliditetom, na hronične bolesnike itd. (Haller & Kramer, 2017; Drkenda i drugi, 2024b: 148). Pozitivni učinci hortiterapije su zabeleženi i u području poboljšanja senzomotornih veština, kognitivnih i psihosocijalnih veština (Drkenda i drugi, 2024b: 148). Horiterapijom se u svetu bave dodatno edukovani zdravstveni radnici, i to kroz brojne modele hortiterapeutske prakse u Austriji, Velikoj Britaniji, Nemačkoj, SAD (Drkenda i drugi, 2024b: 148).

Zaključak

Hortiterapijski i sociološki aspekt u sinergijskom delovanju upućuju na razvijanje kvaliteta odnosa čovek-priroda kroz konkretan dodir, odnosno interakciju čoveka sa različitim biljnim kulturama na zelenim površinama, uz kvalitetnu komunikaciju sa hortiterapeutom shodno uzrastu ciljne grupe i ostalim društvenim i kulturološkim karakteristikama ciljne grupe. Praktično to znači da će, na primer, deca (pred)školskog uzrasta koja borave u hortiterapijskom vrtu naučiti osnovne elemente sadnje, uzgoja i održavanja određenih biljnih kultura kroz igru i željene i adekvatne sportsko-rekreativne aktivnosti, dok će na primer, odrasle osobe zaposlene u određenoj firmi, u hortiterapijskom vrtu steći znanja o sadnji, uzgoju i održavanju biljnih kultura uz primenu hortiterepije – ne samo kao sportsko-rekreativne aktivnosti, već i kao specifične vrste 'team building' programa. Dalje, osobe sa invaliditetom će u hortiterapijskom vrtu steći znanja o sadnji, uzgoju i održavanju biljnih kultura uz primenu hortiterapije i prilagođene fizičke aktivnosti shodno svojim kapacitetima i na taj način se njihov kvalitet života može značajno dugoročno unaprediti itd. Najzad, istaknimo rad u bašti ili vrtu kao jedan od elemenata koncepta 'plave zone' koji se odnosi na određene regione u svetu u kojima je potvrđena dugovečnost stanovništva, odnosno duži životni vek u odnosu na ostale regione u svetu. Sve navedeno potvrđuje značaj hortiterapije ne samo kao vida radne terapije i/ili sportsko-

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rekreativne aktivnosti, već i kao značajnog činioca koji poboljšava kvalitet života i dugovečnost ljudi. Sa tim u vezi jeste i značaj urbane poljoprivrede kao širi okvir primene hortiterapije. S obzirom na sve pomenute karakteristike urbane poljoprivrede koje upućuju na benefite kada je u pitanju poboljšanje kvaliteta života ljudi i posledično dugovečnosti ljudi, edukacija stanovnika gradova globalnog društva o važnosti urbane poljoprivrede i hortiterapije jeste ključna i predstavlja izazov za profesionalce iz različitih oblasti koji bi trebalo da osmisle načine što efikasnije i efektivnije edukacije urbanog stanovništva i posledično praktične primene stečenog znanja.

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UDK 792.8:37(497.11):(497.13)

The Republic of Serbia and the Republic of Croatia through ballet education

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Introduction

An art secondary school is an educational institution where students acquire both general and artistic education over a four-year period, preparing them either for employment in the corresponding profession or for further studies at higher education institutions (Law on Secondary Education, 2023). It is founded on physical activity and education about it, which constitutes the basis of an individual's future. An art secondary school may be specialized in dance education, thereby enabling students to obtain the professional qualification of a dancer upon completing their studies. Dance techniques are based on codified movement techniques, positions, and aesthetic principles, which have been taught as educational programs in specialized institutions for centuries (Hopper, Weidemann & Karin, 2018).

The first state ballet school in the former Yugoslavia was the Ballet School in Belgrade, which today bears the name "Lujo Davičo". It was founded in 1947 within the Music Academy and the Ballet Studio of the Opera of the National Theatre, with the aim of establishing a state institution for the training of ballet performers and for the renewal of the ballet ensemble of the Belgrade Theatre. The first teachers were ballet pedagogues and eminent artists, either members of private ballet schools or soloists of the Ballet. The school's system of work was organized according to the model of the Russian six-year ballet school and consisted of professional subjects such as classical ballet, classical partnering, historical dances, rhythmics, and piano. In 1948, the school changed its name to the Secondary Ballet School, and by 1950 the program had been extended to eight years, comprising four grades of lower and four grades of upper school. Since 1960, the Ballet School has provided comprehensive secondary education and has borne the name Ballet School "Lujo Davičo". From that time onward, the school has maintained close cooperation with the National Theatre and has encouraged the specialization of teachers at highly esteemed ballet institutions in Russia (Ballet School "Lujo Davičo", n.d.).

Education at the "Lujo Davičo" Ballet School lasts eight years. The elementary ballet program lasts four years and is attended concurrently with mandatory primary education. The secondary ballet program also lasts four years and is designed for students who choose dance as a professional path, encompassing both specialized dance subjects and general education courses. Basic ballet education is delivered through the classical ballet department in Belgrade, as well as in separate branches in Kragujevac and Čačak. Considering that secondary ballet education includes the educational profiles of classical ballet dancer, contemporary dance dancer, and folk dance performer, the school meets the needs of a large number of students seeking education in these dance forms (Ballet School "Lujo Davičo," n.d.).

The Classical Ballet School in Zagreb was established in 1949 under the name Secondary Ballet School in Zagreb, operating under its current name since 1991. From its inception, the school was combined with the School for Rhythmics and Dance in Zagreb, but differences in educational goals and curricula led to their separation (Classical Ballet School, n.d.). The initial objective of the Classical Ballet School was to train professional classical ballet dancers, and since 1983, the curriculum has been expanded to include folk dance performers. The long-term development and progress of the school have been guided by experienced instructors from Russia and other countries, as well as through the training of teachers at Russian pedagogical institutions, which is why the current system of education is based on the Russian classical ballet model. Over the years, students' regular participation in the ballet repertoire of the Croatian National Theatre has been recognized, providing them with stage practice as an integral part of the educational process (Classical Ballet School, n.d.).

According to the Classical Ballet School (n.d.), it offers preschool, primary, and secondary education, divided into classical ballet and/or folk dance departments. There are several types of preschool programs for children aged 5 to 8, as well as a preparatory program for children aged 8 to 9, which serves to select candidates for enrollment in the first grade of elementary ballet school. Primary education lasts four years, with admission based on auditions, evaluating both dance and musical abilities. Students in the elementary program simultaneously attend general education schools, and according to the curriculum of the Classical Ballet School, they complete: the main dance subject program (classical ballet), the program of other dance subjects (historical and character dances), basic knowledge of music theory (solfège), and instrumental practice (piano) (Classical Ballet School, n.d.).

The aim of education in artistic dance schools is to develop students' movement as a fundamental means of performing various dance pieces, thereby fostering the development of their cognitive and motor abilities (Ljubojević & Bijelić, 2014). Recent developments in measuring educational outcomes have led to increased collaboration among international organizations and better understanding of educational systems (Leste & W. Davidson, 2020). In this context, the aim of this study is to compare the curricula of the Classical Ballet School in Zagreb and the "Lujo Davičo" Ballet School in Belgrade, with particular emphasis on identifying key similarities and differences. This comparison aims to contribute to the improvement of educational practices, standardization of ballet instruction, and enhancement of training methods that can lead to better educational outcomes and professional development of students.

Method

In the preparation of this study, the descriptive method and the comparative method were employed to analyze two active curricula for secondary ballet education from the year 2024. The analysis focused on a secondary school curriculum from the Republic of Croatia (Classical Ballet School, Zagreb) and a secondary school curriculum from the Republic of Serbia ("Lujo Davičo" Ballet School). The variables used in the analysis of these curricula included: the name of the institution, type of subject, number of hours planned per subject, and total number of hours planned per program.

To calculate the total number of hours in both curricula, it was assumed that each academic year consists of 35 working weeks.

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Results

The comparative analysis (CA) conducted in the review of the curricula of secondary ballet schools from the Republic of Serbia and the Republic of Croatia revealed the presence of both similarities and differences in the examined curricula.

Most notably, differences were observed in the names of the schools. The name of the Croatian institution, Classical Ballet School Zagreb, indicates that the school is primarily focused on training professionals tailored to the needs of classical ballet. In contrast, the name of the Serbian institution, "Lujo Davičo" Ballet School, suggests a broader approach to ballet education, which is logical considering that this school offers two ballet-related study profiles: the Classical Program and the Contemporary Program. It was also noted that both schools provide training in folk dance; however, this is not explicitly mentioned in the names of the institutions.

The secondary schools analyzed also differ in the number of available study profiles, or programs. The Serbian Ballet School offers education in three elective programs: Classical Ballet Dancer, Contemporary Dance Dancer, and Folk Dance Dancer. Meanwhile, the Classical Ballet School Zagreb provides education in two elective programs: the Classical Ballet Department and the Folk Dance Department. A comparison of the program titles shows overlap in the use of the terms classical and folk. Therefore, throughout the remainder of this paper, these programs will be referred to as the Classical Program and the Folk Program, with the Contemporary Program also included where relevant.

The comparative analysis of the curricula of the two selected institutions showed that general education subjects are present in both curricula. Table 1 presents their titles and the total number of hours planned over the four-year period.

Table 1. Titles and total hours of general education subjects planned over a 4-year period in the curricula of secondary ballet schools in the Republic of Serbia and the Republic of Croatia.

General Education Subjects	Republic of Serbia	Republic of Croatia
Mother Tongue	420	490
Foreign Language I	280	420
Foreign Language II	280	280
History	280	280
Mathematics	280	140
Computer Science and Informatics	210	70
Psychology	70	70
Philosophy	70	70
Civic Education / Religious Studies	140	140
Biology	70	–
Sociology	70	–
Geography	–	70
Latin	–	70
History of Visual Arts	–	140
Total	2170	2240

As shown in the table, there are 11 general education subjects in the curriculum of the secondary ballet school in the Republic of Serbia and 12 general education subjects in the curriculum of the secondary ballet school in the Republic of Croatia. Nine subjects are present in both curricula: Mother Tongue, Foreign Language I, Foreign Language II, History, Mathematics, Computer Science and Informatics, Psychology, Philosophy, and Civic Education / Religious Studies. Biology and Sociology appear exclusively in the Serbian curriculum, while Geography, Latin, and History of Visual Arts are included only in the Croatian curriculum.

The comparative analysis also revealed that, in addition to general education subjects, specialized dance subjects are present in each of the elective programs. The Classical Program is one of the two programs offered in both curricula, and Table 2 presents the titles and total hours planned for the specialized subjects in these two institutions.

Table 2. Titles and total hours of specialized subjects for the Classical Program planned over a 4-year period in the curricula of secondary ballet schools in the Republic of Serbia and the Republic of Croatia

Specialized Subjects – Classical Program	Republic of Serbia	Republic of Croatia
Classical Ballet – Main Subject	1680	1680
Contemporary Dance	385	140
Character Dances	350	280
Dance History	70	105
Acting and Vocal	70	–

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Classical Ballet Repertoire	490	–
Duet Performance	210	–
Folk Dances	–	70
Historical Dances	–	70
Classical Partnering	–	140
Piano	210	–
History of Dance	–	105
Stage Practice	–	35
Total Specialized Hours	3255	2835
Total Hours (General + Specialized)	5425	5075

The table shows the presence of seven specialized subjects in the curriculum of the secondary ballet school in the Republic of Serbia and ten specialized subjects in the curriculum of the secondary ballet school in the Republic of Croatia. Four subjects are present in both curricula: Classical Ballet as the main subject, Contemporary Dance, Character Dances, and Dance History. Acting and Vocal, Classical Ballet Repertoire, and Duet Performance are subjects included only in the Serbian curriculum, while Folk Dances, Historical Dances, Classical Partnering, Piano, and Stage Practice are exclusive to the Croatian curriculum. The total number of specialized subject hours in the curriculum of the "Lujo Davičo" Ballet School amounts to 3,255, while the total number of specialized subject hours in the curriculum of the Classical Ballet School Zagreb is 2,835. The overall total hours, which include both general education and practical classes, amount to 5,425 for the school in Serbia and 5,075 for the school in Croatia.

As previously mentioned, in addition to the Classical Program, both institutions offer a Folk Program, focused on training folk dance performers. Notably, although the program exists in both institutions, the duration of study differs: at the "Lujo Davičo" Ballet School, the program lasts four years, whereas at the Classical Ballet School Zagreb, it is completed in three years. Table 3 presents the titles and total hours planned for the specialized subjects of this program in the two institutions for the entire study period.

Table 3. Titles and total hours of specialized subjects for the Folk Program, planned for the entire study period in the curricula of secondary ballet schools in the Republic of Serbia and the Republic of Croatia

Specialized Subjects – Folk Program	**Republic of Serbia**	**Republic of Croatia**
Folk Dance – Main Subject	1400	1400
Classical Ballet	385	140
Traditional Singing	385	385
Solfège	70	140
Acting and Vocal	70	–
Ethnology	140	–
Ethnomusicology	140	–
Folk Dance Repertoire	280	–
Contemporary Dance	70	–
Basics of Classical Ballet	–	140
Piano	–	140
Stage Practice	–	210
Required Instrument – Tambura	–	210
Character Dances	–	70
Musical and Dance Folklore	–	140
History of Dance and Music	–	35
History of Music	–	70
Visual Folklore	–	35
Total Specialized Hours	2,940	3,115
Total Hours (General + Specialized)	5,110	5,355

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The information presented in Table 3 shows that there are nine specialized subjects in the curriculum of the secondary ballet school in the Republic of Serbia and thirteen specialized subjects in the curriculum of the secondary ballet school in the Republic of Croatia. Four subjects are present in both curricula: Folk Dance as the main subject, Classical Ballet, Traditional Singing, and Solfège. Acting and Vocal, Ethnology, Ethnomusicology, Folk Dance Repertoire, and Contemporary Dance are subjects included only in the Serbian curriculum, while Basics of Classical Ballet, Piano, Stage Practice, Required Instrument – Tambura, Character Dances, Musical and Dance Folklore, History of Dance and Music, History of Music, and Visual Folklore are exclusive to the Croatian curriculum.

The number of hours planned for the subjects is identical for the main subject (Folk Dance), which has 1,400 hours, as well as for Traditional Singing, which has 385 hours in both institutions. The total number of specialized subject hours over a three-year period at the Classical Ballet School Zagreb is 3,115, while the total number of specialized subject hours over a four-year period at the "Lujo Davičo" Ballet School is 2,940. The overall total hours, which include both general education and practical classes for the entire study period, amount to 5,110 at the "Lujo Davičo" Ballet School and 5,355 at the Classical Ballet School Zagreb.

In addition to the programs present in both curricula, there is also a program offered exclusively at the "Lujo Davičo" Ballet School, namely the Contemporary Program, which trains contemporary dance performers. The subjects and their planned hours over the four-year period are presented in Table 4.

Table 4. Titles and total hours of specialized subjects for the Contemporary Program, planned over a 4-year period in the curriculum of the secondary ballet school in the Republic of Serbia

Specialized Subjects – Contemporary Program	**Republic of Serbia**
Contemporary Dance – Main Subject	1,400
Contemporary Dance Repertoire	420
Classical Ballet	980
Improvisation	210
20th Century Dances	70
Dance History	70
Acting and Vocal	70
Total Specialized Hours	3,220
Total Hours (General + Specialized)	5,390

The total number of specialized subjects is seven, with Contemporary Dance as the main subject having the largest number of hours, amounting to 1,400. The other subjects include Contemporary Dance Repertoire, Classical Ballet, Improvisation, 20th Century Dances, Dance History, and Acting and Vocal. The total number of specialized hours is 3,220, which, together with the general education subjects, amounts to 5,390 hours over the four-year period.

Discussion

The comparative analysis of the curricula for secondary ballet education at the "Lujo Davičo" Ballet School in the Republic of Serbia and the Classical Ballet School Zagreb in the Republic of Croatia revealed differences in the names of the institutions. One name is more specifically focused on the Classical Program, while the other uses a general term for ballet. Neither institution mentions the Folk Program in its name, even though it is studied in both schools.

The number and types of study profiles offered at the analyzed institutions are also not the same. The Serbian school offers three elective programs: the Classical Program, the Folk Program, and the Contemporary Program, while the Croatian school offers two elective programs: the Classical Program and the Folk Program.

A comprehensive analysis showed that general education subjects are present in both curricula. The Croatian curriculum includes one additional general education subject compared to the Serbian curriculum. Of the total number of these subjects, nine are present in both curricula, while five are included in only one of the curricula. Differences in the number of hours per subject are not observed for the five subjects present in both curricula, while the number of hours for all other subjects differs. However, the total number of hours planned for general education subjects in the two analyzed institutions is similar, differing by only 60 hours over a four-year period. The highest number of hours is allocated to the Mother Tongue, with 420 hours in Serbia and 490 hours in Croatia.

The Classical Program exists in both curricula, with a difference of three specialized subjects, which are offered in greater number at the Croatian school. Four subjects are present in both curricula, while the remaining nine are unique to one of the two analyzed schools. Classical Ballet is the main subject in both curricula, with an identical number of planned hours of 1,680. The remaining subjects differ in the number of hours, resulting in a total difference of 420 hours for specialized subjects between the two curricula. The overall total of general and specialized hours differs by 350 hours.

The Folk Program also exists in both curricula, but it is planned over three years at the Classical Ballet School Zagreb and over four years at the "Lujo Davičo" Ballet School. The number of specialized subjects is greater by four in the Croatian school. Four subjects are present in both curricula, while the remaining fourteen are unique to one institution. Folk Dance is the main subject in both curricula, with an identical allocation of 1,400 hours over the entire program. Similarly, the number of hours for Traditional Singing is identical at 385 hours. The remaining subjects differ in the number of hours. The total number of specialized hours differs by 175 hours, with the Croatian school having the higher total. However, the difference in program length must be noted: the average annual specialized hours in Serbia are 1,278, while in Croatia they are 1,785, representing a 40% higher annual workload in Croatia.

The Contemporary Program is offered exclusively at the "Lujo Davičo" Ballet School and comprises seven specialized subjects. The largest allocation of hours is devoted to Contemporary Dance as the main subject, with 1,400 hours. The total number of specialized hours is 3,220, which, together with general education subjects, amounts to 5,390 hours over the four-year period.

Specialized subjects play a crucial role in the specific development of bio-psycho-social and physical characteristics of dancers. They form the foundation for the skills that students are expected to acquire during their training. The presence of significant differences in the type and number of subjects, as well as in the planned number of hours for individual subjects and total instruction time, while aiming to produce the same study profiles, points to new considerations and potential opportunities for collaboration.

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Conclusion

The research reveals differences in the curricula of the given educational institutions regarding the training for the same study profiles. The differences in the names and the number of study profiles among the schools can be considered expected, considering the various factors that influence the operation of these institutions, factors that they cannot significantly impact. Both general education and specialized subjects are equally important during the educational process in secondary schools, which is why they are present in both analyzed curricula.

However, we cannot overlook the fact that the same types of study profiles in different educational institutions may differ by as much as 420 hours over a four-year period. Furthermore, it should be noted that the same study profile has a full year less of education, and that the workload in one of the institutions is 40% greater because the entire program must be completed in a period of three years. Significant differences have been observed in the selection of subjects included in the curricula, as well as in the number of hours allocated to those subjects.

Considering that both schools have similar tasks and goals, it is believed that the greatest success could be achieved through collaboration and the exchange of experiences and knowledge between them, with the aim of developing even higher-quality curricula and analyzing curricula from other countries. By opening up to one another, it is possible to achieve better and more comprehensive insights. This approach would allow the building of a stronger and higher-quality foundation for the future students of these institutions. The written work and the proposed collaborations represent a pledge for the future of dance.

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UDK 796:159.9-053.5

Opinions of young basketball players, parents, and club staff on the need for certain psychological support services

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Introduction

Sport has an exceptional potential to shape the lives of young people, as participation in sports activities can significantly enhance their physical, psychological, and social development. However, the positive effects of sport on the physical and emotional health of children and youth are not always guaranteed, since sport itself is neither inherently good nor bad. Positive benefits may be absent if too much emphasis is placed on competition and winning, which can lead to excessive pressure and stress, suppression of spontaneity, reduced enjoyment, and limitations of children's creativity. Therefore, the impact of sport on the health and development of young people largely depends on how it is guided and organized not only by young athletes themselves but also by other participants (coaches, parents, sports managers) (Trbojević & Petrović, 2020; Chu & Zhang, 2019; Fraser-Thomas, Côté, & Deakin, 2005).

In addition to technical and tactical preparation, which are indispensable in every sport, effective psychological support can contribute to the development of numerous psychological traits, thereby improving overall athletic performance, emotional well-being, and general development. Furthermore, adequate psychological support may reduce the number of young people who drop out of sports early. Namely, despite the growing number of children who take part in sports, it is important to emphasize that at the same time the percentage of those who, dissatisfied and disappointed, give up on sports is also increasing (Bačanac, Petrović, & Manojlović, 2011; Santana, 2005). According to analyses by leading sport psychologists, as many as 67% of children quit sports before the age of 12, an additional 8% by the age of 15, while only 11% manage to reach a high level of athletic performance (Schloder & McGuire, 2007). It is crucial that sport be based on a model that prioritizes educational, developmental, and health values rather than solely results and achievements.

Coaches play one of the key roles in shaping not only the sporting experience but also the entire lives of young people during the most sensitive stages of their physical, social, and psychological development. Through coaching, young athletes encounter sport for the first time, learn technique and tactics, but much more than that – they learn how to compete, cooperate, and cope with stress and pressure. This is achieved by creating appropriate conditions and using specific strategies that provide support for mastering skills and dealing with stressful situations (Tamminen & Holt, 2012). For this reason, most American coaches in their self-assessments emphasize that their most important goal is the psychological, physical, and social development of young athletes, followed by providing fun through sport, while winning is considered the least important goal (Martens, 2004).

Parents also represent an important part of the sporting careers of young people, by supporting them to engage in sport and cooperating with coaches and organizers of sporting activities (Knight, Harwood, & Gould, 2018). Youth sport serves as a shared framework for family interaction, with parental behavior having a significant influence on the child's developmental experience. With increasing investments of family resources in children's sporting progress and success, the extent and quality of parental involvement in youth sport are becoming an increasingly important subject of cultural debate (Osai, Dorsch, Tulane, & Carlsen, 2015). It is recommended that sports federations and clubs support parents by organizing seminars, workshops, and forums to help them understand their role and responsibility toward young athletes. Research shows that parents are essential for young athletes to fulfill their potential and that they should take an active role in their children's sport development (Jowett & Timson-Katchis, 2005).

However, the opinions of club staff, and especially parents, regarding the need for specific psychological services have been the least studied in the current literature. This study aims to assess the perceived need for various psychological support services among young basketball players, their parents, and club staff. Basketball, as a highly competitive sport, places unique psychological demands on young athletes. Specifically, due to its structural complexity and unpredictability, basketball can serve as an ideal educational tool for fostering important psychosocial qualities such as cooperation, self-confidence, independence, self-control, leadership skills, achievement motivation, self-affirmation, and personal identity development (Jakovljević & Mandić, 2021). By examining their views, this research provides insight into the specific psychological resources that may be most useful for young athletes in team sports.

Method

The sample consisted of 706 young basketball players, aged 12 to 18, 579 parents, and 240 members of club staff, from five different countries – Greece, Spain, Italy, Ukraine, and Serbia (Table 1). Respondents who indicated another country were residing in the countries where the research was conducted at the time, so they were not excluded from the study.

For the purposes of this research, a non-standardized questionnaire was applied. The questionnaires were distributed via Google Forms. In the case of young basketball players, the questionnaire was distributed with prior parental consent. The main question was: Which type of psychological support service is most needed by athletes? The questionnaire consisted of 11 items: building self-confidence, stress and anxiety management, focus and concentration, emotional regulation, development of mental toughness, personal responsibility and relationships, development of resilience and perseverance, cooperation and teamwork, relationship with parents and coaches, balancing academic and athletic responsibilities, sports communication. Respondents rated the proposed psychological support services on a five-point scale, from 1 (least needed) to 5 (most needed). ANOVA was used to compare results between the three groups. In cases where differences were observed, the Bonferroni T test was applied. The level of statistical significance was set at $p < 0.05$.

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Table 1. Distribution of respondents

	Serbia	Ukraine	Italy	Spain	Greece	Other	Total
Parents	147	68	128	72	164	0	579
Club staff	19	75	30	98	16	2	240
Athletes	191	97	150	118	145	5	706
Total	357	240	308	288	325	7	1525

Results

Diagram 1 graphically presents the mean values of the assessed psychological support services for all three respondent groups. All proposed services were rated highly by all participants, with mean values ranging from 3.97 for Emotional Regulation to 4.44 for Cooperation and Teamwork. Additionally, the highest individual mean score was given to Cooperation and Teamwork by parents (4.63), which indicates a strong belief in the importance of teamwork skills. Emotional Regulation received the lowest rating from athletes (3.71), suggesting that they may not prioritize this aspect as much as parents or club staff. Building Self-Confidence (mean value = 4.26) was also rated highly, especially by parents (4.48). Sports Communication received the lowest overall mean score (4.03), indicating that it was perceived as somewhat less important compared to other areas. Overall, the results show that parents consistently rated the need for psychological support services higher than the other two groups, suggesting that they see a stronger role for such services in developmental areas compared to athletes and club staff.

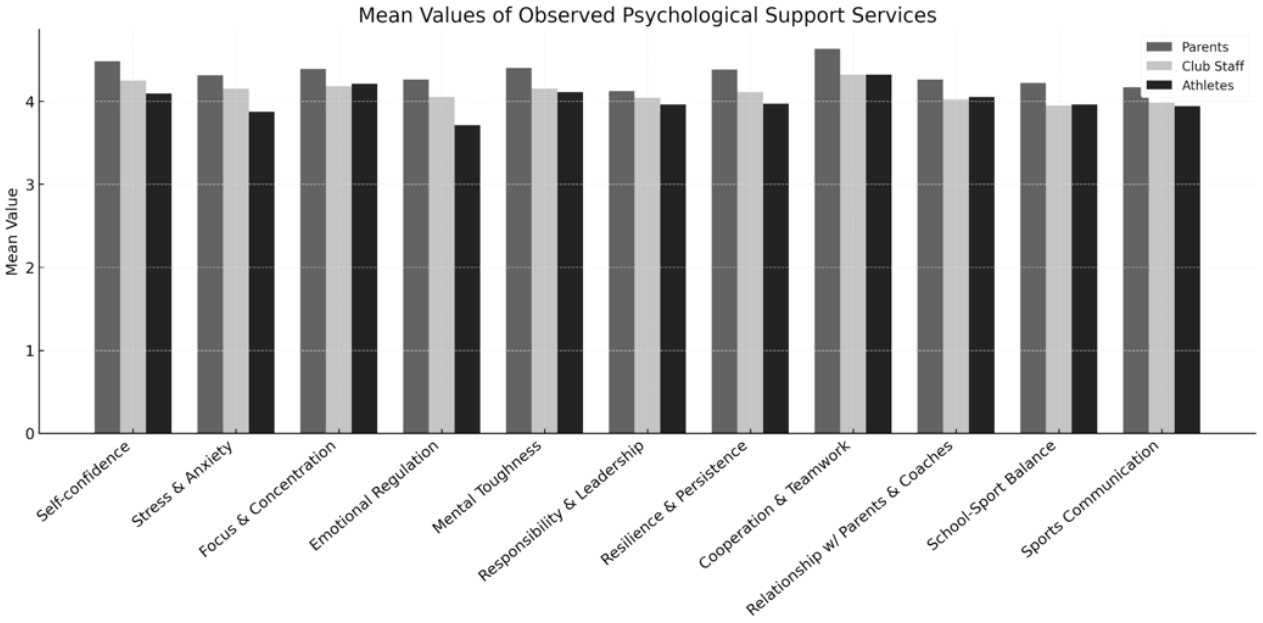

Figure 1. Mean values of observed psychological support services

In addition, lower SD values for parents (Table 2) suggest more consistent perceptions, i.e., more uniform evaluations compared to the other two groups. Athletes tended to rate the need for psychological support services lower, likely due to self-perception bias or different expectations. Higher SD values for athletes (e.g., SD for Emotional Regulation = 1.158) indicate greater variability in their responses, likely reflecting individual differences in experience.

The categories with the largest differences in ratings between groups were Emotional Regulation (F=45.947), Stress and Anxiety Management (F=29.582), Development of Resilience and Perseverance (F=29.185), Building Self-Confidence (F=24.033), and Cooperation and Teamwork (F=20.183). Categories with more similar ratings included Personal Responsibility and Leadership (F=4.812), Focus and Concentration (F=6.732), Sports Communication (F=8.565), and Relationship with Parents and Coaches (F=7.402) (Table 2). Significant differences (p = .001) in nearly every category indicate different perceptions of the proposed psychological support services between groups. Specifically, Bonferroni t-test results showed statistically significant differences between parents and young basketball players in all 11 items (p = .000 – .006), and in 9 items between parents and club staff (p = .000 – .035). Categories where parents and club staff had similar views were Stress and Anxiety Management and Personal Responsibility and Leadership. As for differences between club staff and athletes, statistically significant differences appeared in Stress and Anxiety Management (p = .001) and Emotional Regulation (p = .000). For the remaining psychological services, club staff and athletes shared similar opinions (Table 2).

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Table 2. Descriptive statistics and ANOVA results of observed psychological support services

	Parents		**Club Staff**		**Athletes**			
Psychological Services	M	SD	M	SD	M	SD	F	Sig.
Building self-confidence	4.48*	.861	4.25	.962	4.09	1.079	24.033	.000
Stress and anxiety management	4.31**	.923	4.15***	.933	3.87	1.165	29.582	.000
Focus and concentration	4.39*	.856	4.18	.952	4.21	1.049	6.732	.001
Emotional regulation	4.26*	.905	4.05***	.930	3.71	1.158	45.947	.000
Development of mental toughness	4.40*	.857	4.15	.913	4.11	1.006	15.727	.000
Personal responsibility & leadership	4.12**	.929	4.04	.879	3.96	1.026	4.812	.008
Development of resilience & persistence	4.38*	.828	4.11	.949	3.97	1.052	29.185	.000
Cooperation and teamwork	4.63*	.759	4.32	.905	4.32	1.059	20.183	.000
Relationship with parents & coaches	4.26*	.970	4.02	1.033	4.05	1.195	7.402	.001
Balance between school & sport duties	4.22*	.917	3.95	.967	3.96	1.125	11.724	.000
Sports communication	4.17*	.935	3.98	.981	3.94	1.062	8.565	.000

Notes: M = Mean value; SD = Standard deviation
*p < .05 between parents and the other two groups
** p < .05 between parents and athletes
*** p < .05 between club staff and athletes

Discussion

The main purpose of this research was to examine the opinions of young basketball players, their parents, and club staff regarding the need for certain psychological support services. A total of 11 categories were proposed. The results highlight the recognized importance of psychological support services in youth basketball from the perspective of young athletes, their parents, and club staff. In particular, all proposed psychological services – especially those involving building self-confidence, focus and concentration, stress and anxiety management, as well as cooperation and teamwork – were rated highly, with mean values indicating strong recognition of their potential benefits.

Cooperation and teamwork was identified by all groups as the most necessary service. This confirms the notion that basketball, as a highly collective game, primarily requires good cooperation among team members, which was recognized by all respondents (Jakovljević & Mandić, 2021). In addition to cooperation within the team, the relationship with parents and coaches was also rated highly, likely because good relationships in sports are not limited to player–player interactions but also include coaches and parents (Karalejić & Jakovljević, 2022).

Next in importance were focus and concentration and building self-confidence. Regarding self-confidence, the results are consistent with previous research confirming its importance for athletes, showing that self-confidence is a key factor distinguishing successful athletes from less successful ones (Lazarević, 2003). In other words, athletes with high self-confidence achieve better sports results. Therefore, it is important that athletes invest effort in developing this trait and build a strong belief in themselves. Coaches play a crucial role here by creating situations where athletes can succeed, since personal experiences of success are the strongest and most important factor in developing self-confidence (Vesković, 2017). For such success, young basketball players must remain focused and concentrated on performing specific tasks. Likewise, athletes with lower self-confidence who doubt their abilities tend to experience higher levels of anxiety (Vesković, 2017). This demonstrates that most psychological services cannot be viewed in isolation but rather in interaction with one another.

Parents, alongside coaches, represent key sources of influence in helping young athletes cope with stressful situations (Tamminen & Holt, 2012). Parenting young athletes is often highly demanding, as most parents dedicate substantial time, money, and emotional energy to supporting their children. Sports psychologists can play an important supportive role both for parents and athletes (Knight et al., 2018). Overall results show that parents consistently rated the need for psychological support higher than other participants, suggesting their perception of its greater importance in developmental aspects. However, this may also lead to parents overestimating their influence, which can result in misaligned support strategies. Vesković (2017) notes that parental pressure can be both overt and hidden, often expressed through high expectations for success. For a young athlete who is dedicated and already has high self-expectations, this may not feel like pressure but rather motivation and support for progress. Traits that make the family a strong source of support can also become a source of stress. This stems from the thin line between positive motivation for achievement and excessive pressure (Vesković, 2017; Helsted, 1987).

Tamminen and Holt (2012) showed that parents and coaches help athletes manage stressful situations by encouraging them to monitor their own reactions, building systems of trust and respect, knowing the athlete personally, and fostering independence. This was achieved through specific strategies, including questioning and reminding, providing perspective, sharing experiences, gradually exposing athletes to stress, initiating informal conversations, creating opportunities for learning, and offering direct instructions. Similarly, Gao et al. (2024) emphasize that parents' positive values and goals, moderate involvement, and supportive parent–child relationships are identified as optimal parental strategies.

Lower ratings by athletes may indicate areas where they feel less supported or more independent. On the other hand, they may also reflect a limited understanding of abstract concepts such as certain psychological skills. McCarthy et al. (2010) found that young athletes often have difficulty explaining

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the meaning of psychological skills such as goal setting, mental imagery, self-talk, and relaxation.

Overall, these findings highlight the potential benefits of integrating psychological services into basketball club and school programs, tailored to the age and developmental stage of young athletes, with a particular focus on emotional regulation, stress management, and teamwork skills. These services are essential not only for sports performance but also for the holistic development of youth. Additionally, there is a recognized need to provide parents with educational platforms based on evidence-based parenting principles in organized youth sports (Gould, Pierce, Wright, Lauer, & Nalepa, 2016; Osai et al., 2015; Jowett & Timson-Katchis, 2005). Integrating such services would help parents align their expectations of sporting success with those of their children and better understand and respect their developmental characteristics.

Conclusion

This study highlights the recognized value of psychological support services in youth basketball, as perceived by players, parents, and club staff. The consistently high ratings across all services indicate a strong consensus on the need for psychological interventions, particularly in areas such as cooperation, emotional regulation, and stress management. However, despite the overall high ratings, the analysis also reveals significant gaps in perception between parents, club staff, and athletes, especially in the domains of emotional regulation and stress management. Addressing these shortcomings through targeted interventions may enhance developmental outcomes for young athletes. In addition to direct training, it is essential to organize workshops that specifically address these issues. Regular communication through parent–coach–athlete meetings can also serve as a form of support. At the same time, it should be noted that parents may sometimes overestimate their influence. Providing parental support programs can educate them about effective communication and realistic expectations.

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The study is a part of the Erasmus + sport project ''Delivering a hybrid knowledge transfer network model for basketball engagement and development", Project number: 101133995.

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UDK 796.322.015.8

Relationship between two methods for evaluating handball goalkeepers' save performance

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Introduction

Performance evaluation in handball has long been a subject of interest for researchers, coaches, and practitioners seeking to optimize both individual and team outcomes. Today, there is growing interest in evaluating the performance of handball teams, which involves establishing an impartial method of assessing players (Angulo et al., 2022). Most performance-related research conducted in handball has focused on the physical requirements of field players, specifically locomotion demands and body contacts (Cardinale et al., 2017). In the coaching community, it is well known that the goalkeeper's performance can predict the team's ranking in big events (Hansen et al., 2017). Goalkeepers play a crucial role in handball game. The goalkeepers' role is to prevent the opposing team from scoring goals by blocking the ball using the whole body (goalkeepers are allowed to touch the ball with every body part, unlike field players) within the goal perimeter. There have, however, been relatively few research studies carried out regarding elite goalkeepers. For example, the methodology presented in Schwenkreis (2019) allows the effectiveness of a handball team, or of a single handball player, to be quantified, but it is insufficient for evaluating the performance of a handball goalkeeper in a match. The most important performance indicators often identified are the 'save' statistics (Manchado et al., 2013).

Traditionally, two relatively simple approaches have been most widely used in evaluating goalkeeper performance through game observation. The first method considers only the total number of saves made during a match. The second method accounts for the number of shots faced, with performance expressed as a save percentage. While both methods provide useful information, they lack nuance in distinguishing between the varying levels of difficulty associated with different shooting positions. To address this limitation, a more detailed rating system has been proposed, in which each of the six primary defensive situations is assigned a distinct significance coefficient. Building on this idea, the present study also incorporates the subjective perspective of goalkeepers, collected through a self-assessment questionnaire, to evaluate the relative challenge of different shot types. The aim of this study is therefore to compare two evaluation methods—statistical performance indicators and self-assessment questionnaires—in order to estimate the relative importance (ponders) of saves from different shooting positions.

Method

The sample consisted of 15 male goalkeepers and 15 female goalkeepers from all over Croatia aged 17 to 52 in the 21/22 season. The average age of female goalkeepers was 21±4.2 years, while the average age of male goalkeepers was 28.9±10.1 years. The average height of female goalkeepers was 174.1±6.1 cm, while the average weight was 69.3±7.5 kg. For male goalkeepers, the average height was 189.1±7.3 cm, while the height was 91.9±10.2 kg. Male goalkeepers have a higher average of goalkeeper experience with an average of 16.8±9.0 years, while female goalkeepers have an average of 10.3±3.4 years (Table 2).

The sample of variables consisted of the 7 different shots from different position and distances in handball game.

1. 6M SAVE - 6MS - This variable includes all shots at the goal from 6m line that were made mostly by pivots, but also by the players who entered on the position as second pivot.

2. 7M SAVE - 7MS- This variable includes saves from 7m, from penalty shot. At those shots the ball is thrown without obstruction from opponent players who are at the distance of at least 3m. This shot is performed by the players from different positions who are specialized, mostly two or three players in each team.

3. 9M SAVE - 9MS -The 9m saves are usually the easiest for the goalkeepers because the shots are made from the big distance, so the goalkeeper has more time to react, and the attackers have defensive players in front of them who are trying to obstruct them more or less. The ball can be thrown from the position of the left, middle or right backcourt attackers. In this case synchronized action of goalkeeper and defense is very important because usually the goalkeeper covers one side and the players the other side of the goal.

4. WING SAVE - WS - Shots from the wing position are made from left and right side of the field, from the area closed by base, side and 6m line. The attacker is trying to gain as bigger angle of entrance towards the goal as possible, so he would get in the good position for the shot, while defensive player is trying to make that angle as smaller as possible, to make it easier for the goalkeeper to defend the goal.

5. BREAKTHROUGH SAVE - BTS - Breakthrough can be defined as dribbling of the defensive player, with the aim of wining the space and acquiring as better position for shooting at the goal as possible. Passing through of players as consequence of good and fast passing of all players, usually when a team has one extra player, is also considered to be breakthrough. The shots are thrown from a close range, and penalty shot is given for most unrealized shots, because the attacker was in foul while he was throwing the ball.

6. FAST BREAK SAVE - FBS - A fast break is executed by one or more players when the defense is not yet fully set. Shots in this situation are typically performed as jump shots from a distance of 4–5 meters from the goal line. Saving these shots is particularly challenging. Successfully stopping a fast break shot often has a strong psychological impact, boosting the motivation of the goalkeeper as well as the entire team.

7. FAST THROW OFF SAVE - FTOS - the play will be immediately restarted after a goal is scored to immediately launch a fast break, aiming to exploit the opposing team's disorganized defense for an easy goal. The process

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involves the goalkeeper retrieving the ball quickly and throwing it to a waiting player, initiating a rapid offensive transition to catch the opponent off guard and create a numerical advantage.

Data was collected on a 10-point performance rating scale where goalkeepers evaluated the difficulty of the saves from different playing positions and situations on a scale from 1 to 10, with each point on the scale corresponding to a different level of performance.

The Pearson correlation coefficient was used to analyse the relation between two methods, save performance obtained by goalkeepers through the self-assessment questionnaire and situational efficiency obtained by the calculation method from official tournament statistics (Cvenić, 2019).

Results and discussion

Table 1. presents weighting of the indicators—expressed as coefficients of relative significance (ponder) for each type of save—was determined through an evaluation procedure based on data collected from several European Men's Handball Championships between 2000 and 2018.

Table1. Goalkeepers statistics in European championships from different positions and coefficients of significance (last row)

	MP	6MS	WS	9MS	7MS	FBS	BTS	FTOS	TOT
CRO 2000	38	22	40	45	24	19	17		
SWE 2002	50	30	37	46	26	19	16		34
SLO 2004	48	22	39	46	22	21	16		33
SUI 2006	47	20	38	44	23	20	18		32
NOR 2008	47	23	39	44	22	19	17		33
AUT 2010	47	21	34	44	22	22	21		32
SRB 2012	47	27	33	45	23	20	17		32
DEN 2014	47	24	34	71	20	20	22	21	31
POL 2016	47	27	35	39	22	19	14	25	30
CRO 2018	47	25	33	43	20	19	18	22	31
x		24,1	36,2	44,0	22,4	19,8	17,6	22,7	32
1- $\frac{x}{100}$	0, 759	0, 638	0, 560	0, 776	0,802	0,824	0,773		

Legend: MP– match played, 6MS- 6M save percentage, WS- wing shot save percentage, 9mS-9 m shot save percentage, 7mS- penalty shot save percentage, FBS - Fast break save percentage, BTS- Breakthrough save percentage, FTOS - Fast throw-off shot save percentage, TOT - aritmetic mean of all shots save, x - aritmetic mean, - ponders

Table 2 presents the ranking of save difficulty from different shooting positions for goalkeepers of both sex, assessed using both methods. The average score assigned to saves from the 9-meter line was 4.73, representing the lowest mean score across all positions. This suggests that goalkeepers generally perceive shots from the 9-meter line as the easiest to save. The standard deviation for this variable was 0.56, indicating relatively low variability in responses. In contrast, breakthrough shots (OPR) received the highest average score, with a mean rating of 7.41, highlighting their perceived difficulty. The greatest variability was observed in saves from shots following a fast center (OBC), which had a standard deviation of 2.11. For this variable, the maximum reported value was 10 and the minimum was 1, resulting in a range of 9. This wide spread indicates divergent goalkeeper perceptions: while one respondent considered these shots very easy to save, another rated them as extremely difficult, assigning the maximum score of 10.

Table2. Goalkeepers statistics and values from the survey

N	S	A	H	W	EX	9mS	6mS	WS	7mS	FBS	BTS	FTOS
1.	M	20	185	85	9	6	7	7	8	8	7	7
2.	F	23	178	66	10	7	8	10	7	8	9	8
3.	F	23	167	77	10	7	5	3	7	6	6	7
4.	M	22	188	88	10	6	7	7	7	7	8	8
5.	F	20	172	54	10	4	8	9	8	9	7	6
6.	M	27	196	93	14	6	6	7	8	9	9	9
7.	M	28	187	110	18	5	6	6	7	7	8	8
8.	M	34	195	100	24	5	6	7	7	8	9	10
9.	M	26	195	103	14	7	5	4	4	3	2	1

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10.	M	45	175	90	30	4	7	5	7	8	6	7
11.	F	28	183	83	18	4	7	5	7	8	9	8
12.	F	18	176	72	11	1	4	2	5	7	3	6
13.	F	22	176	76	12	3	4,5	5	6	7	8	9
14.	F	20	178	76	13	3	4,5	5,5	6	7	7,5	8
15.	M	52	191	90	35	5	4	6,4	6	7	6,5	7
16.	F	23	170	62	10	5	6	8,5	6	7	8	7,2
17.	F	18	186	74	12	3	7	6	5	8	7,5	5,5
18.	M	18	184	74	9	4	9	6	7	8	8	7
19.	M	21	199	105	10	5	5	5	5	8	6	5
20.	M	26	187	90	16	5	7	7	6	7	8	6
21.	F	17	174	71	8	5	5,5	6	6,5	7	7,6	8,2
22.	F	21	165	60	7	4	6	7	7,5	6	8	4
23.	M	43	201	100	30	5	7	6	8	6	5	7
24.	F	15	180	67	6	3	4	5	8	8	9,7	10
25.	F	15	170	67	6	5,5	5,7	6,2	7	7,1	7,5	8
26.	M	23	184	78	13	5,6	6,7	7,1	7,5	8	8,2	9
27.	F	29	170	65	15	5	6	7	7	7	8	8
28.	F	23	167	70	7	4	6	5	7	8	9	8
29.	M	26	190	90	5	5	6	5	5	7	8	9
30.	M	22	179	82	14	5	6	8	8,5	8,8	9	9
self-assessment questionnaire						4,73	6,06	6,12	6,7	7,33	7,41	7,33
weights of the indicators (ponders)						0,56	0,76	0,64	0,78	0,8	0,82	0,77

Legend: N– name, S- sex, A- AGE, H- height,W- weight, EX- years of goalkeepers experience

A significant and very strong relationship (r=0.90; p<0,05). was identified between the goalkeepers' save statistics evaluation method and the results of self-assessment questionnaire of Croatian goalkeepers. The 9-meter saves (O9m) typically represent the most advantageous situation for goalkeepers. Shots executed from this distance are taken from a greater range, thereby providing the goalkeeper with increased reaction time.

Moreover, defensive players are usually positioned between the shooter and the goal, offering an additional level of obstruction. In both analytical approaches, this variable was ranked highest in importance (0.56 and 4.53, respectively). Close-range saves (6 m and 7 m) posed a considerably greater challenge for goalkeepers, as reflected in a lower save rate in championship statistics (Table 1) and correspondingly higher ratings in self-assessment (Table 2). Among all shooting positions analyzed, the most demanding situation for handball goalkeepers, according to both evaluation performance methods, was the breakthrough shot (OPR = 0.82 and 7.41).

Conclusion

The evaluation of handball goalkeepers' performance is a highly complex process that requires consideration of multiple criteria. This study demonstrates how such an evaluation can be operationalized and compares two techniques for processing the results. The findings highlight the importance of save rate as a key determinant of team success, with goalkeepers' save percentages showing a moderate to strong association with championship ranking.

Furthermore, the results indicate a strong relationship between performance evaluation based on statistical indicators and self-assessment questionnaires. This confirms the hypothesis that an evaluation method incorporating differentiated ponders for saves from various shooting positions provides a more accurate representation of goalkeeper performance.

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UDK 796.5:613

Active and passive rest in nature: Distinct effects on physical and mental health

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Introduction

Health is a complex and dynamic phenomenon that can be defined in various ways. One of the most widely accepted definitions is that health is a state of complete physical, mental, and social well-being, and not merely the absence of disease or infirmity (WHO, 1948: 100). On the other hand, health also represents the result of harmonious relationships with the environment, a state of balance on all levels, a product of a responsible and healthy lifestyle, a prerequisite or necessity for carrying out daily life, and a potential for self-fulfillment. Health can be viewed multidimensionally, because beyond its exclusively medical function it also carries philosophical, psychological, social, and economic dimensions (https://stvarnozdravo.weebly.com/zdravlje.html). Although it is difficult to define physical health, it generally refers to the body's capacity to function physiologically well. Objective outcomes of physical health are characterized by measures that can be assessed by medical tests, such as the presence of diseases like cancer or disabilities such as traumatic brain injury (Cross, Hofschneider, Grimm & Pressman, 2018). On the other hand, mental health is not considered simply the absence of mental illness. Most people perceive mental health as a category of inner satisfaction (peace, strength, balance), as well as the ability to adequately cope with stress and problems, while a smaller number perceive it as socially adapted functioning, self-control (of thoughts, emotions, behavior), self-esteem, self-actualization, and productivity (Petak, Jureta & Maričić, 2021). As can be seen from the above, physical and mental health, as well as health in general, are complex phenomena influenced directly or indirectly by numerous factors, ranging from hereditary to environmental, such as daily stress, inadequate living and working conditions, and many others.

According to United Nations data, the global urbanization rate reached about 56% by 2020 and is expected to rise to about 68% by 2050. This implies that more than half of the world's population lives in urban environments (United Nations, 2021). Looking at our own region, it is estimated that 75% of the population on the European continent lives in cities and urban settings (Thompson Coon, Boddy, Stein, Whear, Barton & Depledge, 2011). Modern living and working conditions in urban environments carry a much higher risk of hypokinesia and the influence of various negative factors (air pollution, poor water quality, noise, excessive lighting, electromagnetic radiation, etc.) that have harmful effects on human health. Therefore, it is crucial to re-establish the connection with nature. Nature, in the broadest sense, is equivalent to the entire natural world, and is often understood as the "natural environment" or wilderness, consisting of wildlife, rocks, forests, beaches, and, in general, everything not significantly altered by human intervention—or, accordingly, everything that persists despite it. Resting in nature has numerous benefits for both mental and physical health, as confirmed by many scientific studies. Alongside the presence of certain factors that positively affect human health (sunlight, higher concentrations of negative ions), the absence of urban pollutants can also contribute to the benefits gained from spending time in nature.

As research and practice have shown, passive rest in nature has a positive effect on human health, but physical activities carried out in natural settings provide more benefits than exercising in urban outdoor environments. The aim of this study is to examine the effects of active and passive rest in nature on physical and mental health, to highlight the advantages of both approaches, and to explore how their influence—individually and synergy contributes to the overall well-being of the individual.

Method

The literature search was conducted using Google Scholar with keywords such as active/passive rest in nature, benefits of activities in nature, including all age groups (youth, adults, elderly).

Passive Rest in Nature: Effects on Physical and Mental Health

Passive presence in a natural environment—such as staying in forests, mountains, or near large bodies of water (lakes, seas, rivers)—can provide significant health benefits without the need for active participation in outdoor activities.

The physiological advantages of passive rest in nature, that is, benefits for physical health, are not negligible and deserve attention. In nature, much more than in cities, there is exposure to sunlight which, through its UV rays, contributes to the production of provitamin D, the precursor from which the skin synthesizes vitamin D. Lack of vitamin D, due to excessive time spent indoors, can contribute to osteoporosis, cardiovascular disorders, and type 1 and 2 diabetes (Manferdelli, La Torre & Codella, 2019). Forest stays can have positive effects on physical health by lowering blood pressure and improving immune response (Li et al., 2007). Higher concentrations of negative ions in nature support the restoration of the body's homeostasis (Jiang, Ma & Ramachandran, 2018). Studies have shown that being in a natural environment can lead to lower blood pressure and reduced cortisol levels, the stress hormone (Coventry et al., 2021). Moreover, passive rest in nature is associated with improved immune function, which is crucial for overall health (Bratman, Anderson & Hamilton, 2015; Ribeiro et al., 2021).

Beyond physical health, numerous studies have shown that passive rest in nature improves mental health. Research indicates that simply viewing greenery can enhance cognitive functioning and reduce symptoms of mental fatigue (Contini, Di Nuovo, Sinatra, Osmanaj & Monacis, 2022; Ribeiro et al., 2021). Pouso et al. (2021) found that maintaining contact with nature during the COVID-19 pandemic benefited mental health, particularly in reducing levels of anxiety and stress (Pouso, Borja, Fleming, Gómez-Baggethun, White & Uyarra, 2021). Passive rest in nature allows individuals to relieve emotional stress and reduce mental fatigue (Contini et al., 2022).

The beneficial effects of passive rest in nature on human health are also reflected in the absence of pollutants typical of urban environments, such as noise, inadequate

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lighting, and electromagnetic radiation. Chronic exposure to high noise levels can cause various health problems, including hearing loss, sleep disturbances, and elevated stress levels, which may exacerbate cardiovascular disease (Hu et al., 2020; Babatola, 2018). Light pollution, defined as inefficient, excessive, and improperly directed artificial outdoor lighting, can lead to a range of health problems, including sleep disturbances, depression, and increased stress levels (Falchi et al., 2016). Electromagnetic radiation is emitted by every electrically powered device and its associated installations—from power lines and substations to sockets and switches in our homes (Zelić, 2017). The same author points out that electromagnetic radiation causes biochemical changes, constant stress in the central nervous system, brain function disorders, and mental illnesses.

Active Rest in Nature: Effects on Physical and Mental Health

Active rest represents one of the two branches of sports tourism (Ivanovski, 2014). Active rest is intended to satisfy the individual's need to move and to be physically active, in contrast to traditional tourism, which is designed in such a way that people remain passive. Outdoor activities, in the broadest sense, include all activities carried out in natural environments where human influence is minimal or nonexistent. These most commonly include climbing, hiking, kayaking, cycling, nordic walking, rowing, and others. By engaging in outdoor activities, people fulfill their need for active rest.

Exercising outdoors, compared to exercising indoors, has been the subject of growing research interest, particularly because of the advantages associated with natural environments. One of the primary benefits of outdoor exercise is the potential for higher-intensity workouts. This increased intensity is crucial because moderate to vigorous physical activity is associated with reduced anxiety, fewer symptoms of depression, and improved quality of life (Miller et al., 2020). Moreover, nature often provides a more stimulating atmosphere, which can increase motivation and enjoyment during exercise, leading to longer and more frequent training sessions (Noseworthy et al., 2023). Outdoor exercise, i.e., in nature, also contributes to more positive emotional responses. Participants demonstrated significant increases in activation, enthusiasm, and calmness, as well as significant reductions in fatigue and anxiety after hiking (Niedermeier, Einwanger, Hartl & Kopp, 2017).

Outdoor activities are important and beneficial for all age groups, from children to adults and older people. Preschool children who play outdoors in natural environments show statistically significantly better motor skills—coordination, balance, and agility (Fjørtoft, 2001). Outdoor recreation reduces stress and supports emotional and social development in children (Ginsburg, 2007; Kuo & Taylor, 2004; Weinstein, Przybylski & Ryan, 2009). The results of a study conducted on a sample of 120 schoolchildren showed that those who reported spending most or all their after-school time outdoors were more likely to meet the recommended minimum of 60 minutes of moderate to vigorous physical activity per day. In addition, these children reported less time spent in sedentary activities and demonstrated better cardiorespiratory fitness compared to those who reported not spending time in nature (Schaefer et al., 2014). It was also found that each additional hour spent outdoors was associated with reduced likelihood of peer relationship problems (Larouche, Garriguet, Gunnel, Goldfield & Tremblay, 2016).

A group of authors aimed to examine the extent to which low-intensity outdoor running over a longer period is associated with young people's physical health, and then to determine whether there is a specific volume and intensity of activity that influences health (Mao, He, Xia, Xu, Zhou & Zhang, 2022). The results showed statistically significant changes in the experimental group that engaged in long-term low intensity running (jogging) after one year, compared to the control group. The study identified the dose of physical activity necessary to achieve health benefits: 120–140 km annually, approximately 3.43–4 km per week (Mao et al., 2022). Findings from another study, which investigated university students' participation in outdoor recreation programs and the perceived effects of nature on subjective well-being, highlight that nature can play an important role in students perceived well-being during a life stage burdened by stressors, especially during the COVID-19 pandemic (Puhakka, 2019). Besides offering opportunities for physical activity, nature also enables emotional and cognitive restoration, the strengthening of social relationships, and the mitigation of negative physiological effects of stress. It also helps students to reflect on their lives and develop deeper self-awareness (Puhakka, 2019).

One study provided insight into the psychological resilience of students engaged in a two-week outdoor program. The study included 46 students who camped in tents at a remote location and participated in activities such as kayaking, orienteering, hiking, rope descent, and survival skills. The results showed significant differences in levels of psychological resilience before and after the program, indicating the positive impact of outdoor education on students' resilience (Samsudin, Kamalden, Aziz, Ismail & Ujang, 2019).

It is well known that physical activity brings numerous health benefits. Walking at a speed of 5–8 km/h expends enough energy to be classified as moderate-intensity physical activity (Department of Health, Physical Activity, Health Improvement and Protection, 2011), and it is an easy and accessible way to meet the requirements for recommended physical activity (Morris & Hardman, 1997). The results of a study showed statistically significant reductions in mean values for blood pressure, resting heart rate, body fat, body mass index, and total cholesterol, as well as statistically significant increases in maximal oxygen uptake (VO^2max) before and after a one-year walking program in adults (Hanson & Jones, 2015). Another study examined the effects of Nordic walking on anthropometry, body composition, and functional parameters in middle-aged adults (Grigoletto et al., 2022). The results showed that participants engaged in Nordic walking had significantly lower levels of stress and anxiety after the exercise program. Body fat percentage was also significantly reduced in women, while lower-body strength increased significantly in both genders after the training period. The authors concluded that Nordic walking offers many potential benefits and could be recognized as an important exercise for maintaining good health in middle-aged adults (Grigoletto et al., 2022).

A physically active lifestyle mitigates physiological changes associated with aging and helps prevent common chronic diseases (Singh, 2002). Participation in physical activity also improves physical fitness, muscle strength, aerobic capacity, balance, and flexibility in older adults (Keysor & Jette, 2001). Such improvements in physical characteristics are known to help reduce the risk of falls, which are a major cause of decreased quality of life in older people (Skelton, 2001). Most studies examining how outdoor activities affect the elderly do not differentiate between activities performed outdoors and indoors (Keysor & Jette, 2001; Skelton, 2001; Silverstein & Parker, 2002; Singh, 2002). However, the interventions tested by these authors generally included aerobic activities, resistance training, and balance training, which can also be carried out outdoors, and can thus be considered outdoor activities.

A group of authors conducted a study examining the

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positive effects of participating in intensive outdoor activities among older Chinese adults in Hong Kong and whether such effects varied with socioeconomic background (Lai, Ou & Jin, 2022). The results indicated that happiness levels increased in the experimental group, and their overall mental health also improved. Demographic characteristics did not have a significant effect on well-being outcomes (Lai et al., 2022). The same authors also examined the effects of cycling outdoors on psychological functioning, mental health, and overall well-being in older adults. The results suggested that outdoor cycling influences executive functions and mental health, with similar or even greater effects observed in groups using electric bicycles compared to traditional bicycles. This indicates that the physical component of cycling is not the only factor contributing to health benefits, and that older adults can easily experience positive effects from participating in light physical activity such as riding an electric bicycle (Leyland, Spencer, Beale, Jones & Van Reekum, 2019).

Beyond the health benefits related to physical fitness, physical activity also provides various psychological benefits to older adults. Older Swedes who engaged in regular physical activity over a nine-year period reported greater life satisfaction compared to those who did not participate in physical activity (Silverstein & Parker, 2002). Other authors examined the impact of physical activity on depression and claim that activities such as long walks can reduce the risk of subsequent depression (Strawbridge, Deleger, Roberts & Kaplan, 2002). Furthermore, it has been shown that higher levels of physical activity—specifically walking more than ninety minutes per week—can contribute to improved cognitive performance and memory in older women (Weuve, Kang, Manson, Breteler, Ware & Grodstein, 2004).

Rest in Nature and Human Health: Key Considerations

In contemporary times, as well as in this study, rest in nature is regarded as an occasional activity that people most often practice on weekends or on weekdays when they have free time. As can be concluded from previous research, passive rest in nature brings numerous health benefits related to both physical and mental health: reduction of blood pressure and improvement of immune response (Li et al., 2010); restoration of the body's homeostasis (Jiang et al., 2018); reduction of cortisol levels, the stress hormone (Coventry et al., 2021); as well as improved cognitive performance and reduced symptoms of mental fatigue (Contini et al., 2022; Ribeiro et al., 2021); enhanced focus and mental clarity (Bratman et al., 2015); reduced levels of anxiety and stress (Pouso et al., 2021); and lower emotional stress and cognitive fatigue (Contini et al., 2022).

On the other hand, active rest in nature also contributes to health and well-being across all age groups: it reduces stress and supports emotional and social development in children (Ginsburg, 2007; Kuo & Taylor, 2004; Weinstein, Przybylski & Ryan, 2009); it decreases mean values of blood pressure, resting heart rate, body fat, body mass index, and total cholesterol, while significantly increasing mean values of maximal oxygen uptake (VO2max) in adults (Hanson & Jones, 2015); it improves physical fitness in older adults, including muscle strength, aerobic capacity, balance, and flexibility (Keysor & Jette, 2001); and it increases happiness and overall mental health in older populations (Lai et al., 2022).

Although the effects of passive and active rest have been thoroughly studied separately, it still remains insufficiently clear what the effects are when people combine multi-day passive and active stays in nature—that is, when multi-day programs are organized with accommodation in temporary facilities and a variety of activities carried out during the day. Research most often refers to adventure programs in nature, and when conducted with students, these are referred to as adventure education programs, which involve staying in remote locations in nature with organized activities such as hiking, climbing, rowing, rope descent, fishing, and others. Adventure outdoor education can be defined as an educational philosophy that, through experiential learning, uses nature as a place of learning, allowing participants to develop their interpersonal skills in a challenging environment.

In one study, the authors examined the mental health benefits for youth and adolescents who participated in adventure education programs in nature and concluded that such programs can increase self-efficacy, mindfulness, and subjective well-being. Participants reported higher scores in life satisfaction, happiness, and mindfulness, as well as lower levels of stress after completing the program (Mutz & Müller, 2016).

Several other authors attempted to answer whether adventure outdoor education programs bring health benefits to university students (Chang, Davidson, Conklin & Ewert, 2018; Kelly, 2019; Samsudin et al., 2019). Findings suggest that short-term adventure programs in nature provide students with opportunities to step away from everyday challenges, in return reducing psychological stress levels and providing temporary decreases in physiological stress (Chang et al., 2018). In a similar study, results showed that outdoor education programs improved students' psychological resilience (Samsudin et al., 2019). Another study confirmed these findings, indicating that adventure experiences provided temporary evidence of positive effects on subjective measures of resilience, particularly for individuals who initially scored low. Resilience showed its greatest increase immediately after the adventure education program, returning to baseline within three weeks (Kelly, 2019).

A group of authors emphasized that the advantages of participating in adventure education and recreation programs in nature extend beyond those usually mentioned, and include increased academic achievement, leadership and teamwork skills, environmental connectedness, greater employability, enhanced life effectiveness, and other transferable skills (Andre, Williams, Schwartz & Bullard, 2017). Outdoor education and recreation programs can also directly support academic curricula in achieving learning goals, particularly those related to environmental issues, diversity, and inclusion (Andre et al., 2017).

Thus, not only do active and passive stays in nature provide health benefits, but the synergy of activities in nature with multi-day (passive) stays also offers additional advantages.

Conclusion

Based on the above, it can be concluded that rest in nature provides numerous benefits for maintaining good physical and mental health, while also offering opportunities for their further improvement.

However, awareness of the importance of activities in nature is not sufficient; concrete steps must be taken to ensure that people spend time in nature more frequently, as only then can the aforementioned benefits be fully realized.

To enjoy the advantages that nature provides, it is not necessary to organize multi-day stays with activities that require special organizational skills, expertise in specific fields, professional guidance, or logistical support. It is sufficient to regularly engage in simple activities such as walking or cycling to reduce stress, improve mood, and positively influence physiological parameters such as blood pressure, physical

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fitness, and body composition (lower body fat, increased muscle mass).

The aim of this paper was to clarify the importance of both active and passive rest in nature, with an emphasis on the benefits they provide for mental and physical health. Furthermore, it calls for greater attention to be devoted to this topic in the future, precisely because of the knowledge of its importance, as it offers opportunities for simple and easily organized activities accessible to everyone. More attention should be directed toward rest in nature at all levels of education—from kindergartens and schools to universities and sports clubs—so that professionals working with both children and adults are able to convey awareness of its significance. Beyond raising awareness, it is also necessary to teach concrete steps that will enable individuals to practice this type of rest, which could be the focus of future research on the subject.

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The role of recreation and physical exercise in preserving health and quality of life in mature adulthood

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Introduction

This study analyzes the impact of regular physical activity in mature adulthood on physical, cognitive, and emotional health. The primary aim is to examine the effects of exercise in reducing the risk of chronic diseases and enhancing overall well-being among individuals over the age of 40, with a detailed analysis of findings from previous studies. The focus of this research is on identifying the long-term benefits of physical activity for maintaining health and improving quality of life in this demographic group.

Physical activity (PA) is defined as any bodily movement produced by skeletal muscles that results in energy expenditure. PA includes exercise, sports, and physical activities performed as part of daily life, occupations, leisure, or active transportation.

Exercise is a subcategory of PA that is planned, structured, and repetitive, with the ultimate goal of improving or maintaining physical fitness. Physical functioning refers to an individual's capacity to perform physical activities of daily living. It reflects motor function and control as well as physical fitness (Agbangla et al., 2023; Baldelli et al., 2021; Biazus-Sehn et al., 2020; Bangsbo et al., 2019; Battaglia et al., 2016).

PA is a protective factor against non-communicable diseases such as cardiovascular disease, stroke, type 2 diabetes, and certain types of cancer. It is also associated with improved mental health, delayed onset of dementia, and enhanced quality of life and well-being (Cunningham et al., 2020; Reuter & Keating, 2020; Van der Wees & Pluk, 2020; Zhu & Liu, 2020).

The health benefits of PA are well documented, with higher levels and greater frequency of PA being associated with reduced risk and improved health outcomes (Cunningham et al., 2020; Di Lorito et al., 2021; He et al., 2023; Langhammer et al., 2018; McPhee & Stewart, 2020).

The "dose" of PA or exercise is described in terms of duration, frequency, intensity, and volume. For optimal effects, older adults must adhere to a prescribed exercise program and follow the principle of progressive overload in training, meaning they should exercise near their maximal capacity in order to sufficiently challenge physiological systems. This promotes improvements in parameters such as VO_2max and muscle strength (Cunningham et al., 2020; Di Lorito et al., 2021; He et al., 2023; Langhammer et al., 2018; McPhee & Stewart, 2020).

Improvements in mental health, emotional, psychological, and social well-being, as well as in cognitive functions, are also associated with regular PA. Although the health benefits are well established, PA levels among older adults remain below the recommended 150 minutes per week (Pahor et al., 2014).

The global prevalence of physical inactivity is estimated at 31% (WHO, 2020). This indicates that one in every four to five adults is physically inactive or engages in a level of activity below the current World Health Organization (WHO) recommendations (WHO, 2020).

Inactivity and aging increase the risk of chronic diseases, and older adults often experience multiple chronic conditions (WHO, 2020). WHO exercise recommendations include aerobic exercises, strength training, and balance exercises to reduce the risk of falls.

If older adults are unable to fully adhere to these guidelines due to chronic health conditions, they should remain as active as possible within their abilities and health status. It is important to note that the recommended amount of PA refers to additional activity beyond routine daily tasks such as housework, cooking, and shopping.

Physical inactivity is associated with changes in body composition, leading to an increased percentage of body fat and a simultaneous decline in muscle mass (Pahor et al., 2014; Resnik & Nahm, 2019). It is also accompanied by a significant reduction in maximal power output (Pahor et al., 2014; Resnik & Nahm, 2019).

Skeletal muscle atrophy is often considered a characteristic feature of aging and physical inactivity. Sarcopenia is defined as low muscle mass in combination with low muscle strength and/or diminished physical performance (Pahor et al., 2014; Resnik & Nahm, 2019; Sallis & Owen, 2015; Van der Wees & Pluk, 2020).

Aging is associated with a decline in physical functionality and greater dependence in daily activities, which is often more pronounced in older adults with chronic diseases (WHO, 2020). However, strength training is beneficial in increasing muscle mass, improving physical functionality, and moderately enhancing self-reported activities of daily living (WHO, 2020; Zhu & Liu, 2020).

Older adults who remain physically active report a higher quality of life and better health outcomes (Cunningham et al., 2020; WHO, 2020; Zhu & Liu, 2020). They maintain greater independence, can perform more daily activities on their own, and generally face a lower risk of falls and consequent fractures (Cunningham et al., 2020; Di Lorito et al., 2021; He et al., 2023; WHO, 2020; Zhu & Liu, 2020).

Studies indicate that moderate, multi-joint physical activity positively affects the efficiency of performing activities of daily living, thereby contributing to greater independence and higher physical functionality among older adults (Cunningham et al., 2020; Di Lorito et al., 2021; He et al., 2023; Langhammer et al., 2018; McPhee & Stewart, 2020; WHO, 2020; Zhu & Liu, 2020).

To reduce the risk of falls, strength and balance training should be incorporated into physical activity programs, with studies showing that such interventions may decrease fall risk by as much as 21% (WHO, 2020). In this context, it is important to emphasize the role of sex, as women derive greater benefits from these activities due to their naturally higher risk of falls and subsequent fractures.

Physical activity in older adults also lowers cardiovascular mortality, with the underlying mechanism involving changes in cardiovascular autonomic balance that increase vagal predominance (Buchner & Wagner, 2016; Langhammer et al., 2018; Lachman et al., 2018; McPhee & Stewart, 2020; Pahor et al., 2014; Sallis & Owen, 2015). This effect is particularly evident under maximal effort, where cardiac volume, output, contractility, and oxygen uptake increase, while systemic resistance and blood pressure decrease, thereby facilitating cardiac workload (Langhammer et al., 2018; Lachman et al., 2018; Sallis & Owen, 2015). Studies further demonstrate that endurance training reduces cardiac strain and enhances cardiac function (Langhammer et al., 2018; Lachman et al., 2018; Sallis & Owen, 2015).

Exercise may also exert positive effects on the central nervous system, particularly the brain. Studies have

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demonstrated associations between poor executive control and lower levels of physical activity (Biazus-Sehn et al., 2020; Bangsbo et al., 2019; Barha & Liu-Ambrose, 2018; Hadian et al., 2021). Therefore, the promotion of exercise, as well as the integration of new technologies for improving cognitive rehabilitation in older adults, is essential (Biazus-Sehn et al., 2020; Bangsbo et al., 2019; Barha & Liu-Ambrose, 2018; Hadian et al., 2021).

In addition, changes in bodily functions and the environment may hinder the maintenance of physical activity in older adults, particularly under conditions of heat stress (British Geriatric Society, 2014). In this context, studies investigating aging and thermoregulation play a crucial role in understanding physical activity in later life.

The objective of this systematic review is to analyze the role of physical activity in preserving health and quality of life in older adults, drawing upon evidence from twenty-four relevant studies.

Method

This review analyzed 24 scientific papers published between 2013 and 2024 that investigated the impact of physical activity on the physical, psychological, and social health of older adults. The included studies comprised a range of research designs, such as systematic reviews, meta-analyses, randomized controlled trials, and observational studies.

The key areas of analysis focused on: the effects of physical exercise on cardiovascular health, the improvement of cognitive functions, the reduction of anxiety and depression symptoms, the enhancement of the overall quality of life, and the prevention and delay of frailty and loss of functional independence.

The databases searched included PubMed, Scopus, and Google Scholar. The keywords used for the search were: "physical exercise," "cardiovascular health," "general health status," "cognitive abilities," "quality of life," "older adults," "mental health," "recreation," and "functional independence."

Results and discussion

a) The Impact of Physical Activity on Physical Health

Physical activity is a key factor in maintaining health and the normal functioning of physiological systems throughout the lifespan. Compared to their inactive counterparts, physically active older adults demonstrate advantages in terms of physical and cognitive functioning, intrinsic capacity, mobility, musculoskeletal pain, risk of falls and fractures, depression, quality of life, and reduced disability (Agbangla et al., 2023; Bangsbo et al., 2019; Cunningham et al., 2020; Di Lorito et al., 2021).

Physical inactivity in older adults is associated with disease development and an increased risk of all-cause premature mortality (British Geriatric Society, 2014; WHO, 2020). Conditions and diseases (and their key risk factors) include metabolic disorders, cardiovascular diseases, certain types of cancer, and sarcopenia. Collectively, these lead to poor quality of life and reduced functional independence (British Geriatric Society, 2014; WHO, 2020).

Among older adults who were previously inactive, evidence shows that many physiological systems can be improved through increased physical activity and participation in exercise programs (British Geriatric Society, 2014; Di Lorito et al., 2021; He et al., 2023; WHO, 2020). Furthermore, exercise can be used to enhance functional capacities, serve as an adjunct therapy for numerous diseases, and play a role in rehabilitation.

In comparison to inactive peers, older adults who have been physically active throughout their lives exhibit higher levels of physiological functioning, including metabolic, skeletal, cardiovascular, and immune system performance (Barha et al., 2018).

Physical activity has a significant influence on preserving cardiovascular health in older adults. Macera et al. (2017) demonstrated that regular physical activity reduces the risk of developing heart disease and hypertension by 25%. Chavez et al. (2021) further highlighted that aerobic exercise improves lung capacity and muscle strength, while a combination of aerobic and resistance training contributes to weight reduction and lowers the risk of metabolic disorders.

Physical activity exerts a positive effect on physical health, particularly on the functional capacity of the cardiovascular system. The study by Huagang He et al. (2023) demonstrated that regular and long-term physical activity contributes to the stabilization of adaptation coefficients to stress, enhances physical working capacity, and may slow down involutional changes in the body associated with aging. In most women from the experimental group, cardiovascular parameters were recorded within or above the normal range, indicating improved functional capacity of the heart and blood vessels. These findings confirm that physical activity can help maintain and enhance cardiovascular health.

Furthermore, Lachman et al. (2018) reported a significant inverse relationship between physical activity and the risk of cardiovascular disease in older adults. Their results also emphasized that even moderate levels of physical activity reduce the likelihood of developing cardiovascular disease.

b) The Impact of Physical Activity on Functional Ability and Mobility Independence

Healthy aging is defined as the ability to lead a healthy, socially inclusive life, relatively free from disease or disability. This outcome is more likely among individuals who engage in physical activities that enhance their health and well-being (McPhee et al., 2016).

The ability to perform activities of daily living (ADLs) is crucial for independent functioning. Age-related loss of muscle strength can compromise this ability, often leading to disability (Liu et al., 2014). For example, progressive muscle weakness limits the capacity to hold objects, which further hinders activities such as opening jars or lifting items. Such difficulties in performing ADLs and reliance on assistance not only reduce quality of life but also increase the likelihood of long-term institutionalization (Liu et al., 2014).

Numerous studies have shown that progressive resistance training significantly improves muscle strength in older adults, including the oldest age groups (Agbangla et al., 2023; Baldelli et al., 2021; Bangsbo et al., 2019; Di Lorito et al., 2021; Hou et al., 2024).

Progressive resistance training involves gradually increasing the load over a training period to strengthen major muscle groups used for carrying or lifting. This type of training is recommended as a preventive measure or to reduce disability in later life (Agbangla et al., 2023; Baldelli et al., 2021; Bangsbo et al., 2019; Di Lorito et al., 2021; Hou et al., 2024). Recent evidence suggests that benefits for older adults, such as improved physical functioning and reduced premature mortality, can be achieved with lower volumes and intensities than the commonly recommended 150 minutes of moderate-to-vigorous physical activity per week (McPhee et al., 2016).

Other studies indicate that older adults have 30–50%

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fewer motor neurons innervating the leg muscles compared to younger individuals, suggesting that motor unit remodeling is part of the normal aging process (Piasecki et al., 2015).

Although the loss of motor neurons and muscle fibers that occurs with aging cannot be replaced, the structure and function of the cardiorespiratory, metabolic, and musculoskeletal systems can be improved through exercise. For this reason, studying highly active older adults is particularly valuable (Piasecki et al., 2015).

The progressive decline in physiological functions that typically occurs with aging is associated with slower gait, difficulty rising from a seated position, and challenges in maintaining balance (Rechel et al., 2013). Standardized assessments have been developed to measure physical capabilities in older adults, allowing for objective evaluation of functional performance.

Furthermore, Chiung-ju Liu et al. (2014) emphasize that physical activity reduces the risk of falls and fractures, particularly among older adults with osteoporosis. They highlighted that strength and balance exercises significantly contribute to the preservation of mobility and functional independence.

Baldelli et al. (2021) report that high-frequency physical activity can be effective in older adults, enabling improvements in functional mobility, autonomy, anxiety levels, balance, and social interactions. Moreover, moderate-intensity physical activity demonstrated the most notable results, enhancing multiple aspects related to quality of life.

Considering the heterogeneity of the older population, it is evident that further research is needed to determine the most effective types of exercise—such as strength training, balance and flexibility exercises, aerobic activities, or combinations thereof—as well as the optimal duration and intensity required to achieve positive effects.

c) The Impact of Physical Activity on Mental Health

As we age, physical functions gradually decline, often negatively affecting psychological health (Battaglia et al., 2021; Byeon, 2019; Chekroud et al., 2018; de Oliveira et al., 2019; Harada et al., 2019; Hou et al., 2024; Liao et al., 2022; Min and Lee, 2021; Van der Wees and Pluk, 2020; Wheaton and Colon, 2022; Wang and Liu, 2021).

Older adults frequently struggle to adapt to new social roles, changes in their living environment, and lifestyle modifications, which may lead to anxiety, depression, feelings of loneliness, and other negative emotions or psychological disorders (Hou et al., 2024; Liao et al., 2022; Wheaton and Colon, 2022).

Physical activity has a significant impact on mental health and can partially alleviate psychological problems. For instance, a cross-sectional study conducted by Chekroud et al. (2018) on individuals aged 18 and older found that physically active participants reported 43% fewer days of poor mental health per month compared to inactive participants. The most pronounced effects were observed in individuals exercising 3–5 times per week, with an optimal session duration of approximately 45 minutes. Overly long sessions (e.g., more than 90 minutes) did not provide additional benefits and were even associated with negative effects. The greatest mental health benefits were observed from activities such as team sports, cycling, aerobic exercises, and gym workouts (Chekroud et al., 2018).

In another study, Harada et al. (2019) followed 129 participants for one year and found that exercising in a social setting significantly improved the mental health of middle-aged and older adults. Previous studies had indicated effects of physical activity on individual psychology, but their samples were often limited to adolescents and adults from specific geographic areas (Petrella et al., 2021; Ten Have et al., 2011; Tyson et al., 2010).

Byeon (2019) investigated the correlation between regular physical activity and depressive symptoms in 256 Korean participants aged 65 and older, who took part in the "Korea National Health and Nutrition Examination Survey" in 2014. The study found that regular physical activity helped older adults maintain a healthy mental state.

Battaglia et al. (2016) conducted an eight-week, optimally intensive physical activity program with 30 older women, randomly assigned to either control or training groups. Results indicated that a dynamic lifestyle, including regular physical activity, is crucial for maintaining psychological health in older adults throughout aging.

Based on previous research, it can be concluded that physical activity has a positive effect on the mental health of older adults.

d) The Impact of Physical Activity on Cognitive Functions

Age-related changes in brain structure and function can lead to a wide range of cognitive and motor declines in healthy older adults. Research conducted over the past two decades has provided compelling evidence that such declines can be delayed, and in some cases reversed, while certain skills can be reactivated through engagement in various physical activities and maintaining an active lifestyle (Biazus-Sehn et al., 2020; Mroz et al., 2020; Robson and Gant, 2022; Souza and Costa, 2019; Stathokostas and Perri, 2020; Tsai and Yang, 2021; Wei et al., 2019).

Given the relatively rapid increase in the proportion of older adults in Europe and globally, identifying new approaches or interventions to improve motor and cognitive functions, as well as to promote a healthy lifestyle, represents a significant challenge.

Observational studies provide consistent evidence that age-related cognitive decline and neurodegeneration (also observed in diseases such as Alzheimer's and Parkinson's) can be slowed or delayed in physically active adults (Robson and Gant, 2022; Stathokostas and Perri, 2020; Tsai and Yang, 2021; Wei et al., 2019).

Acute moderate-intensity physical activity in older adults (e.g., lasting 10 minutes) leads to short-term benefits for cognitive performance and functional brain responses (Agbangla et al., 2023).

Randomized controlled trials involving older adults, typically consisting of approximately 3 hours of training or physical activity per week over several months to one year, provide modest but growing evidence of improvements in brain structure and function, as well as in cognitive, perceptual, and motor skills (Erickson et al., 2011).

Barha et al. (2018) concluded that different types of exercise, such as aerobic and resistance training, affect cognition and brain health in older adults, and that these effects may be sex-dependent. Biological mechanisms underlying the beneficial effects of exercise on the brain may differ between men and women.

Fernandes et al. (2017) demonstrated that physical activity promotes neuroplasticity and synaptic function in the brain, thereby reducing the risk of developing neurodegenerative diseases such as Alzheimer's. Levin et al. (2017) emphasized that even moderate levels of physical activity can significantly enhance cognitive functions and slow cognitive decline.

Shimada et al. (2018) highlighted that combined physical and cognitive activity improves and maintains both cognitive and physical performance in older adults with mild cognitive impairment, particularly the amnestic type.

Results from Sala et al. (2019) confirmed the association between physical activity and cognitive function. Similar effects were observed for physical functioning, including mobility independence and mental health.

Future studies should investigate potential sex differences in the effectiveness of exercise to develop evidence-based interventions that promote healthy brain aging for all individuals.

e) The Impact of Physical Activity on Quality of Life

The World Health Organization defines quality of life as "an individual's perception of their position in life in the context of the culture and value systems in which they live, in relation to their goals, expectations, standards, and concerns" (WHO, 2020). Accordingly, it is a comprehensive concept that can influence physical health, psychological well-being, personal beliefs, social relationships, and the interaction with the environment.

Physical activity contributes to improved quality of life by enhancing social interaction, reducing isolation, and boosting self-confidence. Meredith et al. (2023) emphasized that participation in group recreational activities strengthens the sense of community and emotional support among older adults. McPhee et al. (2016) highlighted that physical activity significantly increases autonomy and the ability to make independent decisions.

A large body of research indicates that the primary goal of physical activity programs is not only to reduce mortality but also to decrease morbidity, i.e., "adding life to years" rather than merely "years to life" (Reuter and Keating, 2020; Van der Wees and Pluk, 2020; Zhu and Liu, 2020).

Wu et al. (2022) recently demonstrated that physical activity is closely associated with improvements in overall health status and better quality of life in older adults. They also concluded that long-term physical activity delays disability and maintains independent functioning. Furthermore, older adults who expend higher amounts of daily energy (e.g., walking, outdoor work, and exercise) are more likely to perform daily activities independently and without impairment.

The study by Baldelli et al. (2021) investigated how physical activity affects quality of life in older adults. The results indicate that regular physical activity can significantly improve physical, mental, and social health, which directly translates into overall quality of life. The study also emphasizes that physical activity not only enhances physical endurance but also contributes to psychological well-being, helping older adults maintain independence and increase their sense of control over their lives.

Pei-Shan Li et al. (2020) reported that a higher number of chronic diseases, more frequent falls, and higher body mass index (BMI) significantly affect quality of life. The study concluded that physically active older adults have a better quality of life.

Considering all the above-mentioned benefits, this review recommends incorporating physical activity into the daily lives of older adults as a key factor in improving quality of life.

Conclusion

Mature adulthood represents a stage of life characterized by significant physical, psychological, and social changes. The aging process is often accompanied by a decline in physical activity, which can negatively impact health and quality of life. Physical exercise and recreational activities are recognized as key factors in preserving functional capacity, preventing chronic diseases, and promoting mental health during this life stage.

Physical activity plays a crucial role in maintaining health and quality of life in older adults. Regular exercise contributes to improvements in cardiovascular and mental health, enhances cognitive functions, reduces the risk of falls, and increases overall functional independence. Beyond its physical and mental benefits, physical activity also has a significant social dimension, helping older adults feel connected and engaged within their communities.

This review emphasizes the importance of regular physical activity in reducing the risk of various physical and mental health problems in older adults. Emerging meta-analytic evidence supports the protective effects of physical activity against cognitive decline, dementia, and Alzheimer's disease.

Physically active older adults age more healthily. However, many do not engage in sufficient physical activity to realize these benefits. Promoting physical activity during this period of life is essential for enhancing daily functioning and slowing the progression of diseases. Policies and practices must support older adults in achieving recommended levels of physical activity to fully realize these benefits.

Recommendations for Future Research

Future research should focus on:

- Determining the optimal combination of intensity, duration, and type of physical activity for different age groups.
- Investigating the long-term effects of physical activity on the prevention of neurodegenerative diseases.
- Examining the impact of group-based exercise on social inclusion and emotional support among older adults.
- Developing personalized exercise programs tailored to the individual needs and capabilities of older adults.

The promotion of physical activity and its integration into the daily lives of older adults should be a priority in public health policies to ensure healthier and higher-quality aging.

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UDK 796.413.012.5

Specificity of the handstand technique on various gymnastic apparatuses

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Introduction

Artistic gymnastics is one of the fundamental sporting disciplines. In addition to stimulating growth and development, it develops motor abilities and skills that transfer positively to other sports and to everyday movements. Built on a broad base of basic exercises, artistic gymnastics has evolved into a highly complex sport that abounds with skills of exceptional complexity and difficulty. To bring the execution technique of these skills to an acceptable level, athletes must submit to a long and demanding training process.

Along with forward and backward rolls, swings in a hang or support and turns around the longitudinal axis of the body, the handstand is one of the basic exercises in artistic gymnastics. In its integral form and in certain variations, it appears in almost all starting, transitional and finishing positions when performing more complex exercises, whether they are performed in hang or in support.

Every apparatus has its own characteristics that provide different conditions for performing skills and may therefore require certain changes to the basic technique. Consequently, the aim of this paper is to highlight the specific features of handstand technique on different apparatus in women's and men's artistic gymnastics.

Method

Data were collected through a review of the available literature and an analysis of the handstand technique on different apparatus. By systematizing the content, the common foundations and differences in the technique of performing this exercise on different apparatus were clearly defined.

Results

General handstand technique

Because the handstand is one of the basic skills in artistic gymnastics, it is very important to master its technique in order to transfer the skill positively to other apparatus. The handstand position is the starting point for performing many gymnastic skills on the apparatus. In general, the hands are placed on the apparatus parallel to each other at shoulder – width. The wrist, elbow and shoulder joints, as well as the hips, knees and ankle joints, should lie in one vertical line. The trunk also follows this line, which is achieved by tucking or rolling the pelvis, stabilizing the abdominal wall and drawing the chest in toward the axis of the trunk. The head is positioned so that the gymnast can see their hands but does not depart from the vertical line described above.

When performing this movement, the scapulae are elevated and the shoulder joints are slightly externally rotated. These actions "lock" the scapulae and allow better control of the position. They also increase the kinesthetic sensitivity of nerves in all structures of the shoulder girdle, especially in the muscles and connective tissue. Because the handstand reduces the support area to the hands, the entire body must actively maintain the position so that the gymnast's stability is not compromised. As the gymnast does not have a visual representation of all parts of the body during the exercise, they must generate an internal representation based on proprioceptive information. Consequently, all muscles involved in performing the handstand must be contracted to some degree due to increased mechanoreceptor sensitivity in the muscles, tendons and joints.

Maintaining balance in the handstand depends primarily on three body regions around joints crucial for full – body stability: the wrist and hand together with the forearms; the shoulder axis and girdle with the upper trunk and upper arms; and the hip axis with the pelvis, lower back and abdominal wall. The elbows and, to a lesser extent, the knees and feet also play roles. Experimental research has confirmed that oscillation above the support surface is smallest at the wrist and elbow axis, larger at the shoulder axis and largest at the hip axis. Observations from practice indicate that body oscillation above the support surface is greater in the antero – posterior direction than in the medio-lateral direction. Oscillations of the feet – the most distal body parts from the support surface – are also significant in the antero-posterior direction, and together with the lower legs and entire legs their moment of inertia counterbalances oscillations of body parts closer to the support.

Specificity of handstand technique on the floor (men's and women's artistic gymnastics)

Handstands on the floor exercise (parter) can be considered the general technique because the conditions for performing it are the most favorable and safest. A handstand can be achieved under dynamic or static (quasi-static) conditions. Most often it is performed dynamically through a lunge from a stride position. After the lunge and transfer of body weight onto the lead leg, the gymnast bends forward and places their hands on the floor parallel to each other at shoulder width. On the floor the fingers are spread, the support is on the distal parts of the metacarpal bones and the fingers are in the same plane as the palm. A handstand can also be reached quasi-statically by "pulling" the legs from the ground into the final position. The position is maintained by alternating palmar and dorsal flexion of the wrists. Exiting the handstand is performed by lowering the legs and returning to the starting position or by moving into a forward roll. The distance between the hands when placed on the floor plays an important role in achieving a stable position; the wider the hands are placed, the greater the stability but also the greater the muscular strength required. The optimum position is achieved by placing the hands at shoulder width.

Parallel bars (men's artistic gymnastics)

The rails of the parallel bars must have a wooden coating with a certain coefficient of friction and elasticity and must not vibrate during the routine. The support surface on each rail is elliptical, about 4.1 cm wide. A handstand on the parallel bars can be performed on any part of the rail. The entire elliptical surface of the rail is grasped by the metacarpal

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bones and fingers. The thumb is separated from the other fingers and the forearms are supinated. This external rotation of the forearm is a characteristic of the handstand on the parallel bars. Although the support area is smaller than on the floor, certain apparatus characteristics favor stability: the rails' elasticity provides a better reaction to the athlete's muscular force and improves stability. Because of the elliptical support surface and grip on the rail, the forearm muscles are activated to a greater extent and intensity, increasing stability. The shoulder joints are externally rotated, the scapulae elevated and the forearms supinated, "locking" the scapulae as in the general technique. On the parallel bars, the handstand can be a starting, transitional or finishing position. The most common entry to a handstand is by swinging through support. It can also be performed by "pulling" into position, as on the floor. Corrections of the position are made by adducting and abducting at the wrist joint. The most common exit from the handstand on this apparatus is a return to support by lowering the legs backwards, or a dismount by pushing off with one hand or through an acrobatic skill such as the Healy twirl.

Pommel horse (men's artistic gymnastics)

The pommel handles are round with a diameter of about 3.4 cm – the support area that the gymnast can grasp entirely with the fingers. The handstand can also be performed on the body of the pommel horse, where the support surface is larger but the ability to use the forearm muscles is reduced. The specific characteristic of the handstand on this apparatus is that it can be performed on support surfaces of different dimensions – using the body of the horse or the handles. For example, the gymnast can place one hand on a handle and the other on the body of the horse. On this apparatus the handstand is usually a transitional or finishing position within individual elements. According to the Code of Points, the handstand must be reached dynamically, most commonly by swinging from a circle or flair. Because the pommel horse routine is continuous with no interruption, it is necessary to emphasize the handstand position and then continue moving. As on the parallel bars, the shoulder joints externally rotate and the forearms supinate when performing the handstand. The most common exit from the handstand is a dismount, but the gymnast can also continue into flairs or scissors. A swing to a handstand may be performed on a single pommel handle, where both hands grip the same handle; this requires tremendous strength in the forearm and shoulder girdle muscles to execute correctly.

Rings (men's artistic gymnastics)

The rings are not a static apparatus; they oscillate during performance, so the gymnast must exert greater muscular force to stabilize not only their own body but the apparatus itself. The gymnast's support is only through the hands, and the workspace is very limited. During routines on the rings, competitors are allowed to use specially made grips to ensure a safer hold and increase friction between the hands and the apparatus. The handstand is a basic skill on this apparatus and constitutes a specific requirement: the gymnast must assume a handstand at least once during their routine on the rings. When performing the handstand, the shoulder joints externally rotate and the forearms supinate, but due to the rings' oscillations and their tendency to separate during the routine, the shoulder girdle also adducts. This position on the rings requires tremendous muscular force because the gymnast must control both their body and the rings. The position is corrected by contracting the abdominal wall, deep back muscles and gluteal muscles. Continuous corrections are necessary because the characteristics of the apparatus do not allow stable conditions. The rings can be completely grasped with the hands, providing better control. The straps to which the rings are attached prevent the gymnast from placing the hands at shoulder width, so the hands are placed slightly closer together. On this apparatus the handstand can be a starting, transitional or finishing position. Entry into the handstand is usually achieved by swinging but can also be by "pulling." Exiting the handstand can be forwards or backwards and usually ends in a dismount, although the gymnast can return again to a handstand.

Horizontal bar (men's artistic gymnastics)

On the horizontal bar, the handstand is performed exclusively as a transitional position because the routine requirements on this apparatus do not permit pauses. The gymnast passes through the handstand only by swinging – specifically through a giant swing (a full rotation of the extended body around the bar, with the axis of rotation passing through the hands). The position of the hands is similar to that on the floor, except that the gymnast grips the rail completely. As they pass through the handstand on this apparatus, the shoulder joints undergo slight internal rotation and the elbows pronate. The gymnast can pass through the handstand along the entire length of the bar. Corrections are made before and after passing through the handstand. Before entering the position, the gymnast slightly flexes at the hip to reduce the moment of inertia and increase angular velocity, facilitating passage through the handstand. After passing through, they slightly extend the back and elevate the scapulae to increase the moment of inertia and use the positive effect of gravity on the body.

Uneven bars (women's artistic gymnastics)

As on the horizontal bar and rings in men's gymnastics, athletes on the uneven bars are allowed to use special grips to increase friction between the hands and the apparatus and provide a more secure hold. Given the rail diameter, the gymnast can grasp the bar with their palm and fingers, and the hands are placed at shoulder width. On the uneven bars, the handstand can be a starting, transitional or finishing position. One of the basic skills is a swing to handstand, from which other skills follow – for example, a backward circling element (Stalder) to handstand without contacting the bar. When the handstand is a starting position reached by swinging, the gymnast opposes the thumb to the fingers, grasping the bar fully to increase the frictional force and thereby enhance stability. If the gymnast needs to pass through the handstand, the thumb will be repositioned along the fingers so that friction is reduced, allowing a faster rotation into the finishing position. This hand position is also used when the handstand is the finishing position. Corrections are made by flexing or extending the wrists and contracting the abdominal wall or the back and gluteal muscles. If the gymnast transitions from the higher rail to the lower rail of the uneven bars, the handstand position is modified, which is not considered an error. At the end of the rotation around the sagittal axis and grasping the lower rail, the gymnast extends the back (arch), raising the lower limbs slightly over the support surface. This allows for a more effective continuation of movement by utilizing the elasticity of the connective tissue and abdominal muscles. The most common exit from the handstand on this apparatus is by flexing at the hips and lowering the legs backwards toward the trunk to continue into the next skill (e.g. transitioning from the lower

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to the upper rail). The exit can also continue into a giant swing, which in turn may lead to another skill or a dismount.

Balance beam (women's artistic gymnastics)

On the balance beam, the handstand can be a finishing or transitional position. As a starting position it may be used in younger categories. A handstand on the beam can be performed in two ways: frontal (facing the beam lengthwise) or sagittal (sideways). When the gymnast is positioned sideways to the beam, the handstand is executed identically to the floor exercise, except that the support surface is limited to the 10 cm width of the beam; thus the hands are placed narrower than shoulder width. In this case the support is mainly on the base of the hand, while the fingers wrap around the beam from opposite sides and provide additional stability in the handstand position. Entry into the handstand, when performed sideways, can be by swinging or "pulling"; this method is more common in younger categories. When the gymnast is positioned frontally, the hands are placed perpendicular to the beam axis at shoulder width. Here the support is predominantly on the bases of the fingers, while the fingers grasp the lateral edge of the beam on the same side. This position requires minimal corrections of the body relative to the vertical line formed by the wrists, elbows, hips, knees and ankles, because in maintaining balance the head lies outside the support surface. Corrections may involve slight flexion at the hip or moving the chest and shoulder girdle toward the rear edge of the support surface (opposite the edge where the fingers are placed) in order to maintain stability. When this handstand is the finishing skill in a sequence, it is characterized as such when reached during a mount to the beam (e.g. a straddled "pull" to handstand). As a transitional position, it may appear in various skills such as a handspring or back handspring (Menichelli step – out). Exiting the handstand, when it is the final skill, involves returning one leg and then the other to the starting position (when the gymnast is positioned sideways). It can also be performed by dismounting with a 180 – degree turn or by controlled lowering with hip flexion onto mats beside the beam. A controlled lowering of the legs combined with flexion at the hips into a straddle support can also be performed from the sideways position, but this exit is more common when the gymnast is positioned frontally.

Discussion

An analysis of handstand technique under different conditions clearly shows the need to modify the technique of this exercise on various apparatus to achieve greater stability and create conditions for continuing movement. Since the handstand technique on the floor represents the basic form of this element, it is learned first. After mastering this technique, athletes proceed to learn the handstand on other apparatus. On the horizontal bar, the handstand technique differs substantially from the basic form because no pause is allowed during the routine. The largest modification involves arching the body when passing through the handstand so as to create conditions for continuing movement into the next skill, whether a release skill, a skill performed close to the bar or a dismount. A similar modification can be found on the uneven bars, especially when transitioning from the higher to the lower rail. Depending on whether the gymnast intends to finish the movement in a handstand or continue into the next skill, a specific grip is used. On the pommel horse, the handstand is performed only dynamically. If the skill is performed on a single handle, unlike the basic technique, the gymnast must elevate the scapulae and place the hands slightly narrower than shoulder width to grip the handle with both hands. On the parallel bars there is also greater scapular elevation during the handstand, while the hands are generally placed shoulder-width apart. In certain skills where the finishing position is on one rail, it is necessary to place the hands one behind the other to enable stable performance of the handstand on this apparatus. On the parallel bars, the handstand can be performed by "pulling" as well as by swinging, which is similar to the possibilities on the floor, rings and beam. On the beam, modifications to the technique arise from the limited support surface, so it is necessary to place the hands so that the support and load are shifted more toward the base of the hand. In the basic technique the support is in the distal metacarpal area. Depending on the position from which the gymnast enters the handstand, the hands are placed either at shoulder width or slightly narrower so that both hands fit on the beam. Also, when the gymnast is positioned frontally to the beam, compensatory movement of the hips and trunk opposite the head is needed because the head is moved forward, outside the support surface. The largest modifications in handstand technique can be seen on the rings. The characteristics of this apparatus do not allow complete stability when maintaining the position because the rings move along with the gymnast. Therefore, a greater muscular force must be produced to control both the body and the apparatus. In holding the handstand on the rings there is greater external rotation of the shoulder joints and greater supination of the forearms. There is also a slight extension of the trunk as a compensatory response to the oscillations of the apparatus when maintaining the handstand.

Conclusion

Considering the analyzed handstand positions and their corrections on different apparatus, it can be concluded that this exercise truly is one of the basic elements in artistic gymnastics and that it is used on almost all apparatus in the all – around program. The general form of the handstand is the same on all apparatus, with minor or major modifications of body position depending on the apparatus. Despite the numerous modifications to the general handstand technique on different apparatus, it is important during training to establish a good motor pattern of the handstand. Systematic work on technique, with additional focus on developing specific muscle groups and coordination, could greatly facilitate the performance of this exercise on multiple apparatus, improve execution of entire routines and reduce the risk of injury. This paper could serve as a basis for new studies addressing the general methodology of handstand performance, as well as training periodization that includes guidelines on when to transition from learning and perfecting the general handstand to learning the technique on different apparatus in artistic gymnastics.

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UDK 796.41.012.1:616-001

Development of explosive strength, frequency and prevention of injuries in artistic gymnastics

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Introduction

As a sport with a long ongoing tradition, artistic gymnastics is more and more popular and represents an evergrowing challenge for younger generations. Even though that sometimes with a profound purpose of educational and healthy growth and development, artistic gymnastics is full of elements that are more than just attractive, they border the extremes. Boundaries that are moved ever so fast in artistic gymnastics, are a consequence of rapid development of scientific research in sports training as well as the technology and construction of the gymnastic apparatuses.

Some authors (Arkaev and Suchilin, 2004; Jemni et al., 2011) have noticed that artistic gymnastics needs an even better equilibrum between strength and power are needed, because of the increase in the difficulty of the elements in artistic gymnastics, which is even more so emphasised by the latest rule changes in the FIG rulebook (Code of Points, 2022-2024). The trend of development of artistic gymnastics is especially noticed in women's artistic gymnastics (Jemni et al., 2001), and even more so in the last few decades. Even though there was a gap between men's and women's artistic gymnastics, there is little to no difference in technical performance nowadays.

Creating an elite gymnast requires the development of all motoric abillities, although soem of them can be titled as dominant, as is power (explosive, relative, repetitive), flexibillity and coorditation, especially balance (Douda et al., 2008; Louer, Elferink-Gemser and Visscher, 2012). For an athlete to develop a greater level of power, they need to have great muscle strength (Jemni et al., 2006; Cormie, McGuigan and Newton, 2011), and to achieve that strength, they need to have a good foundation in terms of aerobic endurance.

Energy requirements are mostly fulfilled from anaerobic sources (Jemni, 2013), taking into consideration that the competitive activities are done in a very short time period with a very high intensity (Jemni et al., 2000). The longeoutine in men's artistic gymnastics on floor is 70 seconds long. Routines on the pommel horse, parallel bars, still rings and high bar are roughly 35 seconds long, while vaults are done in approximately 6 seconds. That is also the case in women's artistic gymnastics, where the floor routine is the longest as well as the beam routine, 90 seconds at most, while the routines on the uneven bars and vault are identical with the routines in men's artistic gymnastics. A large number of authors point out that the improvement of VO2 max, or otherwise said aerobic endurance that is characterized by exercises such as jogging or activities with a longer duration like riding a bicycle or a bicycle ergometer, are extremely important for gymnasts, in terms of faster recovery after an intensive activity and for keeping an optimal body mass for female gymnasts (Sands et al., 2002). Although, VO^2 max isn't a predictor of success like relative muscle strength and maximum power are (Jemni et al., 2016).

Most of the aspiring gymnasts are getting into intense training procedures and selection as early as in the age of five. The scope of the training practices increases during the adolescence period, which ranges from 20 to 30 hours weekly (Caine et al., 2003). The reason for the early approach in this sport is the relative short competitive career of the gymnasts which comes due to biological development and growth especially present in the women's artistic gymnastics. Considering the complexity of gymnastic exercises, sensitive periods of motoric skill development also need to be taken into consideration, since some of them dominate later in the competitive period and contribute to better competitive results. Development of some of the motoric skills like coordination, should be started since the pre – school period.

On the other hand, coach's and athlete's ambition to hurdle towards results, and most of the time misunderstanding the aspects of growth and development, basic training principles, lead to overtraining syndrome, exhaustion of the whole organism as well as incurring acute or chronic injuries.

Explosive exercises with both upper and lower extremities are that are executed with power and speed at the same time, are dominant in the most gymnastic events. With importance and application of these gymnastic exercises in mind, especially for acrobatics, rhythmic and vaulting exercises, the goal of this research was to determine the important aspects of explosive power development, frequency of injuries as well as to point out the important aspects of injury prevention. Analyzing the relevant literature, special importance has been given to research of explosive characteristics, conditions in which it is manifested in artistic gymnastics, important periods as well as resources and methods of it's development that are mostly used in artistic gymnastics, the most important aspects of injury prevention as well as the most common injuries in artistic gymnastics, lower extremities first and foremost, were pointed out.

Method

This is a descriptive qualitative research. The data were gathered and analyzed by reviewing the available literature.

Results

Manifestation of explosive force in artistic gymnastics

Explosive force is defined as the ability of neuromuscular system to develop dynamic force of an open kinematic chain very quickly (Aagard et al., 2002), where the rate of force development is close to maximum. The key element of explosive force is the rate of force development (RFD) in time which is in correlation with acceleration and it is expressed in Newton by second (N/s). In artistic gymnastics, the exercises that are dominant are the ones where the explosivity of lower extremities is needed, like various acrobatic and rhythmic elements. In practice, it is often found that between the two gymnasts that perform the same exercise, the gymnast that does the exercise with greater amplitudes, in terms of more gained height or faster reach of the final position in the exercise, gets the higher score. In both cases, the result depends on the level of developed explosivity. Acrobatics is

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present in more disciplines. The rate of turning along the vertical as well as sagittal axis, as well as the score, is dependent of the achieved height. Vertical elevation of the center of body mass is detrimental for performing a somersault as well as the acrobatic elements (Mkaouer et al., 2012). Greater jump – off speed and higher elevation of the center of body mass during a somersault, enable better stability during the landing, especially in exercises with multiple rotation along the vertical and sagittal axes. The ability to develop greater force in the least amount of time (explosive force) determines the success in acrobatic performances (French et al., 2004). While there are only two apparatus, out of six, where acrobatic exercises are present in men's artistic gymnastics, in women's artistic gymnastics they are present on the balance beam as well (three out of four apparatuses). Among the acrobatic exercises in women's artistic gymnastics there are also rhythmic exercises on the floor and balance beam that are also considered as explosive.

On apparatuses that include hanging and supports in men's as well as woman's artistic gymnastics, explosive upper extremities exercises are also dominant. In women's artistic gymnastics the most interesting groups of exercises on uneven bars are fly – overs from bar to bar as well as releasing and re – catching the bar, are considered to be explosive upper extremities exercises. Similar situation can be found on men's high bar and parallel bars, where the utilization of elastic properties of the apparatus as well as the amplitude of the exercise, is dependent on the rate of force development.

Jemni et. al, (2006), have determined that there was a general improvement in maximal force in gymnasts (developed in the first ten seconds) in the last few decades. Gymnasts show superiority in manifesting the explosive force in regards to other athletes like tennis players, handball players or swimmers (Bencke et al., 2002).

Aleksić-Veljković et. al, (2006) have analyzed the difference in jump height, relative and maximal developed force in counter movement jump (CMJ) between sexes of gymnasts and confirmed the differences in greater jump height are in favor of male gymnasts, even though some of the variables were relativized by body mass. Authors have determined, in the same research, a positive correlation between body mass and jump height in elite gymnasts ($r = 0.542$). The determined differences in jump height between males and females are going up to 12 cm, authors have explained it as a possible consequence of differences in cross section and stiffness of the muscles, in maturation and the number of fast muscle fibers. Hence the justification of higher demands for acrobatic exercises on the floor for men as well as that some of the exercises, even though the same, have a higher difficulty score for women.

Development of force and prevention of injuries in artistic gymnastics

Considering the importance and benefits of explosive force in improving the quality of exercises on various gymnastic apparatuses, it is necessary to respect the sensitive periods of it's development in training. The literature shows different data that are connected to the sensitive and critical training periods of this ability. According to Guzhalovski (1984), sensitive period are between 10 and 12 years for girls and 13 to 15 years for boys. Other group of authors point out that the period of rapid development of explosive force, comes earlier, that is from the age of 5 to 8 for girls and 7 to 10 for boys (Viru et al., 1998), while according to Issurin (2008), that period is moved a bit further ahead so it correlates to the period of 11 – 13 years for girls and for boy it is from 13 all the way to 17 years. It is necessary to pay great attention to training contents that influence the improvement of explosivity in the periods of pre – puberty, puberty and early adolescence. In these periods, the body naturally goes through phases that are suitable for fast muscle contraction development needed for explosive force. Also, the literature points out that children best react to exercises when they are a part of playing or challenges and not formal exercises. Children motivation increases when the exercises aren't monotone and when they are done in groups through activities like polygons, games with a ball or competitive games.

In preschool and school age, exercises should be aimed at learning new movement patterns: jumping, running, throwing and catching. These patterns provide a foundation for later upgrades on specific explosivity. Games, polygons and activities that include various directions and speeds of movement, help children develop coordination and foundational strength.

Exercises that increase the speed of muscle contraction, without additional load that may cause injuries, are recommended for children of the age 9 to 12. Recommended exercises include jumps, sprints and low intensity plyometric exercises that help develop "explosive speed" that are short but require maximal effort. The literature points out the importance of gradual increase of intensity of these exercises with constant coach surveillance as to avoid injuries, especially during the period of puberty when joints and ligaments are more susceptible to injury due to accelerated growth.

Introducing low to medium intensity plyometric exercises for development of explosivity is acceptable during puberty as well as minimum load exercises (medicine balls, elastic bands). Development of muscle mass and power, which is a nus – product of puberty change, enables children to perform exercises of higher intensity that will help in explosivity development, but with coach surveillance and gradual load increase. Many authors turn the attention to sensitivity of the organism to appliance of exercises for force and power development at this age. Due to still unfinished growth and development, there is a higher possibility of injuries to occur when applying exercises with loads. Inappropriate loads have a negative effects primarily on the skeletal system because of the muscle attachment points to the bones. Bone deviation is a not so rare occurrence due to the intensity of the muscle forces on the skeletal system. Studies results indicate that the most frequent gymnast's injuries are those of the lower extremities (35,9 - 70,2%), first of all ankle injuries (Kolt and Caine, 2010). Those injuries are a result of inappropriate technique, applying maximum loads as well as exercising without professional surveillance. Greater training loads should be avoided, because in this period the gain of muscle strength is gained primarily through neuromuscular changes that happen during these periods and not by the level of testosterone and growth hormone (Kraemer and Fleck, 1993).

In that regard, the vertical jump height is based on physiological processes in muscular and nervous systems. Considering that the vertical jump is a multi – joint movement, it's performance is requires intermuscular and intramuscular coordination. That means that the jump height will be greater for those athletes that have better coordination of agonist muscles, antagonist muscles as well as synergist muscles during the exercise. Training stimulation with explosive exercises in gymnastics training, may incur insignificant changes regarding muscular hypertrophy, while changes in power dominantly occur on the account of neural mechanism adaptations (Kums et al., 2005).

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Means and methods of explosive force development in artistic gymnastics with the goal of injury prevention

Muscle explosivity of upper and lower extremities is manifested during the execution of complex rotations during acrobatic jumps on the floor and balance beam, forward as well as backwards (Mkaouer et al., 2012), and during the execution of complex vaults (Hall et al., 2014, Hall et al., 2016). Elite gymnasts execute around 1000 to 2000 jumps on average on a weekly basis, if all acrobatic exercises are considered (Marina et al., 2013). Various types of jumps with both or one leg, are used for explosivity development, while the known training methods are: high intensity load training, explosive method with load and plyometric training method (Wilson et al., 1993). The most represented method of training in artistic gymnastics is the plyometric method. This method is characterized by re – contraction regime of muscle contraction, which means that the muscles elongate for a brief amount of time before it contracts. Plyometric method is primarily used with the aim of improving the maximum power output as well as the ability to jump (Marković, 2007). Certain authors (Fatourous et al., 2000, Diallo et al., 2001) state that by using the plyometric training, it is possible to simultaneously influence the improvement of maximal muscle strength and jumping ability. Bartosiewicz (1985) and Aragon-Vargas (1997) have already proven that on the development of these abilities can not be influenced in the same way, with the explanation that for reaching the maximum strength values, exercises need to be executed as fast as possible while in regular jump development training it is not a necessary condition, rather the time of execution is individual choice of the athlete (Makaruk i Sacewicz, 2010). Bishop et. al (2009) came to the results that show that plyometric training method has positive effects on power development in adolescents. Plyometric exercises for gymnasts are mostly present in the form of lower extremities explosivity development, that is quick "impacts" and hops with the upper extremities. Gymnasts should be trained to be able to develop force as high as possible for the least amount of time, because of the short time span during acrobatic jumps. Series of acrobatic jumps last as short as 150ms (or less). Therefore, jump exection success rate is closely correlated with rate of force development, especially in the first 40 ms (De Ruiter et al., 2006).

Great importance is given to plyometric method of drop jumps for improving explosivity in gymnastics training. Gymnasts have series of acrobatic elements that include jump – offs as soon as they land as a requirement in their floor and balance beam routines. Presence of re – contraction regime of muscle contraction can be seen in those situations, therefore, drop jumps are justified and necessary in gymnastics training. These jumps are preformed from various heights and dimension areas. Marina et. al (2012), suggest that drop jumps, as a part of plyometric trainings, should be performed from heights of 40 to 60 cm, even though elite gymnasts, of both sexes, have shown the largest improvement when they did these jumps from the height of 80 cm. They state that the suggested height is more accommodated to the majority of gymnasts. It is suggested that the height should be raised to the level where the manifested power is increased but the time of contact and a following jump stays the same.

It is necessary to be extra precocious when giving plyometric exercises to younger population in terms of span and intensity (Johnson et al., 2011). These authors suggest a span of two to three times a week during a period of 8 to 10 weeks, with the starting load of 90 to 100 jumps. It is suggested that the choice of these jumps be as various as possible. It was shown that female gymnasts that train two times a day, up to 30 hours a week, including 2 to 3 high intensity trainings lead to better results in general (Marina et al., 2014). Authors state that, even in pre – puberty growth period, combining high intensity load trainings with and high intensity plyometric trainings is especially efficient due to already achieved state of training, but it needs to be done in strictly controlled conditions. Also, it is thought that with constant repetition of sole gymnastic exercises, the optimal level of force and power that is required in artistic gymnastics, can not be achieved. Risk of potential injuries will diminish if the training is done under medical surveillance and if the athletes receive regular and adequate physiotherapeutic treatments.

Hall et. al (2016) have determined a positive effect of an additional plyometric training, during the period of six weeks, on the vault performance for younger female gymnasts.

Suchomel et. al (2016), have conducted a study on a 21 junior gymnasts, and examined the differences of three types of jumps: squat jump (SJ), countermovement jump (CMJ), and drop jump (DJ), between upper and lower extremities. Results indicate to significant differences in all variables between upper and lower extremities. Differences were determined across all variables in regards to the jump type as well as a significant effect between the interaction of the extremity and jump type. Gymnasts showed better results for CMJ than SJ jumps, while the DJ jump was significantly weaker.

Bruce – Low and Dave Smith (2007) state that explosive exercises are followed by greater risk of injury. They state that it is more efficient to apply training with loads than some training with explosive exercises for explosivity development.

Marina et. al (2013) have compared plyometric performance of elite gymnasts of both sexes, with same control groups, compatible by age and sex. Authors have determined significant differences with gymnasts on one side and untrained control group on the other, benefiting greater differences in female groups, trained and untrained, than it was for male groups. Elite gymnasts have executed CMJ jump significantly better than the untrained group. When vertical jump was normalized by body mass, the differences between the groups have increased even more, especially for men ($p<0.001$). Kums et al. (2005) have gained similar results for a vertical jump between young rhythmic gymnasts and untrained girls.

Frequency of Injuries in Artistic Gymnastics

During gymnastic acrobatics, gymnasts' bodies are frequently exposed to extreme loads that stress various parts simultaneously. The combination of high physical strain, strict scoring demands for routines, and psychological pressure inherent to this sport predisposes gymnasts to injuries. The location and type of injury depend on multiple factors—most prominently age, sex, competitive level, specific event, and whether the activity occurs in a competitive or training environment. Studies consistently find that competitive athletes are injured more often than recreational participants.

Research has shown a sex-based distinction: male gymnasts are more prone to upper-extremity injuries, whereas female gymnasts are more susceptible to lower – extremity injuries (Campbell et al., 2019). An analysis of injuries over three Olympic cycles demonstrated that the most common injuries were to the lower extremities (63%), followed by the trunk (23%) and upper extremities (14%). Regarding injury types, sprains were most common (35%), followed by tendinopathies, arthritis, and impingement syndromes (17%), contusions (10%), and fractures (7%) (Thomas, 2019). In addition to having more recorded acute injuries, female gymnasts also exhibit more chronic lower-extremity injuries than male gymnasts, a

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difference partly explained by the different apparatus and events in women's and men's gymnastics. In women's gymnastics, lower extremity exercises dominate on three of the four apparatus, whereas in men's gymnastics, they occur on two of six. A decade-long injury analysis in U.S. collegiate gymnastics NCAA (National Collegiate Athletic Association) from 2001 to 2011 found that for female gymnasts, the most common lower-extremity injuries were to the ankle and foot (39% of all injuries), while male gymnasts most frequently suffered wrist and hand injuries (24%). Moreover, injuries among female gymnasts were more frequent (8.78 per 1,000 male gymnasts versus 9.37 per 1,000 female gymnasts) and more severe, often necessitating surgery (24.4% of female injuries required surgery, compared with 9.2% among male injuries) (Westermann, 2015). To better understand the rate of ankle and foot injuries in sports, Hunt and colleagues analyzed 1,076 elite athletes across 37 NCAA Division I sports over two years. Out of 3,861 recorded injuries, 1,035 (27%) were foot and ankle injuries. The study identified women's gymnastics as one of the sports with the highest overall rate of ankle and foot injuries and the greatest number of missed playing days due to recovery. The most common injuries in this category were ligament injuries, tendinopathies, fasciopathies (such as plantar fasciitis), and bone injuries of the ankle. Notably, injuries to the ankle joint and Achilles tendon were most prone to recurrence.

Ankle sprains are very common injuries among gymnasts. They were the most commonly reported injuries among female gymnasts who took part in U.S. championships from 2002 to 2004, as well as at the Olympic Games in 2008, 2012 and 2016 (Edouard et al., 2018.) Research has shown that ankle sprains can affect gymnasts for up to three years after the initial injury. These sprains are often caused by trauma, such as contact with a static object like the apparatus or floor. Mechanisms of injury include inversion or eversion of the ankle during a poor landing, stepping wrongly off the mat, or landing with the foot caught in a seam between mats. In particular, insufficient rotation during an acrobatic element can lead to a landing in which large forces hit the ankle at a sharp angle to the floor and/or in a hyper-dorsiflexed position. These impact positions force the ligaments to stretch beyond their anatomical limits, which can cause tearing, either acutely or through repeated stress. Because ankle sprains can affect gymnasts for up to three years after the injury, treatment should include preventive strategies in addition to treating the current injury. The extent of immobilization and physical therapy will depend on the severity of the injury, but early mobilization is encouraged. Athletes with an ankle sprain may also benefit from wearing orthopedic supports during training and competition to reduce the rate of re-injury while rehabilitating the ankle and restoring it to its original condition (Katz et al., 2019).

The knee joint is also frequently injured among female gymnasts. In one study that followed six years of competitions in senior categories at the national level in France, 43 gymnasts recorded 285 injuries—an average of 2.6 injuries per gymnast per season. The knee was the most frequently injured joint (16%), followed by the elbow (12%) and the ankle (12%).

Although the ankle and knee are the most frequently injured joints among female gymnasts, the location and frequency of injuries vary depending on age and sex. It is important to consider how the specific physical demands of gymnastics contribute to the frequent injuries seen in gymnasts. Almost every discipline requires both take-off and landing, which exposes the tibiotalar and talonavicular joints to high loads. The forces to which these joints and the entire foot are exposed during take-off and landing in acrobatic elements range from four to eleven times the gymnast's body weight. Genetically, gymnasts have different thresholds for stress and muscle strain; however, physical stress and strain can often exceed the biomechanical limits of body structures and negatively affect muscle tissue. The muscular forces of the upper extremities can be one and a half times body weight on vault, almost four times on the high bar, over nine times on rings, twice on the pommel horse and about three times body weight on the uneven bars (Caine et al., 2013). It is assumed that this amount of mechanical stress on the joints contributes to injuries being more severe and more frequent.

In addition to the anatomical stress present during take-off and landing, the mechanics of the sport itself predispose gymnasts to injury. Routines on all apparatus except the floor end with a dismount. Dismounts are usually performed with rotation around the transverse and longitudinal axes, where gymnasts cannot always control whether the landing will be fully cushioned. In competition there is additional psychological pressure to perform the dismount without error so that gymnasts do not receive deductions for execution; this can affect how the dismount is performed. The probability that female gymnasts will suffer a ligament injury is 3 to 9.95 times higher in competitions than in training, and the probability of a knee injury is 5.43 to 6 times higher in competitions (Katz et al., 2019).

Female gymnasts are susceptible to tearing the anterior cruciate ligament (ACL), especially during landings from rotational acrobatic jumps and vaults, and during dismounts from apparatus. This is true even when they have prepared the landing, and particularly when the landing is not well prepared. The most common situation is that upon landing, the feet are fixed to the surface while the gymnast continues the rotation of the lower extremities and trunk around the longitudinal axis. Women are more prone to ACL injuries because their ACLs are smaller and they have a smaller intercondylar notch on the femur (Hutchinson & Ireland, 1995). Treatment of ligament injuries may include a combination of activity modification, immobilization (orthopedic supports), physical therapy and/or surgery. ACL reconstruction is recommended for gymnasts who wish to return to the sport because surgery is expected to reduce the risk of further cartilage and/or meniscus injuries. Surgical treatment—replacement of the ACL with a tendon graft—is the most common and most effective method. Recovery after surgery takes between nine and twelve months to regain full competitive form.

Acute ruptures of the medial and lateral meniscus can occur in gymnastics due to landings that complete acrobatic jumps, vaults and dismounts with rotation around the longitudinal axis of the body, or because of landings with knee hyperextension. Treatment of such injuries depends on associated ligament tears or cartilage damage. The goal is to preserve as much of the meniscus as possible because of its load – absorbing properties.

Conclusion

Success in artistic gymnastics depends greatly on the development of explosive ability. This ability is particularly important in floor acrobatics, balance beam and vault. Training often emphasizes lower-limb explosiveness more than upper-limb explosiveness; however, to achieve top results in all – around competition, optimal development of explosiveness in both is necessary. Because children begin participating in this sport at an early age, explosiveness must be developed from the outset. When well and timely established, this ability becomes a springboard for building more advanced skills.

When selecting exercises and methods to develop explosiveness, the coach should take into account the level and age of the athletes with whom they work to respect individual characteristics and achieve the best possible training

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stimulus while avoiding unwanted injuries. If athletes are better prepared and closer to the top level, that training stimulus – particularly the use of explosive plyometric exercises – must be greater in both volume and intensity. The use of these exercises provides a good foundation for further complexity of gymnastic skills, provided the athlete's body is sufficiently prepared for the current work intensity. Otherwise, poor judgement often leads to injuries of the lower extremities, such as the ankle and knee.

The most complex challenge in sports practice is programming training for the youngest participants, from initial selections through advanced final selections of children who are chosen to be developed towards elite sport. The literature still does not resolve the question of applying optimal volumes and intensities of training in these categories. In women's artistic gymnastics this covers ages from about six to thirteen or fourteen years, corresponding to the categories from the first selection in the youth gymnastics league to the junior category. Conducting a study that would investigate the effectiveness of general and specific training means (exercises derived from basic gymnastics elements that express this ability) on the development of explosiveness, especially in younger age groups (6-9 years), would be highly valuable. Future research should aim to define reference values and norms for test results in explosiveness. The need for this arises from the fact that the level of development of this ability directly affects the quality of competitive routines and results. The quality of work achieved in developing explosiveness at a younger age determines the later advancement of gymnastic skills in mature athletic age. As a first step, a future study might focus on the training of coaches who worked with leading elite gymnasts when they were younger – analyzing the methods they used and then defining "promising" exercises that best stimulate the development of explosiveness. It is also necessary for future studies to define standardized, specific tests for assessing explosiveness in artistic gymnastics. For example, if young gymnasts are already performing forward somersaults – whether in easier conditions off a springboard, under real conditions on the floor, or under more difficult conditions onto an elevated surface or even into a forward roll – it would be useful to establish reference values for the quality (strength) of the take-off appropriate to that age.

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UDK 796.85.012.862

Notation analysis of the competitive activity of top european and world competitors in the disciplines of kick-boxing and savate

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Introduction

The development of martial sports is present in all its segments. In order for the athletes to respond to the high demands in the competition, top-level preparation is necessary both in technical and tactical preparation, as well as in physical and psychological preparation. By monitoring and recording various parameters in sports competition, it represents a path to successful planning of the training and competition process (Koprivica, 2013). By analyzing competitive activity, it is possible to observe both general and specific characteristics in individual martial arts (Brković, 2005; Koropanovski and Jovanović, 2007), to follow trends in the development of martial arts (Jovanović, Ćirković and Kasum, 2001; Kasum and Radović, 2008), but also to detect certain laws that are essential for the formation and shaping of competitive activities in individual martial arts (Kasum and Bačanac, 2007). Based on the analysis of a large number of researches, indicators of competitive activity are grouped into time and result indicators, representation of standard techniques and indicators of scoring techniques (Jovanović et al., 2010).

Kickboxing and savate are martial arts based on blows with a marked change in tempo and rhythm and the participation of various offensive and defensive techniques (Ćirković et al., 2010). With the development of kickboxing and savate, there is a need to research the competitive activity of fighters in different time periods. In this way, changes in the technical-tactical characteristics of the most successful representations are monitored, as well as the current trend in the monitored period. In this connection, for the purposes of this paper, an analysis of the competitive activity of the final matches of the World Kickboxing Championship (Albufeira-Portugal in 2023) and the European Savate Championship (Rugvica-Croatia in 2023) was performed. Given the differences in technical-tactical characteristics between the competitive disciplines in these two combat sports, the analysis was carried out only in the semi-contact disciplines of kick boxing (kick light) and savate (assaut).

Method

The research was conducted in the semi-contact disciplines of kickboxing (kick light) and savate (attack), on a sample of 20 competitors. A total of 10 final fights were analyzed, four in the women's category and six in the men's category. The observed fights took place at the following competitions: the World Kickboxing Championship (Albufeira-Portugal in 2023 in five fights, in the categories 60 (w), 70 (w), 63 (m), 74 kg (m), 84 kg (m)) and the European Savate Championship (Rugvica-Croatia in 2023 in five fights, in the categories 60 kg (w), 70 kg) (w), 65 kg (m), 75 kg (m), +85 kg (m)).

Data collection was performed using the notational method, i.e. methods of recording events, i.e. by analyzing recordings of final fights in the mentioned categories. Time parameters were measured using the chronometry method using a stopwatch and visual recording - counting the total number of punches performed. The stopwatch was used to measure the passive time, i.e. the duration of the fight without performing hand or foot techniques, as well as the active time, i.e. the time during which hand or foot techniques were performed. By counting, hand or foot standardized techniques were recorded in the full range of motion without analyzing the final success of the performed techniques. In addition to the notational analysis of fight records, a statistical analysis was performed for the purposes of processing the analyzed variables (descriptive statistical data processing, analysis of differences - ANOVA), logical and causal analysis for the purposes of explaining the obtained results of the examined variables.

For the purposes of the work, the following elements were analyzed:

- Total number of manual techniques (RT), expressed in quantitative values;
- Total number of foot techniques (NT), expressed in quantitative values;
- Total number of techniques (SumaT), expressed in quantitative values;
- Relative representation of techniques (RT%, NT%), expressed in percentage values
- Active and passive part of the fight (AdB, PdB) expressed in quantitative (seconds) and percentage values (%)

Results with discussion

Tables 1 and 2 show the basic descriptive indicators of the analyzed fights for the sample of women and men.

Table 1. Results of basic descriptive statistics for the sample of women.

	SAVATE women			KICK BOXING women		
	MEAN	SD	cV%	MEAN	SD	cV%
MT – Manual techniques	91	9,9	10,9	132	22,6	17,1
FT – Foot techniques	207	34,6	16,8	105	55,9	53,5
SumaT - Suma Techniques	298	44,5	15	237	78,5	33,2
MT %	30,7	1,3	4,1	57,4	9,5	16,5
FT %	69,3	1,3	1,8	42,6	9,5	22,2

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Based on the results obtained in relation to women (Table 1), it can be claimed that the average value of the sum of techniques performed during one match in savate is 298 ± 44.5, with a coefficient of variation of 15.0%. In relation to kick boxing, the average value of the sum of techniques during one match is 237 ± 78.5, with a coefficient of variation of 33.2%.

Table 2. Results of basic descriptive statistics for the sample of men.

	SAVATE women			KICK BOXING women		
	MEAN	SD	cV%	MEAN	SD	cV%
MT – Manual techniques	88	17,6	19,9	86	38,9	45
FT – Foot techniques	173	21	12,2	95	36,1	38,2
SumaT - Suma Techniques	261	20	7,7	181	75	41,4
MT %	33,8	6,4	18,9	47,3	1,6	3,3
FT %	66,2	6,4	9,7	52,7	1,6	2,9

Based on the results obtained in relation to men (Table 2), it can be claimed that the average value of the sum of techniques performed during one match in savate is 261 ± 20.0, with a coefficient of variation of 7.7%. In relation to kick boxing, the average value of the sum of techniques during one match is 181 ± 75.0, with a coefficient of variation of 41.4%.

Active time was collected a total of 30 times, in each of the three rounds for a total of 10 fights. The minimum is 24 seconds, and the maximum is 80 seconds of the 2 minutes each round lasts. The arithmetic mean is 49.17 seconds with a measurement error of 2.794 seconds. The standard deviation is equal to 15,304 seconds.

The variances within women's and men's fights were analyzed as a function of sports disciplines, during which leg, hand, and all techniques were compared in total. Based on the obtained results (Table 3), it was determined that the differences between women in savate and kickboxing when analyzing all techniques are not statistically significant.

Table 3. ANOVA table of all techniques in women

	Sum of Squares	**df**	**Between groups**	**F**	**p**
Between groups	24,364	1	24,364	,138	,711
Within groups	17695,479	100	176,955		
TOTAL	17719,843	101			

Table 4 shows the results of the analysis of manual techniques between women in savate and kickboxing, where it was determined that there are no statistically significant differences for the observed variable.

Table 4. ANOVA results for the manual technique variable in women

	Sum of Squares	**df**	**Average of Squares**	**F**	**P**
Between groups	186,778	1	186,778	,784	,382
Within groups	8097,778	34	238,170		
TOTAL	8284,556	35			

Table 5 shows the results of the analysis of foot techniques between women in savate and kickboxing, where it was determined that there are statistically significant differences for the observed variable.

Table 5. ANOVA results for the leg technique variable in women

	Sum of Squares	**df**	**Average of Squares**	**F**	**P**
Between groups	582,817	1	582,817	4,137	,047
Within groups	8171,767	58	140,893		
TOTAL	8754,583	59			

Table 6 shows the results of the analysis of all techniques between men in savate and kickboxing, where it was determined that there are no statistically significant differences for the observed variable.

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Table 6. ANOVA results for the all-techniques variable in men

	Sum of Squares	df	Average of Squares	F	P
Between groups	172,125	1	172,125	2,000	,159
Within groups	12995,875	151	86,065		
TOTAL	13168,000	152			

Table 7 shows the results of the analysis of hand techniques between men in savate and kickboxing, where it was determined that there are no statistically significant differences for the observed variable.

Table 7. ANOVA for the manual technique variable in men

	Sum of Squares	df	Average of Squares	F	P
Between groups	,667	1	,667	,010	,922
Within groups	3618,593	52	69,588		
TOTAL	3619,259	53			

Table 8 shows the results of the analysis of foot techniques between men in savate and kickboxing, where it was determined that there are statistically significant differences for the observed variable.

Table 8. ANOVA for the manual technique variable in men

	Sum of Squares	df	Average of Squares	F	P
Between groups	567,511	1	567,511	5,967	,017
Within groups	8369,644	88	95,110		
TOTAL	8937,156	89			

Table 9 shows the results of the analysis of active time between women in savate and kickboxing, where it was determined that there are no statistically significant differences for the observed variable.

Table 9. ANOVA results for the variable active time in women in savate and kickboxing

	Sum of Squares	df	Average of Squares	F	P
Between groups	396,750	1	396,750	1,970	,191
Within groups	2013,500	10	201,350		
TOTAL	2410,250	11			

Table 10 shows the differences in the active time of men in savate and kickboxing, calculated using the Mann-Whitney U non-parametric test, because the condition of homogeneity of the variance of these two sports is not met. Based on the test used, statistically significant differences were obtained.

Table 11 shows the differences between men and women in savate related to the variable of stroke frequency. Based on the obtained results, no statistical significance was determined for the observed variable.

Table 10. Results of the Mann Whitney U-test for the variable active time of men in savate and kickboxing frequency

	frekvencija
Man-Whitney U	2,000
Wilkokson W	47,000
Z	-3,407
p	,001

Table 11. ANOVA results for the stroke frequency variable between women and men in savate

	Sum of Squares	df	Average of Squares	F	P
Between groups	44,100	1	44,100	,456	,501
Within groups	12853,500	133	96,643		
TOTAL	12897,600	134			

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Table 12 shows the differences between men and women in kickboxing related to the variable of kick frequency. Based on the obtained results, no statistical significance was determined for the observed variable.

Table 12. ANOVA results for the kick frequency variable between women and men in kickboxing

	Sum of Squares	df	Average of Squares	F	P
Between groups	154,012	1	154,012	1,019	,315
Within groups	17837,854	118	151,168		
TOTAL	17991,867	119			

Table 13 shows the differences between men and women in Savate related to the variable active time. Based on the obtained results, no statistical significance was determined for the observed variable.

Table 13. ANOVA results for the variable active time between women and men in savate

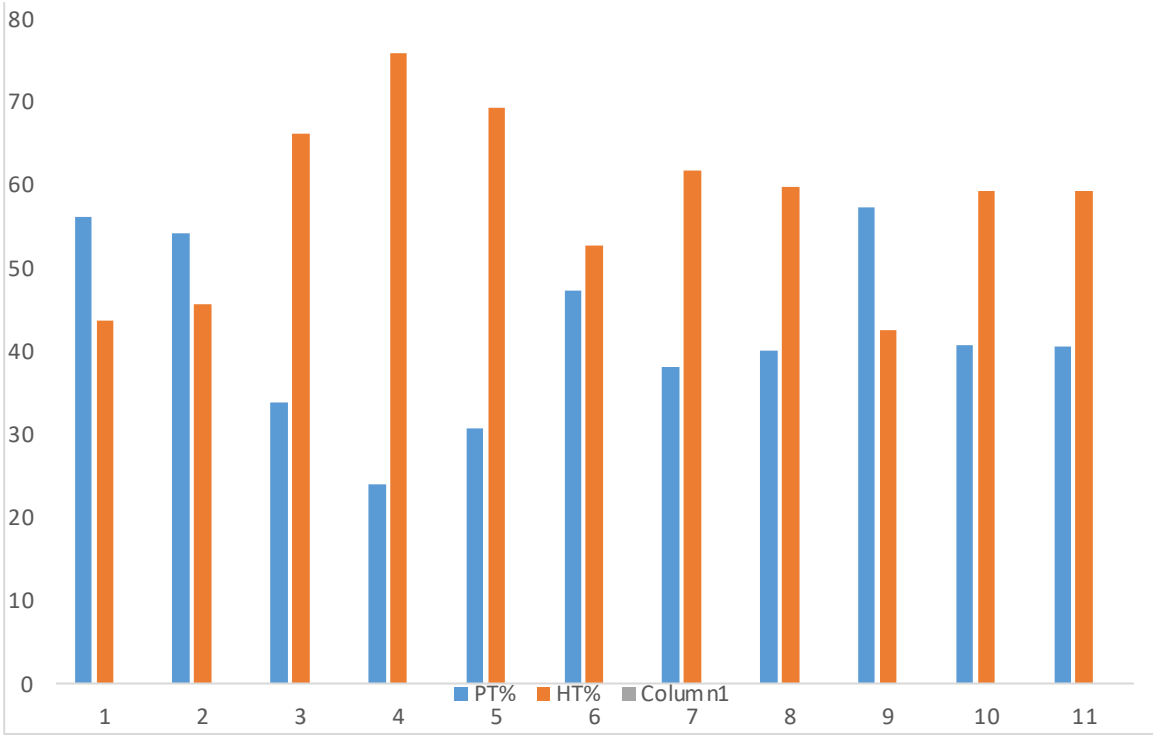
	Sum of Squares	df	Average of Squares	F	P
Between groups	84,100	1	84,100	,529	,480
Within groups	2065,500	13	158,885		
TOTAL	2149,600	14			

Table 14 shows the differences between men and women in kickboxing related to the variable of kick frequency. Based on the obtained results, no statistical significance was determined for the observed variable.

Table 14. ANOVA results for the variable active time between women and men in kickboxing

	Sum of Squares	df	Average of Squares	F	P
Between groups	683,378	1	683,378	4,866	,046
Within groups	1825,556	13	140,427		
TOTAL	2508,933	14			

Graph 1. Percentage ratio of hand and foot techniques at international competitions



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Graph 1 shows the percentage representation of hand techniques (blue color) and foot techniques (red color) in women and men in the two disciplines of kickboxing (kick light and low kick) and savate (aceo and combat) in the following competitions:

1. Sport chord combat games-savate discipline combat 2013 (M)
2. European Championship combat-savate discipline combat 2022 (M)
3. European championship aso-savate discipline aso 2023 (M)
4. Sport chord combat games-savate discipline aso 2013 (W)
5. European Championship aso-savate discipline aso 2023 (Women)
6. World Championship kick light-kick boxing discipline kick light 2023 (M)
7. European championship low kick-kick boxing discipline low kick 2014 (M)
8. European cup low kick-kick boxing discipline low kick 2014/2015 (M)
9. World Championship kick light-kick boxing discipline kick light 2023 (W)
10. European low kick championship 2014-kick boxing discipline low kick (W)
11. European low kick cup 2014/2015-kick boxing discipline low kick (W)

Looking at the results of research from this paper and previous research on graph 1, a greater representation of foot techniques can be observed in the semi-contact discipline of savate (aso) compared to the other observed disciplines in both sports. Accordingly, the percentage representation of manual techniques in the semi-contact discipline of savate is lower compared to the observed disciplines in both sports. The results of research in the previous period in the full-contact discipline of savate (combat) indicate a higher prevalence of hand techniques compared to foot techniques.

The results shown in graph 1 indicate a higher prevalence of foot techniques compared to hand techniques for both disciplines in kickboxing (Piščević, Gavrilović and Dopsaj, 2015). The difference in favor of the share of foot techniques, in both observed kickboxing disciplines, in relation to hand techniques, is not pronounced as it is the case in the savatea-assaut discipline, but it was realized. In contrast to other results related to kickboxing disciplines (Graph 1), female competitors in the kicklight discipline use hand techniques in comparison to foot techniques in a higher percentage.

Conclusion

This paper presents the results of selected segments of the competitive activity of top competitors in the semi-contact disciplines of kickboxing (kick light) and savate (assaut) at the World Kickboxing Championship (Albufeira-Portugal in 2023) and the European Savate Championship (Rugvica-Croatia in 2023).

Based on the results obtained in this research, it was determined that there are no statistically significant differences between women in savate (assaut) and kickboxing (kick light) when analyzing manual techniques, as well as all monitored techniques in total. However, differences were found during the analysis of foot techniques between women in the disciplines of kickboxing (kick light) and savate (assaut). The analysis of the results for men showed that there is no statistical significance when it comes to the representation of hand techniques, as well as all techniques in total, while differences were found during the analysis of foot techniques. Also, the results of the research found no differences in the active time between men and women in savate, while a difference was found in the active time between the sexes in kickboxing.

Observing the descriptive results of the observed sample, on the graph of the percentage ratio of hand and foot techniques, competitors of both genders in the semi-contact discipline of savate have a higher representation of foot techniques compared to competitors of both genders in the semi-contact discipline of kickboxing. In contrast to the legs, hand techniques are more common among subjects of both sexes in kickboxing compared to subjects in savate.

Comparing the obtained research results with previous research on the elements of technique in the full-contact disciplines of savate and kickboxing, smaller differences in the representation of technical elements between the semi-contact discipline of kickboxing (kick light) and the full-contact disciplines of savate (combat) and kickboxing (low kick) are noticeable, in relation to the differences in the representation of technical elements of semi-contact savate (assaut) and full-contact disciplines of savate (combat) and kickboxing (low kik). Respecting the results of the research, in the potential transfer of competitors from one sport to another, in both directions and to different disciplines, caution and adequate preparation are recommended.

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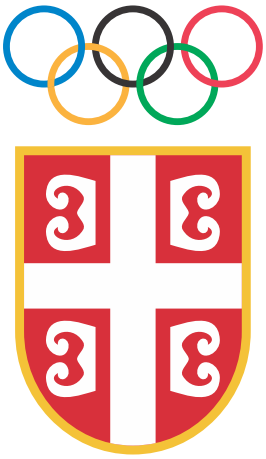

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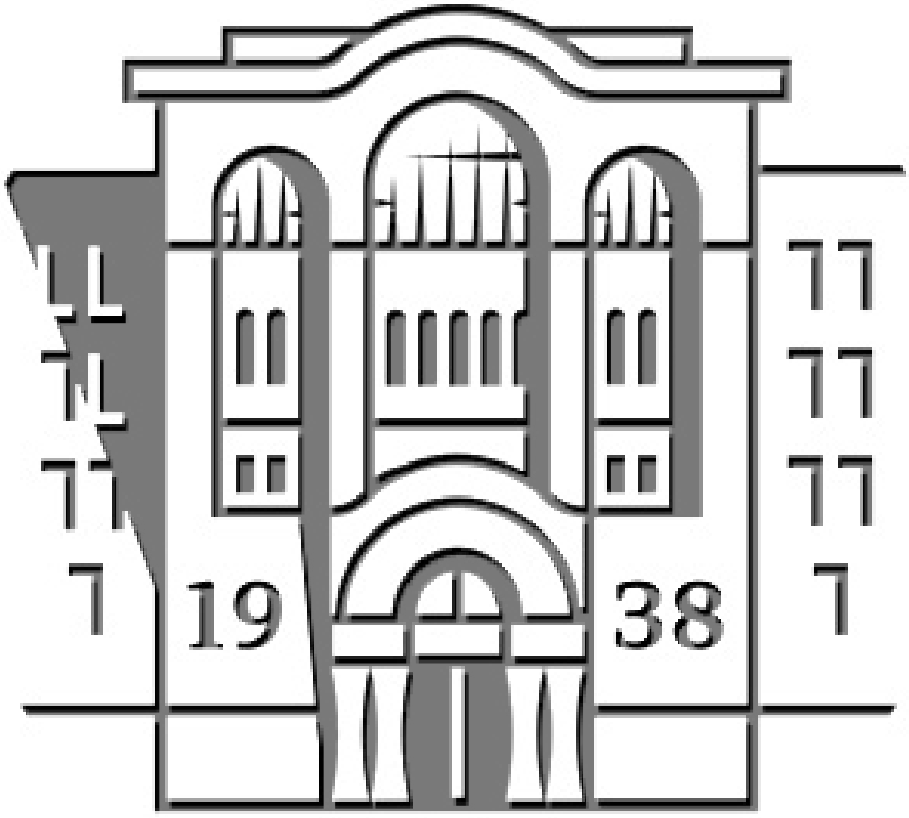
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