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CONTEMPORARY KINESIOLOGY: ACTIVE LIFESTYLE

7th International Scientific Conference

Split, 18th – 20th of July

PROCEEDINGS BOOK

7th International Scientific Conference "Contemporary Kinesiology: Active Lifestyle"

PROCEEDINGS

EDITORS:

Goran Kuvačić
Toni Modrić
Šime Veršić

Split, July 18–20, 2024.

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INVITED LECTURES

A New Opportunities for Physical Education in Whole Day Model of School Work: Where are We Now and What Are We Striving for?

Josip Burušić

Institute of Social Sciences Ivo Pilar, Croatia

ABSTRACT

Republic of Croatia started with important structural changes in compulsory education, currently introducting and piloting whole-day school model of primary school (2022-2027). A new educational framework and program structure provides a new opportunities, harmonizing education in Croatia with the best rules models of education in regards to educational quality, effectivness and equity. National implementation of Whole-Day School is expected to lead to better school outcomes of all students, with reduced social differences and better conditions for teachers' work. Whole-Day School aims to transform current schools into modern and dynamic primary schools, with better public services for all parents, as well as improved well-being and quality of life for students, teachers and parents. With a special emphasis on the educational field of physical education, presentation will highlight educational and methodical approaches implemented in the whole-day school, and discuss an opportunities available to teachers, schools, faculties of kinesiology education, and all stakholders involved in teaching and other educational forms of work inside and/or outside a primary school.

24-Hour Movement Behaviour Adherence in Early Childhood

Andrew Dalziell

Department of Psychological Sciences and Health, University of Strathclyde, UK

ABSTRACT

This presentation will discuss the barriers and facilitators that families with young children experience in adhering to the 24-Hour Movement behaviours guidelines as outlined by World Health Organisation (WHO). This cross-sectional study used a mixed-methods approach which included: 1) an online questionnaire for parents, 2) objectively measured physical activity (PA), sedentary behaviour and sleep, 3) online focus groups with parents. Conclusions are presented along with final remarks from the presenter around how public messaging can both aid and hinder guidelines being followed.

Active Aging and Quality of Life

Darinka Korovljev

Applied Bioenergetics Lab, Faculty of Sport and Physical Education, University of Novi Sad, Serbia

ABSTRACT

Active Aging emphasizes the universal nature of aging and the importance of context in achieving longevity, quality of life, and overall well-being for older adults. This approach recognizes the significance of health, lifelong learning, independence, participation in physical activity, and quality of life in aging. The concept of active aging, introduced by the World Health Organization, promotes ongoing engagement in various aspects of life emphasizing the necessity of physical activity. Physical activity is a crucial component of active aging, contributing to improved physical health, mental well-being, and overall quality of life among older adults. In active aging frameworks, physical activity plays a vital role in enhancing the quality of life by promoting physical health, social engagement, and emotional well-being. Older adults who engage in regular physical activity experience benefits such as improved mobility, reduced risk of chronic diseases, enhanced mood, and increased social connections**.** Physical activity is integral to the active aging approach, supporting autonomy, independence, and overall well-being for older adults. By incorporating physical activity into daily routines, individuals can optimize their health, maintain functional independence, and enjoy a higher quality of life as they age.

The Model of Whole Day School: A Fundamental Change of the System Stressing PE or Only A Marginal Alternative

Nevenka Maras

Faculty of Teacher Education, University of Zagreb, Croatia

ABSTRACT

For almost three decades, the Croatian educational system has been the target of criticism. Some of the key shortcomings are visible at all levels: an often insufficiently motivating and "suffocating" institutional climate, the orientation of the system to the program instead of the student, and insufficient autonomy given to the teacher as an expert. There were certain initiatives for change, however, the reforms that were implemented were mostly unsuccessful because they did not act holistically, taking into account all the mentioned elements of the education system. The current experimental model of the Whole Day School introduces changes at different levels. A particularly challenging area for an innovative approach to learning and teaching is the area of physical and health culture, due to its primary focus on skills development. Considering the current social challenges, greater focus should be placed on knowledge and attitudes, that is, on the development of physical literacy, both among students and teachers. The aim of this paper is to offer an answer to the question whether the Whole Day School model can lead to a change in the teaching and learning paradigm and whether knowledge will finally be treated as a means to achieve important goals or only as a goal?

Interdisciplinary Best Practices in Adapted Kinesiology: Strategies and Future Research

Lidija Petrinović

Faculty of Kinesiology, University of Zagreb, Croatia

ABSTRACT

The goal of Adapted Kinesiology is to make physical activity accessible and beneficial for individuals with disabilities. This field aims to encourage those with physical, sensory, and intellectual impairments to become more physically active. The primary objectives are to determine the specific needs of people with various impairments and identify the types of exercises and sports that will best enhance their physical functioning. Adapted Physical Activity (APA) is considered a cross-disciplinary body of knowledge aimed at identifying and solving psychomotor problems throughout the lifespan. It promotes an attitude of acceptance of individual differences, advocates for access to active lifestyles and sports, and encourages innovation and cooperative service delivery programs and empowerment systems. The European Association on Research into APA (EARAPA) defines APA as encompassing movement experiences and applications tailored to individual needs. An interdisciplinary approach is essential if the goal of Adapted Kinesiology is to ensure that individuals enjoy a combination of exercise and sporting activities within a supportive environment. This approach fosters a comprehensive understanding and application of practices that support the physical and psychological well-being of individuals with disabilities.

The Importance of Physical Activity in Preschool and School Age

Ranko Rajović

Faculty of Education, University of Primorska, Slovenia

ABSTRACT

Physical activity plays an important role in the development of children in preschool and school age. This phase of life is crucial for forming healthy habits and shaping the physical and mental health of the child. Regular physical activity during these years brings numerous benefits that extend throughout the child's lifetime. Children in preschool and school age have a natural inclination to move and explore the world around them. Therefore, it is important to encourage them to engage in various forms of physical activity to develop motor skills, coordination, and muscle strength. In addition, regular physical activity helps maintain a healthy body weight, strengthens the immune system, and reduces the risk of developing various diseases such as obesity, diabetes, and heart disease. Physical activity also has a positive impact on the mental health of children. Children who exercise regularly have better concentration and cognitive abilities, which can help them in school and everyday activities. A lack of aerobic activities can negatively affect the basal ganglia, which are important in the development of cognitive abilities. Activities such as soccer, basketball, swimming, or athletics can help children develop teamwork, discipline, and collaboration skills. Parents, caregivers, and teachers play a crucial role in promoting physical activity in children. It is important to ensure that children have daily opportunities for outdoor play, sports activities, or physical education at school.

School-Based Physical Activity Policies: Where Are We and Where To Go From Here?

Maroje Sorić

Faculty of Kinesiology, University of Zagreb, Croatia

ABSTRACT

Healthy lifestyle is a complex phenomena that needs to be promoted on a population-level. Owing to the universal reach, schools are an ideal setting for introducing lifestyle change Because academic activities are mostly sedentary, ample opportunities for PA should be provided to introduce the well-known benefits of PA for health and academic performance. This talk will provide a collective summary of dr. Sorić's recent research on school-based physical activity policies and discuss future directions in this policy area.

It's (Not) Fair: Transgender Athletes and Female Categories in Sports

Matija Mato Škerbić

Faculty of Croatian Studies, University of Zagreb, Croatia

ABSTRACT

The ongoing debate on the inclusion of transgender athletes in female categories in sports is considered through the 'internal/external values of sport' framework. In the first part, three dominant positions developed in the literature on the issue are presented: pro-inclusion (Karkazis, Burke, Pielke), pro-exclusion (Pike, Imbrišević, Howe), and the 'third way' (Lopez Frias, Torres). In the second part, the 'intrinsic/extrinsic values of the sport' model is introduced, demonstrating that sports philosophers and (bio)ethicists generally agree that intrinsic values are essential for sport and that (broad) internalism is the default normative theory for sports. It is shown that there is a deep misunderstanding and a mixing of the importance and roles of social and sports values, both in society at large and specifically within sports society. The claim is made that external values such as inclusion or tolerance are social values in sports, while internal ones are intrinsic or essential sport-specific values. The conclusion is that social values can be transferred and applied to sports, but only conditionally, with the condition being the respect for sports specifics: laws, ethos, and values.

ABSTRACTS

Relationship Between Jump Performance, Speed and Change of Direction Speed in Youth Female Handball Players

*Mila Vukadinović Jurišić[1], Anja Obradović[1], Bojan Rašković[1], Jelena Obradović[1]

[1]Faculty of Sport and Physical Education, University of Novi Sad, Serbia

*Corresponding author

ABSTRACT

Handball, a sport that demands high physicality and intensity, is a complex game with a multitude of anaerobic actions. These actions include change of direction speed (CODS) with and without the ball, jumping, and short sprints. The motor superiority of female handball players is based on their CODS, jumping performance, and speed. The aim of study was to analyzed relationship between jump performance, speed, and CODS in youth female handball players. Forty-five youth handball female players (age: 16.13 ± 0.89 years: body height 166.86 ± 5.68 cm; body weight 63.85 ± 8 .80 years; training experience: 6.18 ± 1.33 years) participated in the study. The players were tested for 10 m, 20 m, and 30 m sprint, Squat jump (SJ), Countermovement jump (CMJ), and T-test. The Pearson correlation coefficient was used for statistical analyses. The Pearson coefficient correlation shows a moderate to large significant relationship between all running tests and CODS (Sprint 0 - 10 m $r = 0.49$, $p = 0.001$; Sprint 0 - 20 m $r = 0.76$, $p = 0.000$; Sprint 0 - 30 m $r = 0.69$, $p = 0.000$). Additionally, a large coefficient correlation ($p = 0.000$) was noticed between two running tests (Sprint 0 - 20 m and Sprint 0 - 30 m) and jump performance (r values range from - 0.64 to - 0.72). The results suggest a large coefficient correlation between jump performance and CODS (SJ $r = - 0.64$, $p = 0.000$; CMJ $r = - 0.62$, $p = 0.000$). The findings suggest a correlation between running at 10 m, 20 m, and 30 m, jump performances, and CODS in young female handball players. In handball, speed is manifested in various motor activities that are performed fast, explosive, typically lasting between 2-6 s. To perform these activities, glycolytic units are activated, which implies the short-term energy system and central nervous system. Also, biomechanical demands for running, jumping, and CODS are similar, where individual capacity produces substantial amounts of relative force over short periods. This study highlights the correlation between three crucial motor performances (jumping, running, and CODS) for young female handball players. Consequently, the proper development of jump and running abilities by using specific training exercises has promise for improving the CODS in youth female handball players.

Keywords: Team sport, Motor performances, Agility

Effect of Corrective Multisport Training on Spine Posture in Healthy Children: A Randomized Controlled Trial

*Dragan Marinkovic[1], Draženka Mačak[1], Danilo Radanović[1], Bojan Rašković[1], Dejan Madić[1], Aleksa Madić[1]

[1]Faculty of Sport and Physical Education, University of Novi Sad, Serbia

*Corresponding author

ABSTRACT

Postural disorders in children are a prevalent issue, with studies revealing various aspects of this concern. Furthermore, postural disorders can contribute to musculoskeletal imbalances and pain, affecting a child's ability to perform daily activities. This study aimed to evaluate the effects of corrective multisport training on spine posture healthy preschool and school children. 290 participants (Age: 6.83±1.85 years; Body height: 122.14±11.73 cm; Body weight 23.21±5.18 kg) were included and randomly assigned to experimental group (n=147) and control group (n=143). We used a laboratory-calibrated Contemplas 3D photometric system and a specific "3D Posture Compact" protocol to evaluate Cervical, Thoracic and Lumbar displacement in the frontal plane. The structured multisport corrective exercise program spanned nine months indoors in a well-equipped gym twice weekly for about 60 minutes each session. Meanwhile, the control group participated in regular activities at kindergartens or schools. General linear models (2x2 mixed-design analyses) estimated whether mean changes [95% CIs] in measure from initial to final testing. The experimental group exhibited a significant decrease in the cervical spine measurement (Mean = -0.089 cm, 95% CI [-0.12, -0.06]) compared to the control group (Mean = -0.013 cm, 95% CI [-0.05, 0.02]), with the ANOVA indicating a significant effect ($F = 10.81$, $p = 0.001$, partial $\eta^2 = 0.036$). Moreover, the experimental group demonstrated a significant decrease in the thoracic spine measurement (Mean = -0.098 cm, 95% CI [-0.13, -0.06]) compared to the control group (Mean = 0.024 cm, 95% CI [-0.01, 0.06]), with the ANOVA indicating a significant effect ($F = 21.87$, $p = 0.000$, partial $\eta^2 = 0.071$). Lastly, the experimental group showed a significant decrease in the lumbar spine measurement (Mean = -0.035 cm, 95% CI [-0.05, -0.01]) compared to the control group (Mean = 0.033 cm, 95% CI [0.01, 0.05]), with the ANOVA indicating a significant effect ($F = 10.25$, $p = 0.002$, partial $\eta^2 = 0.034$). The findings suggest that such interventions can lead to positive changes in spine alignment, particularly in the cervical, thoracic, and lumbar regions. Multisport training involves various activities and movements and may be particularly effective in promoting overall musculoskeletal development and alignment. This study highlights the potential benefits of corrective multisport training in improving spine posture in preschool and school children.

Keywords: Exercise, 3D analysis, Postural deformities, Musculoskeletal imbalances

Age-Based Anthropometric Differences in Young Football Players

Stefan Maričić[1], Vladimir Šipka[1], Damjan Jakšić[1], Miloš Kojić[1], *Lidija Marković[1]

[1]Faculty of Sport and Physical Education, University of Novi Sad, Serbia

*Corresponding author

ABSTRACT

Football involves intermittent activity with varying intensities and incomplete recoveries, making it crucial to maintain a high level of physical fitness and optimal body mass for performance in different ballistic efforts. High-level athletes are distinguished by their unique morphological and body composition characteristics. The aim of this study was to examine how anthropometric characteristics and body mass index (BMI) differ from the different age categories of young football players. The study included football players from the youth category of the Vojvodina football club in Novi Sad. The sample comprised 147 young players (average age: 16.12 ± 1.29 years). They were divided into four age categories: Under 19 (28.6%), Under 17 (12.9%), Under 16 (36.1%), and Under 15 (22.4%). The anthropometric characteristics were assessed using the following measurements, according to recommended guidelines: body height, body mass, BMI, various skinfolds (triceps, subscapular, supraspinal, lower leg), elbow and knee diameters, and calf and upper arm muscle circumferences. Significant differences were observed when assessing the various age categories and their corresponding anthropometric measurements. Specifically, there were notable differences in body height ($p=0.000$), body mass ($p=0.000$), BMI ($p=0.000$), subscapular skinfolds ($p=0.001$), as well as calf ($p=0.000$) and upper arm muscle circumferences ($p=0.000$). Measures of body height, body mass, BMI, calf, and upper arm muscle circumference increased with age. Additionally, significant differences in subscapular skinfolds were observed between players under 15 and those under 17 ($p=0.030$) and under 19 ($p=0.001$), as well as between players under 16 and those under 19 ($p=0.001$). This study revealed significant age-related differences in the anthropometric characteristics of young football players. Measures such as body height, body mass, BMI, and muscle circumferences increased with age, while significant differences in subscapular skinfolds were observed between various age groups. These findings highlight the importance of age-specific training and nutrition programs to optimize player development and performance. This significant age-related differences in the anthropometric characteristics of young football players were identified as age progressed. These findings are important for coaches in the context of physical fitness assessment and talent identification.

Keywords: anthropometric measures, football players, body composition, age

Isokinetic and Isotonic Hamstrings Exercise After Knee Surgery: A Retrospective Study

*Bojan Rašković[1], Siniša Nikolić[2,3], Mila Vukadinović Jurišić[1], Dejan Javorac[1], Vanja Dimitrijević[1], Borislav Obradović[1], Patrik Drid[1]

[1]Faculty of Sport and Physical Education, University of Novi Sad, Serbia; [2]Institute of Physical Medicine, Rehabilitation and Orthopedic Surgery "Dr Miroslav Zotović", Banja Luka, Bosnia and Herzegovina; [3]Faculty of Medicine, Department of Physiotherapy, University of Banja Luka, Banja Luka, Bosnia and Herzegovina

*Corresponding author

ABSTRACT

Anterior cruciate ligament (ACL) ruptures are among the most common injuries in sports today. Strength deficits after ACL injury and reconstruction are prevalent and impact the balance between the quadriceps and hamstring muscle groups. Muscle weakness can alter the hamstring-quadriceps ratio (H/Q ratio), leading to dynamic instability and an increased risk of further injury. This research aimed to compare the effects of isokinetic and isotonic exercises on the restoration of hamstring mobility after knee surgery. Concentric/concentric (con/con) isokinetic tests were analyzed for hamstring contractions at an angular velocity of 60°/s. The sample of 180 respondents was divided into two subsamples based on the type of rehabilitation treatment received. Group A (isokinetic) consisted of 90 male subjects with an average age of 28.54 ± 4.44 years, all of whom underwent surgery using a hamstring graft and followed a rehabilitation protocol based on isokinetic exercises for the hamstrings. Group B (isotonic) consisted of 90 male subjects with an average age of 27.93 ± 4.27 years, who followed a classic isotonic protocol to strengthen the hamstrings. Before starting rehabilitation, an initial isokinetic con/con test was performed at an angular speed of 60°/s for all subjects. Control isokinetic tests were conducted after three and six weeks of rehabilitation. MANOVA and discriminant analyses showed significantly better isokinetic test results in Group A (isokinetic) compared to Group B (isotonic). HT autografts can reduce hamstring muscle strength for up to 1-2 years after ACL surgery. Notably, when the time from injury to surgery exceeds three months, it significantly reduces symmetrical knee muscle strength. Achieving sufficient hamstring strength and maintaining a proper hamstring-quadriceps balance are critical goals of ACL rehabilitation. Based on the research results, we conclude that isokinetic exercise is more effective than traditional physiotherapy in addressing hamstring hypotrophy after knee surgery.

Keywords: isokinetic; isotonic; exercise; knee surgery; hamstrings; hamstrings graft

Daily Rhythm and Performance Relation of Stress Biomarkers During Official Sport Climbing Competition

*Dario Vrdoljak[1], Barbara Gilić[1,2], Nikola Foretić[1,2], Zoran Nikolovski[1,2]

[1]Faculty of Kinesiology, University of Split, Split, Croatia; [2]High Performance Sport Center, Croatian Olympic Committee, Zagreb, Croatia

*Corresponding author

ABSTRACT

Previously it was shown that the competition environment is highly stressful for the athletes. This stress produced because of physiological or psychological demands could influence athletes' performance. Therefore, this study aimed to determine the daily fluctuation of stress biomarkers and their relation to the performance of sports climbers during official competition. Twelve sport climbers (6 females) average age of 20.33±5.21 years, body height of 174.00±10.27 cm, body mass of 64.75±10.80 kg, and training age of 10.30±2.40 years took part in this study. Their saliva cortisol (C) and alpha-amylase (AA) were sampled during the official competition (qualification and final). The statistical analysis included a t-test for the determination of differences between different measurements of C and AA. Furthermore, Pearson's correlation defined possible relations between the position achieved by the athlete and stress biomarkers. The analysis of the results showed that AA has significantly higher values post- (qualification, 156.07±133.24 U/ml; final, 199.09±162.41 U/ml) than pre-competition measurement (qualification, 88.18±80.24 U/ml; final, 90.36±53.41 µg/dL), in both qualification and final round. On the other hand, there is a decrease in AA between rounds of competition (post-qualification, 156.07±133.24 U/ml; pre-final, 88.18±80.24 U/ml) but it showed no significance. Moreover, C showed a similar response during the qualification (pre-, 0.45±0.24 µg/dL; post-, 1.02±0.43 µg/dL). Significant difference was observed between rounds of competition (post-qualification, 1.02±0.43 µg/dL; pre-final, 0.29±0.19 µg/dL) and no significant increase during the final phase (pre-, 1.02±0.43 µg/dL; post-, 0.46±0.27 µg/dL). Furthermore, pre- (0.68) and post-competition (0.69) AA shows a positive relation with position in qualifications. Other relations showed no significant connection with the position achieved during competition. Overall, the results showed a strong endocrine and nervous system response during the official competition. Also, the period of rest between rounds of competition showed a significant decrease in C but not in AA. These findings lead to the conclusion that sports climbing competitions present a highly stressful environment that influences the daily rhythm and fluctuation of biomarkers. Moreover, it can be concluded that athletes who enter the competition with lower levels of AA achieve better results. Therefore, the nervous system plays a significant role in the performance of these athletes.

Keywords: Cortisol, Alpha-amylase, performance, competition, sport climbing

Climate Change and Health – Evaluation of Curriculum

*Marijana Ranisavljev [1,2], Valdemar Štajer [1,2], Darinka Korovljev [1,2], Nikola Todorović [1,2], Dragan Milošević [2,3], Borislav Tapavički [4], Sergej M. Ostojić [1,2]

[1] Faculty of Sport and Physical Education, University of Novi Sad, Serbia, [2] Center for Health, Exercise and Sport Science, Belgrade, Serbia, [3] Meteorology and Air Quality Section, Wageningen University & Research, Wageningen, Netherlands, [4] Faculty of Medicine, University of Novi Sad, Serbia

*Corresponding author

ABSTRACT

Climate change has been found to significantly impact individuals with chronic diseases, leading to increased mortality and hospital admissions. Regular physical activity and exercise are instrumental in promoting health and mitigating the effects of numerous chronic diseases. To ensure that materials from which students of medicine and health sciences are learning, it is necessary to create appropriate teaching curricula that deal with climate change and how it affects people with chronic diseases. Additionally, giving adequate prescriptions and advice for physical activity or training. The objective of this article is to evaluate a new climate change curriculum and learning materials for medical and health students within the Erasmus+ project "CLIMATEMED". Students evaluated the quality of learning materials after the course at the Faculty of Medicine, University of Novi Sad, Serbia. They rated each of the sixteen qualitative characteristics of the lecture with a five-point Likert scale. Descriptive data show that medical and health students positively evaluated the presented lecture, with more than half strongly agreeing that materials promote critical thinking and that the illustrations support the topic understanding. Over 60% of students strongly agree the materials tie in with primary objectives, have met their expectations based on descriptions and give a preliminary overview, are not overly large, explain how subtopics fit together, indicate the sources used, and provide relevant medical knowledge. More than 70% of respondents strongly agree that lecture objectives are stated, the concepts are explained clearly and concrete examples are used to demonstrate relevant points. Finally, 80% strongly agree the materials stay on the theme of the lecture, and only 25.7% strongly agree that the materials repeat difficult ideas. Based on the analysis of the student evaluation, the quality of the presented materials and their applicability in the educational setting is very well received. The lectures and their aim seem to be explained and presented clearly with enough visual aids and examples, which will ultimately help students stay up to date with recommendations regarding physical activity and exercise, among others, influenced by climate change and its impact on health. The students at the Faculty of Medicine, University of Novi Sad, Serbia, believe the lectures prepared during the project are fitting and applicable to the future curriculum.
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Keywords: climate change, physical activity, health, curriculum, chronic diseases

Examining the Relationship Between Physical Literacy, Activity Levels, and Sedentary Behavior in Preadolescent Children: A Cross-Sectional Study

*Antea Šipalo Lilić[1], Nataša Zenić[1]

[1]University of Split, Faculty of Kinesiology, Split, Croatia,

*Corresponding author

ABSTRACT

Physical literacy (PL) is recognized as an important factor influencing physical activity levels (PAL), yet the relationship between PL and PAL in preadolescents is not well-studied. Therefore, this study aimed to evaluate the associations between PL, PAL, and sedentary behavior (SB) in preadolescents. Participants included 333 children aged 9 to 11 years (52% girls) from southeastern Europe. PL was assessed using the PLAYself questionnaire, while PAL was measured through the Physical Activity Questionnaire for Children (PAQ-C). Pearson's correlations and multiple regressions were used to analyze the relationships between the variables. There was a significant correlation between PL and PAL across the total sample, accounting for 16% of the common variance. Gender-specific analysis revealed that PL accounted for 10% of the variance in PAL for boys and 25% for girls. Multiple regression analysis of PL subdomains and PAL confirmed these findings, with R^2 values of 0.23 for the total sample, 0.15 for boys, and 0.31 for girls. In contrast, SB showed no significant correlation with either PL (<2% common variance) or PAL (<1% common variance), with p-values greater than 0.05. Girls had a higher association between PL and PAL compared to boys, which may be due to gender variations in PA engagement. In preadolescence, guys tend to engage in non-structured activities, whereas girls primarily engage in structured PA. The study indicates a stronger association between PL and PAL in girls compared to boys, suggesting that the nature of physical activities engaged in may influence these associations. Future research should include intervention studies to further explore causality.

Keywords: elementary school children, lifestyle factors, physical fitness, behavioral analysis, lifestyle medicine

Muscle Power and Anthropometric Determinants of Sprint Speed in Youth Female Athletes

*Gaspari Vasiliki[1], Bogdanis Gregory C.[1], Panidi Ioli[1], Terzis Gerasimos[1], Donti Anastasia[1], Kanna Dimitra A.[1], Salagas Andreas[1], Dimitropoulos Konstantinos[2], and Donti Olyvia[1]

[1]School of Physical Education and Sport Science, National and Kapodistrian University of Athens, Athens, Greece; [2]Sports Science Department, Scientific College of Greece, Athens

*Corresponding author

ABSTRACT

Sprint speed performance is influenced by multiple factors, including lower limb muscle strength and power, and anthropometric characteristics. Previous studies in adults reported strong associations between anthropometric characteristics and sprint speed however, research on the association between lower limb muscle power and speed is conflicting, and there is limited evidence in youth athletes. Thus, the aim of this study was to examine the association between jumping performance force and power parameters and sprinting ability in child female athletes. Thirty-three rhythmic gymnastics (RG) athletes (age: 9.24±0.55 years, training age 4.08±1.09 years; BMI: 14.97±1.13 kg/m^2) participated in the study. Height, sitting height, body mass, maturity offset, leg and calf length were measured. Dual-energy X-ray absorptiometry (DEXA) assessed bone mineral density (BMD) fat and muscle mass. From the force–time curve of countermovement jump (CMJ) peak force and average rate of force development were calculated as well as jump height and power. The gymnasts also underwent two sprint ability tests (0-10 and 0-20m). Significant correlations were found between anthropometric characteristics (body mass, height, leg length, calf length, maturity offset, bone mass and bone density) and 0-10 and 0-20 m sprint speed (r=-0.345 to -0.497, and -0.389 to -0.501, respectively, p<0.05). Flight time, jump height and power significantly correlated with 0-10 m (r=-0.382 to -0.502, p<0.05) while only one association was found between 0-20m sprint speed and jump power (r=-0.371, p<0.05). Multiple regression analysis indicated that specific anthropometric variables (i.e., height, fat mass and femoris length) accounted for 38.2% (F=7.585, p=0.001) of the variance of 0-10m sprint speed while bone mass density accounted for 22.7% (F=10.405, p=0.003) of the variance of 0-20m sprint. Jump power was the only predictor of both, 0-10 m sprint (AR^2=23%, F=10.579, p=0.003) and 0-20 m sprint (AR^2=11%, F=4.962, p=0.033). Body dimensions and fat mass are important determinants of sprint acceleration (0-10m) in youth rhythmic gymnasts thus, confirming previous research in adults. Notably, lower limb muscle power is more important for sprint acceleration than for running sprint (0-20m) due to the need to develop high amounts of horizontal external force and power output. For coaches and specialists, it is important to consider the different contribution of body dimensions and lower limb muscle power to sprint speed components in children.

Keywords: jumping height, force, power, rhythmic gymnastics

Analysis of Elite Football Goalkeepers' Match Performance According to Match Outcome

*Jakov Vladović[1]

[1]University of Split, Faculty of Kinesiology, Split, Croatia

*Corresponding author

ABSTRACT

Goalkeepers' unique roles, including goal protection and ball distribution during the initiation of an attack, may be essential for winning in soccer. However, studies rarely investigated goalkeepers' match performance (MP) according to the match outcome, especially in elite-level competitions. Therefore, this study aimed to evaluate goalkeepers' MP when winning and losing in the UEFA Champions League (UCL). Data were collected using an optical tracking system (Wyscout Spa, Chiavari, Italy) from all UCL matches in the 2022/23 season. Variables related to the ball distribution included total and accurate number of passes, percentage of accurate passes, total and accurate number of passes beyond own third and percentage of accurate passes beyond own third. Variables related to goal protection included conceded goals, saves, save percentage (i.e. number of saves per shots against), reflex saves, reflex save percentage, total and won aerial duels and exits. Depending on the normality of the distributions, which were tested using the Kolmogorov–Smirnov test, T-test or nonparametric Mann-Whitney U test were used to compare goalkeepers' MPs in won and lost matches. Cohen's d was used to identify effect sizes. Winning in UCL matches resulted in goalkeepers' greater save percentage ($d = 1.31$), reflex save percentage ($d = 0.54$), more exits ($d = 0.37$), total ($d = 0.41$) and won aerial duels ($d = 0.44$) and lower number of shots against ($d = 1.39$), saves ($d = 0.52$), reflex saves ($d = 0.50$) and conceded goals ($d = 2.13$) compared to losing matches. No differences in ball distribution variables were found irrespective of the winning and losing. In highest-level soccer, goal protection abilities, specifically saves, reflex saves, aerial duels and exits, may be important determinants for achieving positive match outcomes. On the other hand, it seems that ball distribution abilities do not play a vital role in achieving match success. Training sessions for highest-level soccer goalkeepers should challenge them to maximize saves, exits, and aerial duels through competitive situational drills. Such a training approach may positively influence these performances during the match, consequently enabling a greater possibility of winning.

Keywords: soccer, match demands, ball distribution, goalkeeping abilities, success

Positional Differences in The Injury Occurrence and Characteristics Among Elite Youth U19 Football Players

*Jakša Škomrlj[1,2], Šime Veršić[1]

[1]Faculty of Kinesiology, University of Split, Croatia; [2]HNK Hajduk Split, Split, Croatia

*Corresponding author

ABSTRACT

Youth football injury incidence is known to increase with age, with the oldest categories (i.e., U19 age category) sustaining the highest total numbers and severity of injuries. Due to a varying position-specific game demands (e.g., higher number of tackles, jumps and landings in central defenders), certain positions seem to be at higher risk for sustaining an injury. The main aim of the study was to compare the injury characteristics among the five outfield playing positions. A total of 59 injuries was analyzed in the study. The injury data was gathered during the competitive 2023/24 season, with all the players of the U19 squad having sustained at least one injury during the study period. All injuries were collected by the medical professionals and were classified according to the type, location, character and injury mechanism. The players were divided into five groups according to their respective positions on the field: central defenders, full backs, central midfielders, wide midfielders and attackers. The Pearson Chi-square test was carried out to identify the difference in injury occurrence among the five playing positions. The results indicated a significant difference among the positions only in the variable type of injuries. Namely, full backs and central midfielders had a significantly higher number of contusions compared to all other playing positions ($p<0,05$). Game demands of different positional roles require different physical outputs, thus resulting in an unequal injury risk. Frequent presence in the box and consequent large number of collisions with opposing defenders might be the reason for full back contusion injuries. Similarly, a large amount time spent with the ball in the densest part of the field could have left the central midfielders vulnerable to a higher number of suffered contusion injuries. Full backs and central midfielders seem to be highly vulnerable for contusion injuries in the U19 category. Reduction in number and severity of the contact injuries, particularly of the unsportsmanlike tackles, could be achieved through continuous education from the youngest to these oldest academy age categories.

Keywords: injuries, playing positions, youth, football

The Dynamic of A 6km Rowing Ergometer Race – Analysis of Heart Rate and Speed Trends

*Mate Kuko[1]

[1]Faculty of Kinesiology, University of Split, Split, Croatia

*Corresponding author

ABSTRACT

Rowing is an Olympic sport performed collectively and individually on water surfaces, characterized by the specific cyclic movement repeated during the race and the high physiological and metabolic load on rower's bodies. Official rowing races are 2000 meters long, but one of the most important tools for estimation of aerobic endurance is the ergometer rowing test on 6000 meters. This study aimed to analyze speed and heart rate trends during a 6km rowing ergometer race. Participants in this study were male junior and senior level rowers of HVK Gusar Split competing at club and international levels (N=8). The study included heart rate and speed values for each 500-meter part of the race. Research was conducted as a part of early-season physical testing, generating high motivation levels among the athletes. To analyze trends over the observed period, Joinpoint Regression Program 4.9.1.0 was used. The Joinpoint regression model for the heart rate showed two segments with statistically significant changes during the race with a 2.10% change in the first (0-1500 meters) and 0.44% in the second period (1500-6000 meters). The analysis of speed trends showed three periods of the race with significant differences between each 500-meter in all of them (0.62%, 0.22% and 2.46%). The highlighted simultaneous drop in athletes' heart rate and rowing speed could be recognized as a "black hole" of a rowing ergometer 6km race. This could be triggered by miscalculation of energy distribution in prior parts of the race, leading to higher mental fatigue and psychological crisis from 4000m to 5000m point. Potentially, this puts high mental pressure on athletes, and it seems that they consciously reduce their efforts to recharge and prepare for the final part of the race. The study showed different speed and heart rate trends during a 6km ergometer race alongside with simultaneous drop of given variables around 4000m point, representing a potential psychological crisis and poor energy distribution. This should be practically applied in rowing training and race approach, to put athletes in greater control over the race, avoiding significant speed drops.

Keywords: rowing, ergometer, speed, heart rate, mental fatigue

Differences in Perfectionism Among Young Athletes

*Paula Matijašević[1,3], Bruno Matijašević[2], Frane Žuvela[1]

[1]Faculty of Kinesiology, University of Split, Croatia; [2]Faculty of Humanities and Social Sciences, Osijek; [3]Faculty of Kinesiology, University of Zagreb, Croatia

*Corresponding author

ABSTRACT

Perfectionism is a common phenomenon both in life in general and in sports. It is often considered a desirable feature of athletes, but given the different occurrence types, it can also have negative consequences for athletes, especially at a younger age. The sample comprised 256 young athletes aged 11 to 17 years, including both sexes (105 females and 151 males). For this research, a questionnaire consisting of two parts was used: a sociodemographic questionnaire and a Sport Multidimensional Perfectionism Scale 2 (SMPS-2) (Gotwals & Dunn, 2009). The obtained data were analyzed by factor analysis, Mann-Whitney U test. The results showed differences in the representation of perfectionism in individual and group sports, as well as differences about the gender of the respondents. The data are grouped into six factors that include setting goals in sports performance, parent-athlete and parent-coach relationships, as well as accepting negative sports consequences and dealing with uncertainty. The obtained data indicate the occurrence of perfectionism in young athletes, which is especially significant for athletes who play individual sports. The stated results are from recent scientific literature. According to the appearance of perfectionism in young athletes, there is an important developmental component that can mean riskiness at that age. Also, the significance of the youth microsystem proved to be a significant component of young athletes, which points to the further need to correlate the narrow environment of young athletes to gain a broader insight into the developmental aspect that can influence sports success. Accordingly, further research is needed to prevent the negative consequences of perfectionism. The common occurrence of perfectionism is a significant indicator of future scientific research, which, in addition to the physical component, should also consider other psychological and pedagogical aspects to perfect the sports, as well as the developmental sports component.

Keywords: adolescents, children in sports, individual sports, team sports

Injuries and Illnesses in Slovenian Men's Handball League: Insights from the Slovenian Oslo Sports Trauma Research Center on Health Problems Questionnaire Validation

Kristina Drole[1*], Armin Paravlic[1,2]

[1]University of Ljubljana, Faculty of Sport, Institute of Kinesiology, Slovenia; [2]Science and Research Center Koper, Slovenia

*Corresponding author

ABSTRACT

Handball is a high-intensity contact sport associated with a significant risk of injuries and illnesses. This study aimed to document the characteristics of health problems among elite male Slovenian handball players during the 15-week validation study of the Slovenian Oslo Sports Trauma Research Center Questionnaire on Health Problems (OSTRC-H2-SLO). A total of 188 athletes (23.3±4.3 years) were followed for 15 weeks. Athletes reported their training, competition load, and health problems weekly with the OSTRC-H2-SLO questionnaire administered through an online platform. Spearman's rank order correlation coefficient was used to assess the associations between severity score, days lost due to health problems, and total load. A total of 514 health complaints were reported, with 39% representing first-time complaints and 61% recurrent cases. Acute injuries comprised 52% of cases, overuse injuries 31.7%, and illnesses 16.3%. The study documented 1726 lost training days: 1237 days due to acute, 303 days to overuse injuries, and 176 days to illnesses. The highest severity scores were observed for illnesses, followed by acute and overuse injuries. High positive correlations (all $p<0.001$) were found between severity score and days lost due to acute injury ($r=0.754$), overuse injury ($r=0.785$), and illnesses ($r=0.894$). Moderate to high negative correlations (all $p<0.001$) were found between severity score and total load for acute injuries ($r=-0.468$), overuse injuries ($r=-0.410$), and illnesses ($r=-0.589$), as well as between days lost and total load for acute injuries ($r=-0.543$), overuse injuries ($r=-0.451$) and illnesses ($r=-0.820$). The study revealed a significant burden of health problems among elite Slovenian handball players. Stable severity scores for acute injuries suggest a consistent risk throughout the season, while peaks in illness severity indicate periods of increased vulnerability. The findings emphasize the importance of monitoring total load, as it is a predictive indicator of future severity score increases. The study unveiled the strong associations between the severity of health problems and their impact on athletes' absence from training or competition. The significant impact of total load peaks on health problem severity highlights the importance of monitoring and adjusting training load to mitigate health risks, potentially influencing athlete training practices and informing injury/illness prevention policies.

Keywords: epidemiology, training load, health questionnaire, load management

Qualitative-Related Differences in Physical Profile Among U17 Futsal Players From Croatia

Tomislav Pranjić[1]

[1]University of Split, Faculty of Kinesiology, Split, Croatia

ABSTRACT

Futsal is a demanding and complex sport characterized by high-intensity, intermittent activities that require players' high physical abilities. Despite the sport's growing popularity, there is a notable lack of research focused on the physical profiles of youth futsal players. This study aimed to explore quality-related differences in the physical profiles of under-17 (U17) futsal players from the highest futsal league in Croatia. Nineteen U17 futsal players were categorized into two quality groups by their head coach: advanced (A) (n=11) and non-advanced (B) (n=8). The participants underwent 11 motor tests to evaluate various physical attributes essential for futsal performance. These tests included Sprint on 5 (S5M), 10 m (S15M), 20 m (S20M) and 30 m (S30M), Counter Movement Jump (CMJ), Squat Jump (SJ), Drop Jump (DJ), Shooting with Non-dominant Foot (SHOOT_ND), Shooting with Dominant Foot (SHOOT_D), 20 Yards Agility Test (20Y), and Triangle Reactive Agility Test (T RAG). Descriptive statistics were calculated for all measured parameters, and a T-test was used to identify differences between the advanced and non-advanced groups. The analysis revealed statistically significant differences between the advanced and non-advanced groups in three key parameters: SHOOT_ND (p=0.048), SHOOT_D (p=0.009), and DJ (p=0.012). The results indicate that futsal coaches at the U17 level prefer players who demonstrate greater power, as evidenced by superior shooting speed and a higher Reactive Strength Index. These attributes are crucial for the high-intensity, dynamic nature of futsal. The emphasis on these physical attributes highlights their importance in the sport and suggests that their development should be prioritized in youth training programs. The findings provide valuable insights for coaches, emphasizing the need for targeted training interventions to enhance these key physical attributes. This study demonstrates that success in youth futsal depends on the development of specific motor abilities, particularly shooting power and reactive strength. The development of these abilities should begin at an early age to maximize player potential. Future studies should include larger sample sizes and a broader range of predictors to obtain a more comprehensive understanding of the physical profiles of youth futsal players. This will help refine training programs and talent identification processes to support the development of young futsal players.

Keywords: Futsal, Youth, Quality groups, Shooting Power, Reactive Strength Capabilities

Association Between Muscle Activation and Technique Quality of the Cross Punch in Right and Left Boxing Stance

*Gordan Vukman[1] , Dario Vrdoljak[1]

[1] Faculty of Kinesiology, University of Split, Split, Croatia

*Corresponding author

PURPOSE: Kickboxing is a high-intensity sport in which muscle activation is an important performance aspect. Therefore, this study aimed to determine possible associations between muscle activation of serratus anterior and triceps brachii on both the left and right sides with quality of technique. Participants in this study were male kickboxers competing on club and international levels (N=8). All participants performed cross punches with both hands from the left and right boxing stances. During punch muscle activation, the triceps brachii and serratus anterior were measured using electromyography (EMG). The punches were repeated three times in each stance and were video-recorded for expert estimation. The judges estimated the quality of the technique of the cross punches by grading them from grade 1 (lowest) to grade 3 (highest). Statistical analysis included descriptive statistics of all variables. Spearman's non-parametric analysis was also used to determine the association level between variables. Results indicate no significant correlation between EMG variables and the overall grade of the triceps brachii and serratus anterior technique. Similarly, no significant correlation was observed between the left and right stance. To conclude, the quality of the punch showed no major association between the mentioned variables and the technique of cross punch. Therefore, other parameters and factors may indicate a better technique. Precisely, strength, velocity, and/or power of muscle activation are not significant in the quality of technique. Finally, more variables and a larger sample of participants should be included in future research to gain a complete picture of the aforementioned association.

Keywords: kickboxing, EMG, correlation, muscle activation, technique, experts

Differences in Agility With and Without The Ball Between Starters and Non-Starters in The Women's Football Team

*Anja Macan[1,2], Jakov Marasović[1]

[1]Faculty of Kinesiology, University of Split; Split, Croatia; [2]ŽNK Hajduk Split, Split, Croatia

ABSTRACT

In today's football, agility, along with speed, is one of the main discriminators that separates the successful from the less successful players. Agility diagnostics play a big role as it can help with player selection. The main goal of this research was to show the differences in agility with and without the ball between starters and non-starters of the women's football team of the first national football league. 20 female players participated in the research, divided by status in the team, with eight players classified as starters and 12 as non-starters. Three agility tests were used, each with and without a ball (slalom, zig-zag, and 93639). The parameters of descriptive statistics were calculated, and the t-test was used to determine the differences between the observed groups. The Statistica 13 program was used to process the data. The results showed significant differences between the starters and non-starters in 2 out of 6 tests, one of which was with the ball and one without the ball (93639 with the ball and slalom without the ball). In both of these tests, the players in the starting line-up were more successful than the players in the reserves (0.034/0.049). The results obtained suggest differences in agility with and without the ball, where the players of the starting line-up proved to be more successful than the non-starters. It is obvious that in women's football, agility is essential for situational effectiveness, both basic and with the ball. Despite the differences, agility should not be a decisive factor in the selection of players, but technical abilities in the game should also be taken into account. Women's football does not have much research on the topic of motor skills and is still a developing sport. With the development of the game and the expansion of the sample, the results would certainly be more susceptible to greater differences. In future studies, it is essential to investigate reactive agility in women's football in order to determine the importance of agility as a motor skill for selection.

Keywords: agility, women's football, selection, starters, non-starters

Differences in Technical Performance of Elite-Soccer Teams According to Intensity of Pressing

*Ivan Šunjić[1], Toni Modrić[1]

[1]University of Split, Faculty of Kinesiology, Split, Croatia

*Corresponding author

ABSTRACT

Pressing is the collective behaviour of a team to win possession of the ball from the opponent. As more ball possession may enable more attacks and opportunities for goal scoring, it is often hypothesized that pressing may be linked to technical performance important for achieving match success. To confirm such considerations, this study aimed to compare the technical performance of teams that utilized low (TULPI) and high (TUHPI) pressing intensity. Raw data of all FIFA World Cup 2022 matches (n = 64) were exported from Statsbomb. Technical performance variables included: the teams' number of ball receipts in the final third of the pitch, forward passes in the opponent's half, total shots, total shots on target, expected goals (xG), and goals. Pressing intensity was evaluated with the teams' number of passes allowed per defensive action (PAPDA). To identify the cut-off value of PAPDA and classify teams as TULPI and TUHPI, k-means cluster analysis was used. Depending on the normality of the distributions, which were tested by the Kolmogorov–Smirnov test, T-test or Mann–Whitney U test was used to compare differences in technical performance between TULPI and TUHPI. Two clusters were identified, cluster 1 (TULPI) with 21.1± 6.6 of PAPDA and cluster 2 (TUHPI) with 7.4±2.7 of PAPDA. TUHPI had significantly more ball receipts in the final third of the pitch (137.7±49.5 vs 64.1±21.6, $t = 5.2$, $p = 0.01$), forward passes in the opponent's half (135.3±51.7 vs 60.1±19.8, $t = 5.1$, $p = 0.01$), total shots (11.5±3.1 vs 6.2±2.9, $t = 3.5$, $p = 0.01$), shots on target (4.1±2.6 vs 1.9±1.5, $z = 2.9$, $p = 0.01$) and xG (1.2±0.8 vs 0.6±0.5, $t = 2.8$, $p = 0.01$) in compared to TULPI. No difference in goals between TULPI and TULPHI was found (1.3±1.3 vs 0.8±0.9, $z = 1.12$, $p = 0.26$). These findings suggest that utilizing greater pressing intensity enabled to perform more offensively oriented technical performance such as invasion in the final third of pitch and scoring opportunities, which is essential for winning. It is highly recommended that soccer practitioners implement training protocols designed to develop the ability to apply high-intensity pressing as such a training approach may enhance the team's chances of winning.

Keywords: football, pressing behavior, match performance, differences, success

The Influence of Goalkeepers’ Average Pass Distance on Teams’ Technical Performance in Football

*Andrija Alebić[1], Toni Modrić[1]

[1]Faculty of Kinesiology, University of Split, Split, Croatia

*Corresponding author

ABSTRACT

Goalkeepers’ key roles in football are protecting the goal and ball distribution during the initiation of a build-up. While goal protection-related variables are commonly investigated, their ball distribution parameters remain understudied. Therefore, this study aimed to determine the influence of goalkeepers’ ball distribution on the key technical performance of their teams, which is an important determinant of success in football. Raw data were exported from every 51 matches during the 2020 UEFA European Football Championship from the Statsbomb database (https://statsbomb.com). Goalkeepers’ ball distribution was assessed with average pass distance. At the same time, technical performance variables included expected goals (xG), number of balls received in the final third, forward pass in the opponent's half, total shots, shots on target, and number of goals scored. Depending on the normality of distributions, which were tested using the Kolmogorov – Smirnov test, Pearson's or Spearman's correlation coefficient was used to determine the influence of goalkeepers’ ball distribution on teams’ technical performance. Significant correlations were found between goalkeepers’ average pass distance and number of balls received in the final third ($r = -0.42$; $p = 0.01$), forward pass in the opponent's half ($r = -0.472$; $p = 0.01$), and total shots ($r = -0.23$; $p = 0.02$). No significant correlations were found between goalkeepers’ average pass distance and xG, shots on target, and number of goals scored (all $p > 0.05$). Negative correlations between average pass length and number of balls received in the final third, forward passes in the opponent's half, and total shots suggest that teams with goalkeepers who preferred shorter ball distributions had more successful entries into the attacking third, forward passes, and scoring opportunities. The findings from this study indicated that goalkeepers' passing abilities may play an important role in achieving greater offensively oriented technical performance, which is essential for winning in football. Therefore, maximizing goalkeepers' passing abilities should be an indispensable part of their training process.

Keywords: soccer, ball distribution, parameters, correlation, success

Performance and Physiological Differences in Medalist and Non-Medalist Wrestlers Following an Exhaustive Testing Protocol

*Krešo Škugor[1], Hrvoje Karninčić[1]

[1]University of Split, Faculty of Kinesiology, Split, Croatia

*Corresponding author

ABSTRACT

This study investigated whether wrestlers of different competitive qualities exhibit differences in specific test performance and cardiac and metabolic responses following a demanding testing protocol. The focus was identifying performance and physiological variances between successful and less successful wrestlers. The research included 29 wrestlers aged 17.62 ± 1.86 years, divided into two performance categories: successful (medalists at the National Championships; n = 13) and less successful (non-medalists; n = 16). The variables included anthropometric indices and specific wrestling fitness test (SWFT) parameters, such as the number of throws, heart rate, lactate concentration, and calculated cardiac and metabolic indexes. Student's t-test and receiver operating characteristic (ROC) curves were utilized to determine differences between the two groups. Additionally, two-way ANOVA for repeated measurements was employed to assess performance, cardiac, and metabolic characteristics differences between the test trials and quality categories. The results demonstrated significant differences between the two groups after the second SWFT trial. Successful wrestlers exhibited a higher total number of throws ($p < 0.01$, AUC = 0.82), better cardiac indices ($p < 0.03$, AUC = 0.73), and improved metabolic indices ($p < 0.04$, AUC = 0.75). These differences were not observed in the first testing trial. The findings suggest that successful wrestlers outperform less successful wrestlers in specific performance variables after undergoing an exhaustive testing protocol. This could be due to better conditioning or superior physiological adaptations in the successful group. The study highlights the importance of considering the effects of exhaustive exercise in evaluating sports-specific performance among wrestlers. This study indicates that wrestlers of different competitive qualities exhibit distinct performance and physiological responses after a demanding testing protocol. Future research on sport-specific performance in wrestlers should include exhaustive exercise or testing protocols to better differentiate between varying levels of competitive success.

Keywords: combat sports, physiology, competition, youth athletes, monitoring

Neuromuscular, Cardiac, and Sleep Adaptations in Soccer Players During Pre-Season

*Josip Maleš[1,2], Frane Žuvela[2], Goran Kuvačić[2]

[1]University of Split, Hotel Management and Gastronomy, Split, Croatia; [2]University of Split, Faculty of Kinesiology, Split, Croatia

*Corresponding author

ABSTRACT

Monitoring internal training intensity (ITI) is crucial for soccer coaches to avoid overtraining and reduce the risk of injuries to players during the pre-season and season. Although expensive devices are used for monitoring players' stress levels, which might not be accessible to all clubs, subjective measures of ITI, such as Borg's (RPE) scale and wellness questionnaires (WBI), are accessible, effective, and cost-friendly alternatives. Tests like the Counter Movement Jump (CMJ) are simple and can easily assess players' neuromuscular fatigue levels. Sleep quality and heart rate variability (HRV) also play a key role in recovery and adaptation to training. Coaching staff goals vary depending on the phase of the season, but adequate monitoring and adjustment of training are crucial for achieving optimal results. Therefore, the main aim of this study was to assess the neuromuscular, cardiac, and sleep adaptations in soccer players during pre-season. This was the longitudinal five-week preparatory period study with ten professional Croatian soccer players. Study variables included ITI, well-being status (WBI), HRV, sleep minutes (SM), and CMJ. Training load (TL) was assessed with the sRPE, WBI through daily questionnaires, and CMJ using OptoJump platforms. HRV and SM were tracked with Xiaomi Mi Fit Band 4. Data were analyzed using nonparametric ANOVA and correlation analysis in SPSS. Significant fluctuations were detected on a weekly basis in CMJ (Counter Movement Jump), TL (Total Load), and WBI (Well-Being Index). During Week 5, there was a significant decrease in TL (288.05 ± 38.80 a.u.) and a modest reduction in CMJ (41.23 ± 5.70 cm) compared to previous weeks. The correlation analysis showed a negative association between TL and CMJ ($r = -0.289$, $p = 0.042$) and a positive between HRV and SM (Sleep Minutes) ($r = -0.399$, $p = 0.004$). This study highlights the importance of monitoring ITI and well-being in soccer to lower injury risks and prevent overtraining of players. The identified relationships indicate that maintaining a greater sleep quality and HRV (heart rate variability) positively affects the recovery process. These findings are consistent with the information already present in the literature. Efficient monitoring of ITI and well-being indicators is essential for controlling players' training intensity and improving performance during the preparatory phase. By using easily available tools like RPE scales, wellness questionnaires, and wearable technology, coaches can obtain comprehensive information regarding the status of players.

Keywords: monitoring, training intensity, perceived exertion

Correlation of Vertical Jump, Speed, and Change of Direction Speed in Female Futsal Players

*Dejan Javorac[1], Sasa Markovic[2], Slavko Molnar[1]

[1]Faculty of Sport and Physical Education, University of Novi Sad, Serbia; [2]Faculty of Sport and Physical Education, University of Banja Luka, Bosnia and Herzegovina

*Corresponding author

ABSTRACT

Futsal, a fast and dynamic variant of soccer, demands exceptional physical fitness from players to compete effectively. Speed, vertical leap, and change of direction speed are pivotal motor skills influencing player performance. Investigating the relationship among these abilities in futsal players is crucial for understanding performance factors. Thirteen university futsal players (Age: 19.69±2.84 years; Body height: 164.14±6.73 cm; Body weight 63.27±8.38 kg) underwent physical fitness tests. Speed was measured at 5 m and 20 m distances; vertical jump was assessed through squat jump (SJ), countermovement jump (CMJ), and vertical jump (VJ) tests. Change of direction speed was evaluated using the Illinois and 505 tests for both left and right feet. Pearson's correlation was employed for data analysis. VJ had significant negative correlations with both 5 m speed ($r = -0.553$, $p < 0.05$) and 20 m speed ($r = -0.756$, $p < 0.01$). CMJ demonstrated a moderate negative correlation with the Illinois test ($r = -0.610$, $p < 0.05$). Change of direction speed, assessed via the Illinois test, positively correlated with both 5 m speed ($r = 0.557$, $p < 0.05$) and 20 m speed ($r = 0.674$, $p < 0.01$). The 505 tests demonstrated significant negative correlations with vertical jump measures: SJ ($r = -0.582$, $p < 0.05$), VJ ($r = -0.461$, $p < 0.05$), and CMJ ($r = -0.572$, $p < 0.05$). The negative correlations between vertical jump measures and sprint speeds suggest that players with higher jump capacities sprint slower. This could indicate a trade-off between explosive power for jumping and sprint speed endurance. Positive correlations between change of direction speed and sprint speeds highlight the importance of linear speed in overall agility. These findings align with previous research indicating that specific training can enhance these interconnected abilities, improving overall performance. These findings highlight the interconnection among speed, vertical jump, and change of direction speed in female futsal players. Coaches can leverage these insights to optimize training sessions and enhance female futsal players' performance.

Keywords: futsal, speed, vertical jump, change of direction speed

Analysis of The Association Between Health Literacy and Physical Activity in High School Adolescents; Preliminary Cross-Sectional Investigation

Jasminka Blažević[1], Mateo Blažević[2], Nataša Zenić[3]

[1]Design, Graphics and Sustainable Civil Engineering School, Split, Croatia; [2]School for Civil Engineering and Land Surveying, Split, Croatia; Faculty of Kinesiology, University of Split, Split, Croatia

*Corresponding author

ABSTRACT

Health literacy (HL) is an important concept in adolescence, and it is theorized that HL is associated with physical activity levels (PAL) as an important indicator of healthy lifestyle. The aim of this study was to evaluate association between HL and PAL in high-school adolescents. The participants were 230 high-school students from Split, Croatia (47% females; 16 to 19 years of age). The Physical Activity Questionnaire for Adolescents was used for analysis of the PAL, while HL was evaluated using the European Health Literacy Survey Questionnaire. T-test was calculated to evidence the differences between genders, while Pearson's correlations were calculated to evaluate gender-specific associations between HL and PAL. Boys had greater PAL than girls (t-test=6.71, $p<0.001$), with no significant differences in HL (t-test=0.76, $p> 0.05$). No significant correlation between HL and PAL was for the total sample ($R=0.08$, $p>0.05$), and in boys ($R=0.05$, $p>0.05$). In girls, HL and PAL were significantly correlated ($R=0.22$, $p<0.05$). It seems that PAL is more related to a healthy lifestyle in girls, than in boys. Most probably, PAL among girls is a result of their health-concern, while in boys it is more related to competitiveness and fun through sports. This study provided preliminary results for studies associations, but for more detailed analyses, prospective analyses are warranted.

Keywords: Physical Activity, Health literacy, Physical education

Physical Activity and Mental health of First-Year Students at the University of Osijek: A Cross-Sectional Study

*Petar Šušnjara[1], Stipe Vidović[2], Goran Dabić[2], Mihael Kolar[2]

[1]Faculty of Kinesiology Osijek, University Josip Juraj Strossmayer in Osijek, Osijek, Croatia;[2]Faculty of Medicine Osijek, University Josip Juraj Strossmayer in Osijek, Osijek, Croatia

*Corresponding author

ABSTRACT

Physical activity (PA) plays a crucial role in maintaining overall well-being, including mental health. This study aims to investigate the relationship between physical activity and negative affective emotions among students at the University of Osijek. This cross-sectional study was conducted in June 2023. All participants were in their first year of study. The International Physical Activity Questionnaire (IPAQ) was used to assess physical activity levels, and the Depression, Anxiety, and Stress Scale 21 (DASS-21) was used to assess mental health. Ethical approval was obtained from the Faculty of Medicine in Osijek. The study involved 437 students (194 male, 243 female) with a median age of 19 years. According to the IPAQ, 44% were classified as high, 49% as moderate, and 7% as low PA. Depression, anxiety, and stress symptoms were prevalent among 45%, 58%, and 38% of students, respectively. Among them, 13%, 24%, and 12% had expressed severe to extremely severe levels of depression, anxiety, and stress symptoms, respectively. Spearman test revealed statistically significant correlation between intense PA and depression ($P<0.001$), anxiety ($P<0.001$), and stress ($P<0.001$) scores. Multilinear regression analysis revealed that an increase in intense PA leads to a decrease in depression (β =-0.46, $P<0.001$), anxiety (β =-0.39, $P<0.001$), and stress (β =-0.53, $P<0.001$) levels. The findings of this study provide important insights into the understanding of PA and its association with mental health among the student population. the distribution of PA levels among participants was relatively balanced, with 44% classified as highly active, 49% as moderately active, and only 7% as low active according to the IPAQ. However, despite high levels of PA, mental health symptoms were significantly present. Spearman's correlation test revealed a statistically significant inverse relationship between intense PA and depression, anxiety, and stress scores. This suggests that students who engage in higher levels of intense PA tend to experience lower levels of these negative mental health symptoms. which is consistent with existing literature highlighting the mental health benefits of PA. High levels of depression, anxiety, and stress were observed among students of the University of Osijek. Intense PA contributed to the reduction of observed negative affective emotions.

Keywords: DASS-21, mental health, physical activity, IPAQ

Gender (In)Equality in Sport Competition

*Adriana Ljubojević[1], Nikolina Gerdijan[1], Kristina Pantelić Babić[1], Anđela Pepić[2], Borko Petrović[1], Aleksandra Stanivuk[1]

[1]University of Banja Luka, Faculty of Physical Education and Sport, Bosnia and Herzegovina; [2]University of Banja Luka, Centre of Development and Research Support, Bosnia and Herzegovina

*Corresponding author

ABSTRACT

This research aims to investigate gender (in)equality across various competition levels and represents one of the activities of the SUPPORTER project (Securing SPORTS Education through an innovative and inclusive Gender Equality Plan project). This project was created because it was recognized that sport is a micro-system in which gender (in) equality is particularly visible. Specifically, the aim of the research is to examine gender distribution at different competition levels. An online questionnaire was distributed to 54 active sports organizations from 8 different sports (athletics, boxing, football, karate, basketball, volleyball, swimming, and handball) in the wider region of Banja Luka. The questionnaire focused on the quantitative indicators of gender distribution across different competition levels. The results indicate a significant gender imbalance in terms of gender representation across various competition levels. At the highest level of competition (national and international), there is a higher percentage of male competitors (60% vs. 40%) in all selected sports, except in karate clubs (women 60% vs. men 40%), and equal distribution in athletics. Similar results were found at the second competition level (entity level of the Republic of Srpska), with a slightly increased representation of women (55.6% vs. 44.4%) in karate, and equal representation in athletics. At the lowest competition levels (regional and younger age competitions), female representation increased compared to the highest levels, especially in basketball (71.4% vs. 28.6%), with equal representation in athletics and karate. Research on the gender distribution of athletes across various competition levels reveals a significant imbalance between men and women. Despite global efforts to achieve gender equality in sports, our findings indicate that female participation remains minimal at all competition levels. These results highlight the need for further analysis and interventions to enhance gender equality and increase women's participation in sports competitions at all levels. It can be concluded that the representation of women in all competition levels of international and national competitions is significantly low. Sports institutions should be more active in promoting equality in sports at all competition levels, and their responsibility is to eliminate stereotypes and gender roles that hinder women’s participation in competitive sports. Through innovative and sustainable activities, the supporter project aims to contribute to the eradication of gender inequality in the sports environment.

Keywords: women athlete, men athlete, distribution, sport, rangs

Effect of McGill Exercise Programmed on Core Muscle Function in Sedentary Male: A Randomized Controlled Trial

*Miloš Kojić[1], Tijana Šćepanović[1], Dragan Marinković[1], Stefan Maričić[1], Lidija Marković[1]

[1]Faculty of Sport and Physical Education, University of Novi Sad, Serbia

*Corresponding author

ABSTRACT

The McGill exercise program, specifically the McGill Big Three (MGB3) consisting of the curl-up, side plank, and bird-dog exercises, aims to improve core muscle function, core stability and core strength particularly in sedentary people. The aim of this research is to investigate the effect of a six-week exercise program on function of core muscle in the sedentary male population. 37 sedentary participants (Age: 21.83±1.75 years; Body height: 183.62±7.23 cm; Body weight 76.91±10.49 kg) were assigned to experimental – Active group (n=22) and control – Sedentary group (n=15). The experimental group exercised twice a week, for half an hour over a period of six weeks, while the control group was not subjected to treatment. General linear models (2x2 mixed-design analyses) and Hedges g estimated mean changes in measure from initial to final testing. The results of a mixed ANOVA analyzing the group-by-time interaction effects on five variables: Trunk extension test, Trunk flexor test, Left side plank, Right side plank, and Double Leg Lowering (DLL) test in active and sedentary male groups. For Trunk extension test, the active males had a Hedges' g of 0.38 with an F-value of 1.542 ($p = 0.228$, $\eta^2 = 0.083$), whereas sedentary males showed a negligible effect size (Hedges' g = -0.03). Trunk flexor test showed a significant interaction for active males (Hedges' g = 0.70, $F = 6.415$, $p = 0.016$, $\eta^2 = 0.155$), while sedentary males had a smaller effect size (Hedges' g = 0.05). Left side plank also demonstrated a significant interaction in active males (Hedges' g = 0.27, $F = 6.1$, $p = 0.019$, $\eta^2 = 0.148$) compared to sedentary males (Hedges' g = 0.01). Right side plank exhibited a substantial and significant interaction for active males (Hedges' g = 0.65, $F = 14.08$, $p = 0.001$, $\eta^2 = 0.287$), with sedentary males showing negligible effect (Hedges' g = 0.01). Lastly, DLL indicated a large and significant negative interaction effect for active males (Hedges' g = -0.74, $F = 16.933$, $p < 0.001$, $\eta^2 = 0.326$), compared to a small positive effect in Sedentary males (Hedges' g = 0.12). The findings of this trial provide valuable insights into the effectiveness of the McGill Big Three (MGB3) exercise program on core muscle function in sedentary males. The six-week intervention showed varying degrees of improvement in core muscle function across different measures, with significant differences between the active and sedentary groups. his study confirms that a six-week program of the McGill Big Three exercises can significantly improve core muscle function in sedentary males. These exercises are particularly effective in enhancing flexion and overall core stability, while also providing substantial benefits in reducing spinal loading. Future research should explore long-term adherence to these exercises and their impact on other populations, including females and older adults, to further validate the effectiveness and generalizability of the MGB3 exercise program.

Keywords: McGill Big, Sedentary lifestyle, Exercise intervention, Core strength & stability

Differences in 3D Spine Posture Parameters Between Active and Sedentary Males

Tijana Šćepanović[1], *Miloš Kojić[1], Dragan Marinković[1], Borislav Obradović[1], Ivana Milovanović[1], Jelena Paušić[2]

[1]Faculty of Sport and Physical Education, University of Novi Sad, Serbia; [2]Faculty of Kinesiology, University of Split

*Corresponding author

ABSTRACT

Active males often exhibit more balanced spinal curvatures and better alignment due to regular exercise, while sedentary counterparts may suffer from exaggerated curvatures and poor posture due to inactivity. This study evaluated differences in spine posture parameters between active and sedentary males. 128 male participants (Age: 21.0±0.5 years; Body height: 181.3±6.03 cm; Body mass 77.08±9.97 kg) were included in this cross-sectional study. We used a laboratory-calibrated Contemplas 3D photometric system and a specific protocol to evaluate Cervical, Thoracic and Lumbar displacement in the frontal plane and Frohner posture index. Multivariate analysis of variance (MANOVA) and Univariate analysis of variance (ANOVA) was used to evaluate differences between active (N=41) and sedentary (N=87) males in 3D spine posture parameters on a statistical level of $p=0.05$. Significant differences were observed in the cervical ($F = 8.651$, $p = 0.004$, $\eta^2 = 0.064$), thoracic ($F = 7.767$, $p = 0.006$, $\eta^2 = 0.058$), and lumbar ($F = 5.095$, $p = 0.026$, $\eta^2 = 0.039$) spine displacement, indicating better alignment in active males. However, the Frohner posture index did not significantly differ ($F = 0.778$, $p = 0.380$, $\eta^2 = 0.006$). The multivariate analysis of variance (MANOVA) further confirmed an overall significant difference in spine posture parameters between the groups ($F = 2.549$, $p = 0.043$, $\eta^2 = 0.077$). The results of this study indicate that physical activity has a significant positive impact on 3D spine posture parameters. Active males demonstrated better alignment in the cervical, thoracic, and lumbar regions of the spine than their sedentary counterparts. These findings highlight the importance of regular physical activity in maintaining optimal spinal posture and preventing related health issues. The findings can inform exercise recommendations by encouraging the development of targeted programs to improve spinal alignment and reduce postural deviations.

Keywords: Spinal Displacement, Musculoskeletal Health, 3D analysis, Posture Analysis

Stature and Its Estimation Utilizing Length of Foot Measurements of Both Gender Adolescents from Kosovo

*Fitim Arifi[1,2], Vullnet Ameti[1], Shpresa Memishi[1], Valbone Hasani-Arifi[3]

[1]University of Tetovo, Physical Education and Sport, Tetovo, North Macedonia; [2]Kosovo Olympic Academy, Olympic Committee of Kosovo, Prishtina, Kosova; [1]University of Prishtina, Physical Education and Sport, Prishtinë, Kosova

*Corresponding Author

ABSTRACT

The purpose of this research was to examine the stature of adolescents of both genders from Kosovo, as well as the relationship between foot length and standing height. The subjects who participated in this study included 993 boys and 894 girls, the average age was 18.23 ± 0.44 years (range 18-20 years) for girls and 18.24 ± 0.46 years (range 18-20 years) for boys. Measurements of standing height and foot length were taken according to the ISAK protocol (Marfell-Jones, Olds, Steele, & Carter, 2006). The results for the average height and foot length were analyzed using descriptive statistics. The relationships between these measurements were examined using simple correlation with a ninety-five percent confidence interval. A comparison of means of standing height and foot length between genders was performed using a t-test. Then, linear regression analysis was carried out to estimate body height based on foot length measurements. The results obtained in this study show that standing height can be estimated from foot length, which reliably predicts standing height for both genders.

Keywords: **S**tanding Height, Foot Length, Boys and Girls

Health Status and Health Literacy Among Recreational Nordic Walkers

*Marijana Geets-Kesić[1], Petra Rajković Vuletić[1]

[1]University of Split, Faculty of Kinesiology, Split, Croatia

*Corresponding author

ABSTRACT

The influence on health outcomes of health literacy (HL), including the relationship between recreational physical activities (PA) and health status, is an area of growing interest. This study was designed to evaluate the association between HL scores and health status variables, namely hemoglobin levels; glucose levels; and lipid profiles, for individuals participating in Nordic Walking. A cross-sectional study was conducted involving 44 individuals (95.5% female) with average age 62.29 (range from 42 to 87 years) who regularly participate in Nordic walking. Health status was assessed through measurements of hemoglobin levels, glucose levels, and lipid profiles (lipid profiles consisted of 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. HL was evaluated using a standardized HL questionnaire (HLS-EU-Q47). While levels of hemoglobin (16.65±17.57 g/dL), and glucose (4.93±0.88mmol/L) were good, participants exhibited dyslipidemia (higher level of TCHOL, LDL-C, and non-HDL-C and low plasma level of HDL-C) with TCHOL 6.41±1.53 mmol/L; TG 1.64±0.65 mmol/L; HDL-C 1.70±0.42 mmol/L; LDL-C 3.92±1.40 mmol/L and non-HDL-C 4.70±1.48 mmol/L. A limited level of HL was observed among the participants (32.57±6.66). No significant association was found between HL scores and any of the health status variables (hemoglobin levels, glucose levels, and lipid profiles). Recreational individuals engaged in Nordic walking maintain favorable hemoglobin and glucose levels but can demonstrate poor maintenance of lipid profile values. Despite limited levels of HL, no significant associations were found between HL and the measured health status variables. These findings suggest that while HL is important, other factors like diverse exercise modalities or different forms/ level of PA or dietary patterns may play a more critical role in determining the health outcomes of recreational individuals involved in Nordic walking and therefore should be further explored.

Keywords: physical activity, glucose, hemoglobin, lipid profile, dyslipidemia

Attitudes and Motivation of Physical Activity of Pregnant Women

Ivana Čerkez Zovko[1], Vajdana Tomić[2], *Martina Rezić[1]

[1]University of Mostar, Faculty of Natural Sciences, Mathematics and Educational Sciences, Bosnia and Herzegovina; [2]University of Mostar, Faculty of Health Studies; Bosnia and Herzegovina

*Corresponding author

ABSTRACT

Physical activity during pregnancy can have many benefits for both mother and child and all women have the possibility to promote a healthy lifestyle that brings positive long-term effects. Regardless of numerous benefits of physical activity many pregnant women stay physically inactive. This is partly related to women's attitudes and motives during pregnancy. This research included 120 pregnant women with an average age of 28.4 years from the cantonal hospital "dr.fra Mihovil Sučić" Livno where physical activity was tested by a questionnaire. Results are tested in the Statistica program and they are presented using descriptive statistics. Difference between attitudes of physically active and inactive pregnant women was calculated using T-test for independent samples. Results of independent T-test showed that there is statistically significant difference between attitudes of physically active and inactive pregnant women (t-value=3,36; p=0,00). Pregnant women believe that physical activity is healthy and safe if it is done in a quality and proper manner. Main motives for physical activity are prevention of health problems and complications in pregnancy and enjoyment and sense of satisfaction. Physically inactive pregnant women mentioned complications in pregnancy and doctor's prohibition of exercise as the most common reason for physical inactivity. Results showed that pregnant women in general have a positive attitude towards physical activities and exercise during pregnancy. Therefore, prenatal programmes of quality activity during pregnancy should be ensured.

Keywords: pregnancy, health, prevention of health problems, motivation, activity

Physical Activity of Pregnant Women in The Herzeg Bosnia Canton

Gabrijela Krišto[1], Ivana Čerkez Zovko[2], *Vladimir Pokrajčić[2]

[1]Livno County Hospital, Bosnia and Herzegovina; [2]University of Mostar, Faculty of Natural Sciences, Mathematics and Educational Sciences, Bosnia and Herzegovina

*Corresponding author

ABSTRACT

Pregnancy is one of the most sensitive periods in a woman's life accompanied by numerous physiological and emotional changes. Therefore, it is important to ensure optimal care for the health of mother and baby. At that stage, physical activity has numerous benefits for health and reduces risks of complications and eases labor recovery after it. This research included 120 pregnant women with an average age of 28.4 from the cantonal hospital "dr.fra Mihovil Sučić" Livno, where physical activity was tested through a questionnaire. Results were tested in the Statistica program and calculated and presented using descriptive statistics and graphs. Results showed that 57% of pregnant women were physically active before pregnancy while 43% of them were inactive. During the pregnancy 54% of pregnant women remained physically active and 46% of them were inactive. Of the total sample of pregnant women, 9% of them had a diagnosis of gestational diabetes and 15% of them had diagnosis of gestational hypertension. Pregnant women mentioned walking and low-intensity activities as the most common activity. The most common reasons for physical activity among pregnant women are enjoyment in physical activity and prevention of health problems. Of the total 46% pregnant women who were physically inactive during pregnancy, doctors prohibited to exercise to 18% of them. Reasons for physical inactivity are lack of time and inconsistency with their work duties and too many household duties. Walking as physical activity most done by pregnant women is recommended to all pregnant women. All other activities are recommended with the permission of a doctor and have to be done moderately and controlled in adequate conditions.

Keywords: pregnancy, health, prevention of health problems, walk, activity

Effects of Aerobic Exercise Interventions on Endothelial Function in Adults: An Inter-Individual Response Difference Meta-Analysis (ACT-ON study)

Armin H. Paravlic[1,2], *Kristina Drole[1]

[1]Faculty of Sport, University of Ljubljana, Ljubljana, Slovenia; [2]Science and Research Centre Koper, Institute for Kinesiology Research, Koper, Slovenia

*Corresponding author

ABSTRACT

The aim of this study was to identify the most effective form of physical exercise for improving brachial artery flow-mediated dilatation ($_{ba}$FMD) and investigate whether true inter-individual response differences (IIRD) occur as a result of exercise intervention on $_{ba}$FMD in adults. Six online databases were systematically searched from inception to May 22nd, 2024. Only randomized controlled studies investigating the effects of exercise interventions on $_{ba}$FMD in adults were included. To address our questions, pairwise meta-analyses were performed using standardized mean differences (SMD) as the effect measure. In total, 14 studies with 615 participants (38% male) were included in the final analyses. A *moderate* increase in $_{ba}$FMD (SMD, 0.86; 95% confidence interval [CI], 0.27 to 1.35, $p = 0.001$) was observed in the exercise intervention group, compared to control group. Subgroup analysis showed a similar increase following both continuous (SMD, 0.88; 95%CI, 0.15 to 1.61; $p = 0.021$) and interval aerobic training (SMD, 0.89; 95%CI, 0.21 to 1.56; $p = 0.017$). Additional analyses indicated that the intensity of exercise tends to moderate the magnitude of the effect on $_{ba}$FMD ($p = 0.057$), with high-intensity interval training (HIIT) being the most effective form of exercise (SMD, 1.03; 95%CI, 0.45 to 1.62; $p=0.005$). Finally, the IIRD analysis showed a greater standard deviation of individual response difference (SD_{IR}) in the exercise group than in the control (SD_{IR}, 0.20; 95%CI, 0.11 to 0.28; $p < 0.0015$), with interval aerobic training showing greater effects (SD_{IR}, 2.90; 95%CI, 1.82 to 3.96; $p < 0.001$) than continuous aerobic training (SD_{IR}, 1.93; 95%CI, 0.85 to 0.301; $p < 0.001$). True IIRD can be attributed to the training itself, as the observed variation in $_{ba}$FMD was significantly greater in the exercise group compared to the control group. Physical exercise interventions are positively associated with improvements in $_{ba}$FMD in adults, with HIIT being the most effective form of exercise. Additionally, true IIRD can be attributed to the training itself, as the observed variation in $_{ba}$FMD was significantly greater in the exercise group compared to the control group.

Keywords: brachial artery, flow-mediated dilatation, health, physical training, IIRD

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The Attacking Phase of The World Championship in Football 2014

*Nebojša Đošić[1,2]

[1]Independent researcher; [2]Sports Association of City Public Transport Company, Novi Sad, Serbia

*Corresponding author

ABSTRACT

It is known that the analysis of technical-tactical and fitness characteristics of individual athletes and teams has been applied for decades in major competitions. The obtained results were later used in the selection of athletes and in the programming of the training process. A total of 96 matches played in the group stage of the World Championship 2014 were analyzed. The match reports were downloaded from site www.fifa.com. 9 characteristics of the attack phase were compared between the National teams that qualified for the continuation of the competition and the National teams that finished with the further competition: ball possession in total %, ball possession in defense zone%, ball possession in the zone of attack organization %, ball possession in the end zone of the attack %, active playing time, corners, shots towards the goal, shots within the goal and goals scored. In addition to descriptive statistics, the Mann Whitney U test was used to determine differences. The National teams that made it to the 1/16 finals and the National teams that finished with the further competition made the same number of shots towards the goal and into the frame of the goal, 991 each. However, the National teams that continued the competition scored 90 goals, and the National teams that finished the competition after the group stage scored 46 goals. Statistically significant differences $p = .001$ were determined only in that variable using the Mann Whitney test. In all other analyzed characteristics of the attack phase, no statistically significant differences $p > 0.05$ were found. The obtained results are important for coaches because they indicate the need to pay more attention in the training process to improving the accuracy of the final shot at the goal. For football theorists and researchers, this is important because they can be used to make comparisons with previous or later competitions of the same or different level. Of all 9 analyzed characteristics of the attack phase using the Mann Whitney U test, statistically significant differences were found in goals scored $p = .001$. In all other analyzed characteristics of the attack phase, no statistically significant differences $p > 0.05$ were found. The shortcoming of this research is that a large number of technical-tactical and racing characteristics of the attack phase were not included.

Keywords: attack phase, possession of the ball, accuracy of football players

Gender Differences in Management Style and Health Literacy Among Elementary School Principals

Nevenka Maras[1], Borna Nemet[2]

[1]University of Zagreb, Faculty of Teacher Education, Croatia; [2]University of Las Vegas Nevada, College of Education, USA

*Corresponding author

ABSTRACT

This study investigates gender-based differences in management style and health literacy among elementary school principals. The sample comprised 25 male and 41 female principals. A comprehensive management style questionnaire, incorporating subdomains of interpersonal relations and management approach, was administered alongside health literacy assessments. The health literacy assessments had a maximum score of 50, indicating excellent literacy. Basic anthropometric measurements were also recorded. Due to the non-normal distribution of some variables, the Mann-Whitney U test was employed for statistical analysis. Results indicated significant gender differences in several areas of management style. Male principals exhibited higher scores in overall management style (mean=2.78, SD=0.67) compared to female principals (mean=2.82, SD=0.61, U=311.50, p=0.008). Additionally, attitudes towards work and interactions with students differed significantly between genders, with male principals scoring higher (mean=2.39, SD=0.77) than their female counterparts (mean=2.49, SD=0.69, U=322.50, p=0.012). Furthermore, male-specific questions revealed significant differences (mean=2.79, SD=0.36) when compared to female-specific responses (mean=2.88, SD=0.29, U=283.50, p=0.012). Interestingly, health literacy scores showed no significant gender disparity. Male principals had a mean score of 35.25 (SD=8.57), while female principals had a mean score of 31.80 (SD=9.41; U=355.50, p=0.268). This lack of significant difference in health literacy suggests that while management styles vary by gender, health literacy levels among school principals are relatively uniform across genders. The findings underscore significant gender-based differences in management styles among school principals, while health literacy levels appear unaffected by gender. These results highlight the importance of considering gender in educational leadership, as it can have a substantial influence on management practices and interpersonal relations within schools. Understanding these differences can help in designing targeted professional development programs that cater to the unique management style needs of male and female principals. This approach can potentially enhance the effectiveness of school leadership and improve overall school performance.

Keywords: Management Style, Educational Leadership, Health Literacy, Elementary School Principals, Gender-based Differences

Respiratory Muscle Performance Before and After Open Water Breath-Hold Dives

*Joseph W Duke[1], Colin D Hubbard[1], Dario Vrdoljak[2], Geoff B Coombs[3], Troy J Cross[4], Andrew T Lovering[5], Ivan Drvis[6], Željko Dujić[6], Nikola Foretic[2]

[1] Department of Biological Sciences, Northern Arizona University, Flagstaff, AZ, USA; [2]Faculty of Kinesiology, University of Split, Split, Croatia; [3]School of Psychology and Sport Science, Bangor University, Bangor, Wales; Faculty of Medicine and Health, The University of Sydney, Sydney, NSW, Australia; [5]Department of Human Physiology, University of Oregon, Eugene, OR, USA; [6]Department of Integrative Physiology, University of Split School of Medicine, Split, Croatia

*Corresponding author

ABSTRACT

Breath-hold diving for sport or recreation is physically and psychologically demanding, particularly when done in open water. Even submaximal breath-holds pose a significant challenge to many physiological systems. To date, no previous research has investigated the impact of diving on respiratory muscle strength. To address this, we studied 7 (2 female) well-trained and experienced breath-hold divers on the island of Murter before and after 3-4 hours of freediving. We assessed respiratory muscle strength by quantifying maximum inspiratory (MIP) and expiratory pressure (MEP) generating ability. MIP was quantified by having participants exhale completely and then inhale maximally against a closed tube. MEP was quantified by having participants inhale completely and then exhale maximally against a closed tube. Pressure inside of the tube during both maneuvers was taken to reflect global inspiratory or expiratory muscle pressure generating ability. Respiratory muscle fatigue was considered present if MIP and/or MEP decreased by 15%. MIP decreased from -144.6 ± 7.9 to -131.1 ± 9.8 cm H_2O ($p = 0.011$) and MEP decreased from 186.7 ± 34.8 to 164.6 ± 32.1 cm H_2O ($p = 0.031$). However, the average reduction in MIP and MEP were only 9.2 ± 5.7% and 11.4 ± 9.8%. Breath-hold dives, even when not maximal, are physiologically taxing and elicit changes in function of the respiratory muscles. Importantly, the level of reduction does not appear to be physiologically meaningful as it did not meet our threshold for the presence of fatigue. These data are preliminary and more data is needed to definitively conclude that submaximal dives in open water do or do not cause respiratory muscle fatigue.

Keywords: fatigue, apnea, spearfishermen

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Diaphragm Strength Decreases Following Maximal Apneas

Colin D Hubbard[1], Dario Vrdoljak[2], Geoff B Coombs[3], Troy J Cross[4], Andrew T Lovering[5], Ivan Drvis[6], Željko Dujic[6], Nikola Foretic[2], and Joseph W Duke[1*]

[1]Department of Biological Sciences, Northern Arizona University, Flagstaff, AZ, USA; [2]Faculty of Kinesiology, University of Split, Split, Croatia: [3]School of Psychology and Sport Science, Bangor University, Bangor, Wales; [4]Faculty of Medicine and Health, The University of Sydney, Sydney, NSW, Australia; [5]Department of Human Physiology, University of Oregon, Eugene, OR, USA; [6]Department of Integrative Physiology, University of Split School of Medicine, Split, Croatia

*Corresponding author

ABSTRACT

Apnea or breath-hold diving is a sport or activity that has been shown to increase energetic demand by the respiratory muscles a maximal breath-hold. However, to date, it is unknown whether or not the diaphragm becomes fatigued following a maximal breath-hold. To address this question, we recruited 7 male, experienced freedivers to participate in our experiment. Diaphragm pressure (P_{DI}) was measured via stimulation of the phrenic nerves pre- and post- a breath-holding protocol. The protocol included a series of 3 preparatory apneas with 2.5 minutes of rest in between, followed by 3 maximal apneas with 5 minutes of rest in between. Fatigue was considered present when P_{DI} declined by >15%. Post measurements of P_{DI} were taken 7 minutes following the final maximal apnea. Pre- and post-P_{DI} was compared via a paired one-way t.test. We found that P_{DI} declined significantly from 46.4 ± 13.5 to 39.4 ± 14.7cmH_2O ($p = 0.006$). Pdi declined on average 16.5% from baseline. Our preliminary findings suggest that the diaphragm becomes fatigued following a series of maximal, static, dry apneas. Not only was the change statistically significant, but it exceeded the threshold for the presence of fatigue. This demonstrates that the reduction in diaphragm strength is physiologically meaningful. The mechanism of fatigue is currently unknown, but it could be the result of isometric contraction of the respiratory muscles and/or involuntary breathing movements that occur during a maximal apnea. More data will be collected to further explore this diaphragm fatigue and future work will aim to elucidate the implications of the fatigue.

Keywords: fatigue, respiratory muscle, breath-hold, diving, IBM

Contribution of Anthropometrics and Wetsuit Thickness to The Maintenance of Core Temperature in SCUBA Divers

Karleigh E. Bradbury[1], Kaitlyn G. DiMarco[1], Igor Glavičić[2], Otto Barak[3], Željko Dujić[4], Andrew T. Lovering[1*]

[1]Department of Human Physiology, University of Oregon, Eugene, Oregon, USA; [2]Department of Marine Studies, University of Split, Split, Croatia; [3]Faculty of Medicine, University of Novi Sad, Serbia; [4]Department of Integrative Physiology, University of Split School of Medicine, Split, Croatia

*corresponding author

ABSTRACT

SCUBA diving is enjoyed by ~6 million people around the globe. SCUBA divers are often exposed to water temperatures that are far below the water temperature that would be considered thermoneutral for humans (~34-35°C), which can be detrimental to physical and cognitive performance and even life threatening. The goal of this study was to quantify the individual and combined influences of wetsuit thickness and anthropometric data on core temperature (Tc) changes during SCUBA dives, which is currently unknown. 31 divers (4 females) participated in the study in Bol Croatia, bottom and surface water temperatures were ~17.5°C and ~24.5°C, respectively. Participants completed one of two dive protocols: 18 m of seawater for 47 min or 30 m of seawater for 20 min. Tc was measured pre- and post-dive using a telemetric pill. Relationships between rate of change in core temperature (ΔTc/min) vs anthropometric factors including wetsuit thickness, body mass (BM), body surface area (BSA), body mass index (BMI) and BSA: BM were analyzed using linear regressions, significance accepted at $p < 0.05$. The strongest positive associations with the ΔTc/min were found when multiplying wetsuit thickness in millimeters by BM ($r^2 = 0.32$, $p = 0.001$), BMI ($r^2 = 0.31$, $p = 0.001$), and BSA ($r^2 = 0.29$, $p = 0.002$). There was a negative linear relationship between BSA:BM and ΔTc/min ($r^2 = 0.28$, $p = 0.003$). The practical implications of these results are that although someone with a high BSA:BM may have a greater decrease in Tc compared to someone with a low BSA:BM, these changes in temperature can be mitigated by selecting a thicker wetsuit. Conversely, an individual with a higher BM will be able to select a thinner wetsuit and be able to maintain Tc. These data suggest that core temperature regulation during recreational SCUBA diving can be facilitated in part by the appropriate choice of wetsuit thickness for a given set of anthropometric characteristics.

Keywords: hypothermia, non-decompression dive, behavioral thermoregulation

The Relationship Between Explosiveness of Lower Limbs, Range of Motion and Strength of Dorsiflexion and Plantarflexion, Unilateral Balance in Adolescent Elite Football Players

*Duje Radman[1], Željko Kovačević[2], Jelena Paušić[3]

[1]HNK Hajduk, Split, Croatia; [2]Univeristy of Split, University Department of Health Studies, Croatia; [3] Faculty of Kinesiology, University of Split, Split, Croatia

*Corresponding author

ABSTRACT

Explosiveness is crucial for young soccer players as it enhances their speed, agility, and ability to change direction quickly, all of which are vital elements for success on the field. This study investigates the relationship between lower limb explosiveness and the range of motion (ROM) in plantar and dorsiflexion, peak strength in these movements, and unilateral dynamic balance and ankle joint stiffness. Pilot study is conducted on a sample of 15 elite adolescent football players, aged 14-16, from a first national league club. Ankle range of motion (plantar and dorsal flexion) was measured with EasyAngle goniometer, while for strength of same movements was used EasyForce dynamometer. Unilateral balance was measured with Biodex Balance system and the Athletic Single Balance Test. Explosiveness of lower limbs was measured with Drop jump test conducted on OptoGait system. Data was analyzed with Forward stepwise regression analysis (Statistica, TIBCO Software Inc). The research confirmed a dependance of drop jump performance on several key factors: greater plantar flexion ROM (β=0,47; p=0,019), lesser dorsiflexion ROM (β=-0,44; p=0,027), and higher peak strength in plantar flexion (β=0,55; p=0,009). The coefficient of multiple correlation indicated a high degree of correlation among the three specified variables with explosiveness measured by the drop jump test (R=0.83), with a coefficient of determination of 68%. The obtained stepwise forward regression model is statistically significant at the 0.005 level of significance. Results indicated that greater flexibility in plantar flexion allows for more effective force generation and energy storage during explosive movements. Conversely, limited dorsiflexion ROM helps maintain stability and control during the loading phase of the jump. Additionally, higher peak plantar flexion strength was associated with better performance in the drop jump, emphasizing the importance of these muscles in explosive athletic activities. Unilateral balance, measured through dynamic tests, also showed significant correlation, suggesting that balance training could enhance explosive performance in young athletes. The study highlights the importance of plantar flexion strength and ROM, along with unilateral balance, in improving lower limb explosiveness in adolescent football players. Further research is needed to explore these relationships in bigger sample of adolescent football players, different athletic populations.

Keywords: young athletes, soccer, EasyForce, EasyAngle

Influence of Different Types of Plyometric Training on The Ability of Acceleration of Young Soccer Players

Emin Mujezinović[1], Fuad Babajić[1], Edin Užičanin[1]

[1]Faculty of Physical Education and Sport, University of Tuzla, Bosnia and Herzegovina

*Corresponding author

ABSTRACT

The main aim of the research is to determine the difference in the influence between the two applied protocols (Unilateral and Bilateral), on the ability of acceleration, according to the results obtained, to determine the influence of both programs. For the purposes of this research, the sample was taken from the population of active young athletes, soccer players (N=30), chronological age of 14 years. By random selection two equal groups were formed (EG; = 15) unilateral group, (CG ; = 15) bilateral group. This research deals with the influence of unilateral and bilateral plyometric training, applied as an integral part of soccer training, and conducted for 8 weeks, with three training units in one week. In order to determine the existence of initial differences between treatment groups, an independent samples t-test was used. The differences before and after treatments within the groups were determined using the t-test of paired samples, for each group individually, in order to determine the differences in the treatments, a combined analysis of variance (2x2 / time x group) was used. Both applied protocols were equalized according to the total load volume, the number of foot contacts with the ground and the character of the jump performance. To check the ability of acceleration, the test was a sprint at 5 and 20 meters. The results show that there are no differences between the treatment groups, but absolute effects were achieved in both groups. The 5 and 20 meters sprint test improved equally in both groups ($p<0.05$). In conclusion Unilateral and Bilateral plyometric training lasting eight weeks led to significant improvements (pre/post = $p<0.05$) of sprint-type explosive power (acceleration ability) and planned agility, but without statistically significant differences in the magnitude of the effects between training groups. A detailed analysis of each group separately revealed significant progress over time in both observed groups ($p<0.05$). A greater progress of the BIL group is noticeable on the five-meter sprint variable (UNI = - 8.02%* ; BIL - 9.9%*), while on the twenty-meter sprint variable, the situation is reversed, where the unilateral group achieves somewhat greater significant progress (UNI= -7.49%* BIL= -7.09%*). However, no significant difference was found in the size of the effects between the groups. Unilateral and bilateral plyometric trainings lasting eight weeks led to significant improvements (pre/post = $p<0.05$) in sprinting explosive power, more precisely in the ability to accelerate up to 5 and 20 meters, but without statistically significant differences in the magnitude of the achieved effects between the training group ($p<0.05$).

Keywords: jumps, unilateral plyometric, bilateral plyometric, stretch-shortening cycle, youth athletes

Knowledge and Attitudes af Soccer Players in Younger Age Categories About Preventive Fitness Programs

*Mate Brekalo[1], Ivan Kvesić[1], Ninoslav Šilić[1]

[1]Faculty of Science and Education, University of Mostar, Bosnia & Herzegovina

*Corresponding author

ABSTRACT

Professional athletes are subjected to higher levels of exertion than others, which increases the risk of injury. Each sport causes different stressors on specific somatic sites, qualitatively and quantitatively, and not everyone is at the same risk of the same injuries. Injuries affect an increasing number of young athletes, therefore education and knowledge about preventive fitness programs are imposed as solutions. The research was conducted during January 2023 on a total sample (n=138) of soccer players of cadet and junior age in soccer clubs Zrinjski, Široki Brijeg by means of a questionnaire. The survey questionnaire was distributed online, via the Google Forms platform, the data was processed with the Microsoft Office Exel SPSS program system, and the Chi-square test was used to test differences between categorical variables. A probability level of $p<0.05$ was taken as statistically significant. All respondents were male. Of the total sample of 138, 56% belong to the age group of 14-16 years, and 44% to the age group of 17-19 years. The largest number of respondents, 87%, have been playing football for more than 7 years, and 23% of them have been practicing football for 4-6 years. 51.4% declare that they had one or two serious injuries during their football career. The most frequent injury was soft tissue injury, muscle injury, followed by joint injury. The largest number of respondents declared that they were poorly informed about preventive exercises and cited strengthening exercises as the most effective prevention program, although a smaller number of respondents said that they do strengthening exercises regularly. Soccer players in the younger age get the most information about prevention programs from coaches and medical staff, and a smaller number of them from the Internet and social networks. Their interest in prevention education programs indicates the need for the same, both among the coaching staff and among themselves. Preventive fitness programs are imposed as an indispensable factor of the training program. Their presence in daily training can affect the number and severity of injuries in young football players. The research shows the need for additional training of coaching and playing staff on prevention programs.

Keywords: injuries in football, prevention, rehabilitation, amount of knowledge

Acute Flexibility Changes in the Iliotibial Tract Following Active Release Techniques

Matea Bajlo[1], Jelena Paušić[1]

[1]Faculty of Kinesiology Split, University of Split, Split, Croatia

*Corresponding author

ABSTRACT

Active Release Technique (ART) is a soft tissue manipulation therapy used to treat various musculoskeletal conditions and injuries. The iliotibial band (ITB) is important to stabilize the knee and hip during numerous movements and, commonly, excessive tension in the ITB can cause issues which lead to pain and inflammation on the outer side of the knee. However, it is not examined in detail whether ART can be used for the acute release of the ITB tension. Therefore, this study aimed to determine whether there are differences in the flexibility of the ITB after an ART protocol specialized for releasing ITB. The research included 17 active athletes (6 female, 11 males) aged 9 to 20 years. The flexibility of the ITB on both legs was assessed by the EasyAngle goniometer in the movement of adduction and external rotation and extension in the hip joint before (pre-testing) and right after (post-testing) the ART protocol. The paired samples t-test revealed the significant differences between pre-and post-protocol degrees of flexibility in the ITB in the total sample ($t=-8.73$, $p=0.001$), with increased degrees after the ART protocol. This is additionally proven on the dominant ($t=-4.69$, $p<0.001$) and nondominant ($t=-8.93$, $p<0.001$) leg. The results of this study indicated that the ITB flexibility is significantly improved (i.e., increased) on both legs after the ART protocol. This study was performed in an acute setting with only one treatment. Larger study groups with more diverse participants are needed to strengthen the conclusions. The number, frequency and duration of ART use in rehabilitation should be determined for optimal results, which should be the focus of future studies. ART may be useful as a tool in releasing soft tissues as a part of the rehabilitation process in musculoskeletal pathology. However, its effectiveness and optimal frequency and duration should be studied further.

Keywords: soft tissue release, Ober test, hip joint, rehabilitation, flexibility

Success of Alpine Ski Knowledge Acquisition With Regard to Students' Regional Affiliation

*Juraj Segin[1], Matea Šostaric[1], Mauro Nemčanin[1]

[1]Faculty of Kinesiology, University of Zagreb, Zagreb, Croatia

*Corresponding author

ABSTRACT

Alpine skiing is extremely popular and widespread in a large part of Croatia. Considering the decreasing number of days of natural snow and the proximity of ski centers in neighboring countries, there is a greater interest in recreational skiing in some parts of Croatia. Although it is known that skiing skills are influenced by many different factors, the assumption is that students who come from regions where there is a tradition of going on winter vacations will more successfully master the basics of alpine skiing. The aim of this paper was to determine the regional affiliation of alpine ski novices who have successfully mastered the basics of alpine skiing. The research included 270 participants, 188 male and 82 female. All were students of the Faculty of Kinesiology, University of Zagreb. All the participants were ski novices. They were included in a standardized ten-day ski school program. Afterwards, their knowledge of parallel turn and short turn was graded by five independent examiners. Differences between groups were examined using MANOVA. Observing the level of skiing knowledge between respondents who come from different regions of Croatia, no significant difference was found. There were no statistically significant differences between the obtained grades in two tested ski elements and the place of residence for ski novices. A possible reason for not finding a statistically significant difference between the groups is that regardless of whether a region is located closer to a foreign ski resort or there is a culture of going skiing, all the respondents were beginners and their origin does not in any way affect their skiing knowledge. In addition, it is known that learning to ski is influenced by many factors such as motor skills, choice of ski terrain, motivation of the teacher and others, and this research was only focused on their affiliation region which is the main limitation of this research.

Keywords: skiing, begginers skiers, ski school

Effects on the Gait Cycle and Balance Control Of Different Volumes of Stretching Applied to A Single Lower Limb

*Marco Alessandra[1], Andrea De Giorgio[2]

[1]Department of Life Sciences and Systems Biology, University of Turin, Turin, Italy; [2]Faculty of Psychology, eCampus University, Novedrate (Co), Italy

*Corresponding author

ABSTRACT

Previous studies have explored the effects of different volumes of stretching on range of motion and flexibility as well as sport performance. Additionally, a substantial body of literature has highlighted the effects of unilateral static stretching, including positive effects on contralateral hip flexion range of motion, a reduced rate of force generation in the non-stretched limb indicating the presence of a cross-over inhibitory effect, and involvement of supraspinal mechanisms. However, to the best of our knowledge, no study has specifically investigated the effects of static stretching on walking and balance control. The aim of this comparative study is to compare the effects of two different volumes of unilateral stretching (60 and 180 seconds) on gait analysis, podobarometric and stabilometric variables. Thirty healthy adults were recruited and divided in two-groups: a group that performed 1-minute of stretching (1M) and a group that performed 3-minute of stretching (3M). The following tests were conducted: podobarometric and stabilometric test and gait analysis. After baseline measurements, both groups performed calf stretching on their dominant lower limb. Following this phase another round of podobarometric platform test and gait analysis was performed. ANOVA did not reveal significant differences in the podobarometric and stabilometric variables. Significant difference in the main effect of the Time was highlighted in step length in the left lower limb ($p=0.031$) with an average increase of 4.6 cm (3.5%) and in the pelvic rotation symmetry in the 3M group ($p=0.028$) with an average decrease of 5.8 points (6.6%). Unilateral static stretching in the lower limbs can induce an asymmetry of the step length and pelvic rotation. It was demonstrated that the asymmetry of gait cycle and of the pelvic rotation is associated with a reduced walking velocity, increased energy expenditure, a lower mechanical efficiency and nonspecific chronic low back pain. The subjects who perform prolonged unilateral stretching for rehabilitation or sporting reasons can develop asymmetrical anatomic adaptation and be exposed to skeletal muscle pain and alterations in sports performance. The use of unilateral static stretching must be carefully planned to avoid functional asymmetry of the musculoskeletal structures that can lead to pains and limitations of the mobility.

Keywords: Unilateral static stretching, gait analysis, stabilometric variables, step length, gait inefficiency

Differences in the Amount of Physical Activity Between Students in Upper Grades of Primary and Secondary Schools in Mostar

*Ivan Kvesić[1], Mate Brekalo[1], Ninoslav Šilić[1]

[1]Faculty of Science and Education, University of Mostar, Bosnia & Herzegovina

*Corresponding author

ABSTRACT

Physical activity is key to childhood obesity prevention and contributes to children's overall physical and cognitive health, but less than half of all children achieve the recommended 60 minutes of moderate to vigorous physical activity per day. Schools are the ideal environment where children should receive an initial impulse and guidance on the impact and importance of physical activity on general health. The research was conducted during April 2024 and the survey questionnaire was carried out on a sample of 97 students. Data were used according to gender, age and amount of physical activity. There were 45 male students and 52 female students, of which 55 students attend the eighth and ninth grades of the Third Primary School, and 42 of them attend the third and fourth grades of the Mostar High School. The data were processed with the Microsoft Office, Excel, SPSS program system, and the Chi square test was used to test the differences between categorical variables. A probability level of $p<0.05$ was taken as statistically significant. It was found that 44.8% of students regularly play sports, 31.3% sometimes, and 23.9% not at all. In the studied sample of students, it was determined that 51% of the students who play sports are of an older age, that is, they attend high school, and 49% are of a younger age, that is, they attend elementary school. No statistically significant difference between boys and girls was found among those who declared that they regularly play sports. A larger number of students who regularly engage in physical activity are active participants in some sports clubs, while a smaller number attend fitness centers and they are predominantly high school students. Not a single student who regularly engages in physical activity spends it playing with his peers on school facilities. An insufficient number of children is involved in regular physical activity. A greater number of them are participants in sports clubs, and a smaller number do independent physical activity. The need to promote physical literacy and involve the best staff in the work of children and young people, as well as increasing the number of hours of physical education and health education in the school system, should be the priorities of modern society.

Keywords: physical and cognitive health, physical activity per week, sports club, independent physical activity

Differences In Fitness Preparedness of Candidates for Naval Commandos In Wartime and Peacetime Conditions

*Boris Maleš[1], Boris Milavić[1]

Faculty of Kinesiology, University of Split, Split, Croatia

*Corresponding author

ABSTRACT

The research aimed to determine whether there are differences in the fitness preparedness of soldiers at the end of the primary training for naval commandos in the Croatian Navy, considering the duration and conditions of the training. The first group of soldiers (war group; n = 18) underwent a two-month training at the beginning of 1992 as volunteers of the Croatian war (1991-1995), coming from various units or civilian life. The second group of soldiers (non-war group; n = 19) were candidates for naval commandos of the Croatian navy who underwent four and a half months of training during peacetime, several years after the end of the war, coming exclusively from other units of the Croatian Army. All soldiers had to pass a rigorous primary selection, including a comprehensive health examination ensuring no abnormalities. Afterward, they underwent training of varying durations to acquire military skills and enhance overall fitness. At the end of the training, the soldiers were tested using a series of tests: PULL-UP - pull-ups with an overhand grip, 6X50m - running on a 6X50 meter course with a 180-degree change of direction, long jump, 1500m - running on a 1500meter course. After preliminary descriptive procedures, differences between groups were calculated using the T-test. Statistically significant differences between the groups were found in the running on the 6X50m ($t = -2.05$; $p < 0.05$) and long jump ($t = 2.53$; $p < 0.05$), where the war group performed better than the non-war group. The non-war group consisted of soldiers with an average age of 22 years, who, as already mentioned, came to the training from military units, while the majority of the war group (with an average age of 25 years) were athletes, with almost half of them being final-year students or graduates of kinesiology studies. It can be assumed that most of the candidates from the war group possessed a higher level of specific kinesiology knowledge, which they acquired during their kinesiology studies. Since there was no initial measurement, this experimental model has limitations for a reliable interpretation of the results.

Keywords: naval commandos, military training, fitness preparedness

Impact of Anticipation on Electrodermal Activity and Stress Responses During a Backward Fall: Implications for Fall-Learning Exercise Program

*Saša Krstulović[1], Goran Kuvačić[1], Maria del Carmen Campos Mesa[2], Carolina Castañeda Vázquez[2], Raúl Fernández García[3], Edoardo Genovesi[4], Miguel Angel Lira[5], Kata Morvay Sei[6], Juan Carlos Pastor Vicedo[7], Roberto Sánchez Reolid[7], Oscar del Castillo Andrés[2],

[1]University of Split, Croatia; [2]University of Seville, Spain; [3]Universitat Politècnica de Catalunya, Spain; [4]Università degli Studi di Milano, Italy; [5]University of Barcelona-INEFC, Spain; [6]University of Pécs, Hungary; [7]University of Castilla-La Mancha, Spain

*Corresponding author

ABSTRACT

Understanding how different anticipatory conditions impact physiological stress responses is critical for designing effective training programs, especially in high-stress scenarios such as fall prevention and recovery. This study investigates the electrodermal activity (EDA) responses of participants performing a backward fall under varying conditions of anticipation and awareness. Specifically, it examines how these conditions influence initial stress responses. Forty fifth-grade students were randomly assigned to two groups performing a backward fall task. Group A (n = 20) was unaware of task and when they would be released to fall, while Group B (n = 20) was aware of task and received a countdown ("3, 2, 1") before release. EDA signals were collected using the Empatica E4 wristband, a commercial wearable device with sensors for measuring physiological signals, including EDA. The device was securely attached to the participant's wrist to ensure accurate data collection. A T-test was used to analyze the differences between the groups. Group B, which was subjected to a countdown, exhibited a higher Skin Conductance Response peak count (SCR: Group A = 717 vs. Group B = 831.43; t = -2.136; $p = 0.039$) and Long-term Activation (AL; Group A = 717.61 vs. Group B = 832.49; t-Statistic: -2.141; $p = 0.038$). Additionally, Shannon Entropy was significantly higher in Group B (group A = 9.12 vs. group = B: 9.45; t = -3.309; p = 0.002). Implementing a structured anticipation technique, such as a countdown, leads to a notable increase in physiological stress responses. This is supported by greater skin conductance response (SCR) peaks, persistent activation, and increased signal complexity. Data indicate that awareness of an upcoming event increases emotional responsiveness and stress levels. Reducing pre-existing anxiety could improve performance during the first evaluations in experimental educational programs such as learning how to fall. Nevertheless, organized anticipation can elicit a genuine stress reaction, equipping individuals to face real-life instances of falling. This study demonstrates the impact of expectation on stress reactions, revealing that organized anticipation leads to heightened electrodermal responsiveness. These findings are significant in developing training programs that effectively manage stress levels while optimizing performance enhancing the ability to learn and complete tasks under stressful conditions. By comprehending these processes, we can formulate more effective techniques for handling stress and bolstering resilience in high-stress situations. The Empatica E4 device and sophisticated signal processing algorithms successfully captured and analyzed EDA data, enhancing the reliability of the study's results.

Keywords: anticipation, falling, learning, school, stress

FULL TEXTS

Student-Centered Approach in Learning Dances

*Katarina Šimunović[1], Alen Miletić[1], Đurđica Miletić[1]

Faculty of Kinesiology, University of Split, Split, Croatia

*Corresponding author

ABSTRACT

In dance education, highlighted goals for student-centred learning approach are to foster autonomy, increased students' responsibility and critical thinking skills. Present research is obtained with two main research goals: (1) to evaluate some metric characteristics (objectivity, sensitivity and homogeneity) of newly constructed tests for assessing the level of performance of dance choreographies of the Pannonian dance zone (*Drmeš, Presjekača –M; Presjekača – F);* and (2) to determine which of the three student-centred teaching methods (individual, couple, or team) will best influence students in the learning of the Pannonian zone dances. The research was conducted on a sample of 58 PE students aged 21 to 24, divided in three research groups according to teaching methods applied as: Individual (N = 7); Couple (N = 17) and Team (N = 34). According to results presented most of the students (58.62 %), chose group-teaching style. Second preferred teaching style is couple (29.31 %), and the fewest percentage of students chose individual teaching style (12.97 %). According to the Tukey post-hoc test, significant differences were obtained between the Individual teaching method and group teaching method in favour of the individual teaching method (p = 0.01). Obtained good metric characteristics of variables presenting Pannonian folk dances could be used in monitoring students own learning with aim to develop the most effective strategies of learning for implementation of student-centered approach on PE classes. Possibility to choose their learning method in dance class could be the good example of student – centered learning approach.

Keywords: **Croatian folk dances, teaching metods, physical education**

INTRODUCTION

Dance education as a part of obligatory education in the Physical education (PE) curricula improve students' motor abilities and health status. Highlighted among other PE content, dance education can improve students' creativity, sensitivity, emotions, originality, inclusion, and understanding between the genders (Mattsson & Lundvall, 2015; Neville & Makopoulou, 2021; Mattsson & Larsson, 2021, Miletić, et al. 2023). Modern education brings new challenges in dance education such as implementation of student – centered learning approach in order to increase students' responsibility, activity and critical thinking skills. In dance education, one central goal for student-centred learning is to foster autonomy and increased responsibility on the part of the student. Both educational approaches, teacher – centered and student - centered are used and applicable in dance education. Generally, teacher-centered approach refers to the traditional transfer of knowledge and skills in a learning environment, in which the teacher has the dominant role, and student-centredness should encourage student's activity and develop critical thinking skills by using problem-solving methods during PE classes (Serin, 2018; Matsuyama, et al., 2019; Miletić et al, 2023). According to Rothmund, (2023) student-centred approach is focused on holistic development through a discovery process, and teacher-centred approach is focused on training of dance artists, with an emphasis on skill acquisition in dance technique. Author, also defines middle model for teaching contemporary dance, as combination of skill acquisition and personal growth through problem solving methods. In student-centered dance teaching classes, the role of the student can be recognized as active participation in creating choreography, making decisions about what and how they will learn, creating new dance patterns based on previously learned dance skills, understanding expectations, and using self-assessment evaluations, monitoring their dance improvement to develop strategies for future learning, working in collaboration with other dancers, demonstration of authentic dance performance (Miletić, 2024). During the learning process, dancers integrate what they have learned before and create new, original dance patterns and choreographies. Finally, a student-centered dance class is expected to develop positive interactions among dancers and provide a supportive environment in which the student feels respected.

To understand better which teaching methods should be preferred and when during dance classes, more scientific data obtained during educational processes are needed. Prerequisite for analysing effect of student – centered approach in dance education is existence of a valid tool for evaluate dance skills in education process. In this process, self-assessment and choreography evaluation should become important part of student-centered learning approach in learning dances. The main importance of this investigation is manifested in the application of student – centered teaching method in learning dances which indirectly affects students' creativity, sensitivity, emotions, originality, inclusion, and understanding between the genders. Also, analysing and implementation of new and effective educational tools are in accordance with today's societies strive to apply the UN's Sustainable Development Goals, (SDGs), for example, Goal number 4, which refers to quality education.

The first goal of the research is to evaluate some metric characteristics (objectivity, sensitivity and homogeneity) of newly constructed tests for assessing the level of performance of dance choreographies of the Pannonian dance zone (*Drmeš, Presjekača – M; Presjekača – F)*. Assessment and metric characteristics applied in this investigation is well known practice (for creating objective measurement tool for assessing level of dance performance (Miletić, 2022) and improvement of dance learning process (Miletić, et al 2023). in education practices. Due to large number of dance structures used in education, each dance needs to be investigated separately metrically. The second goal of the research is to determine which of the three student-centred teaching methods (individual, couple, or team) will best influence students in the learning of the Pannonian zone dances.

METHODS

The first phase of the research was conducted on a sample of 58 PE students of Faculty of Kinesiology, aged 21 to 24, through the Theory and Methodology of Dance course. Two dances of the Pannonian dance zone (*Drmeš and Presjekača)* were selected for research because of their applicability in PE classes. Dance *Presjekača* has two types (male and female version) that are totally different in choreography. Those two forms of the same dance are considered as different variables as: *Presjekača –M* (male version of dance) and *Presjekača – F* (female version of dance). In dance learning process, female and male students were practicing both versions of the *Presjekača* dance in the same way. According to Miletić (2022), the criteria for evaluating the choreography were determined before, and three independent evaluators, experienced dancers and PE professors, evaluated the level of performance of the choreography, in the real time during dance classes, without the possibility of mutual consultation. The evaluation was carried out so that the choreography was broken down into basic sequences or parts, and each sequence was evaluated with a score of 2 (if part of the choreography was performed correctly); 1 (if part of the choreography was performed partially correctly and 0 (if part of the choreography was not performed correctly). The total maximum score for each choreography was 10.

The second phase of the research, student - centered approach was applied in learning process. The students chose one of three methods of teaching and the evaluation of dances independently as: Individual (N = 7); Couple (N = 17) and Team (N = 34). In *Individual* teaching method group, students chose to practice dance steps independently and they were evaluated during independent performance. In *Couple* teaching method group, students chose to practice dance steps in couples, and they were evaluated during couples' performance. In *Team* teaching method group, students chose practice dance steps in groups of five to eight students, and they were evaluated during team performance. The basic dance steps in all teaching methods (individual, couple, or team) were the same. Before the beginning of the study, it was determined whether the students had already had any previous experience in folk dances, and those having such experience did not participate in the study.

Data analysis

The methods for data analysis were chosen according to the set goal of the research, to analyse the metric characteristics of the newly constructed tests for assessing the level of performance of the choreography of the dances of the Panonian dance zone, *Drmeš and, Presjekača.* In order to analyse sensitivity, descriptive statistical parameters were calculated: arithmetic means (AS), standard deviations (SD), minimum scores (MIN), maximum scores (MAX), and the normality of distributions was checked with the Kolmogorov-Smirnov test (KS). In order to analyse the objectivity of the judges, the Cronbach alpha coefficient was calculated, and in order to analyse the homogeneity, the first main component was calculated through factor analysis. In order to determine the influence of different student-centred learning methods on successful dance performance, a one-way ANOVA was used with the independent variable of teaching methods (individual, couple, team). The Tukey post-hoc test was used to determine the significant differences among means. Statistica 13.0 (TIBCO Software Inc, USA) was used for all analyses and a p-level of 95% was applied.

RESULTS

Based on the results of descriptive statistics (Table 1) it can be determined that the test for assessing successful performance of *Drmeš* and *Presjekača* dances from Pannonian dance zone have satisfactory metric characteristics of sensitivity. According to KS test results for all three dance variables does not deviate significantly from the Gaussian curve at the error level of 0.05 and results were distributing normally. The most difficult choreography was *Drmeš*, and then *Presjekača – F* and *Presjekača – M*, according to means results. According to the results of the Cronbach alpha coefficients, all three variables show good measurement characteristics of objectivity, which indicates clearly set and transparent criteria for evaluating the performance of dances *Drmeš* and *Presjekača.*

Table 1. Descriptive statistics, values of the Kolmogorov-Smirnov test (KS) and Cronbach's alpha (Alpha) for variables Drmeš, Presjekača-M, Presjekača - F

Dances	*Mean*	*Min*	*Max*	*SD*	*KS*	*ALPHA*
Drmeš	*6.43*	*1.67*	*10.00*	*2.27*	*.10*	*.90*
Presjekača - M	*7.41*	*2.00*	*10.00*	*1.85*	*.12*	*.87*
Presjekača - F	*7.32*	*1.33*	*10.00*	*2.15*	*.16*	*.92*

**KS test is significant on the level of 0.05 for: d<0.21 (when N=58)*

The latent dimension in the space of evaluator variables (Table 2) explains 80% (*Presjekača - M*) to 87% (*Presjekača – F)* of the total variance of the system of items with a uniform and homogeneous projection of all judges on the common object of measurement. In all three variables, third judge has the highest projections on the common object of measurement.

Table 2. Structure of the latent dimension in the area of components of evaluators

V	Drmeš	Presjekača - M	Presjekača - F
S1	-0.92	-0.84	-0.93
S2	-0.90	-0.90	-0.92
S3	-0.93	-0.94	-0.95
Expl.Var	2.52	2.40	2.62
Prp.Totl	0.84	0.80	0.87

According to results presented (Fig 1) most of the students (58.62 %), chose group-teaching style. Second preferred teaching style is couple (29.31 %), and the fewest percentage of students chose individual teaching style (12.97 %). In order to determine which of the three student-centred teaching methods (individual, couple, or team) will best influence students dance performance, the One-way Analysis of variance (one-way ANOVA) was used (Fig 2) and significant differences were detected (($F=2.34$; $p<0.04$). The Tukey Post Hoc Test was calculated to determine significant differences between means (Table 3). According to the Tukey post-hoc test, significant differences were obtained between the Individual teaching method and group teaching method in favour of the individual teaching method ($p = 0.01$).

DISCUSION

According to presented results all three choreographies are suitable measuring tools for assessing level of dance performance on PE student population. All three variation of dances are performed to a characteristic rhythm of Pannonian dance zone where vertical vibrations of the whole body are produced with small steps. Therefore, it is hard to evaluate level of performance of Pannonian zone dances based only with performance of basic steps. For a complete and accurate assessment of these dance skills, it is more correct to evaluate the overall choreography in the natural rhythm of the Pannonian dance zone. Therefore, satisfactory metric characteristics of Pannonian dances in this investigation presents significant step forward in assessing dance skills in PE classes. At the same time, the existence of valid tests for assessing dance skills enables application of student – centered approach in dance education.

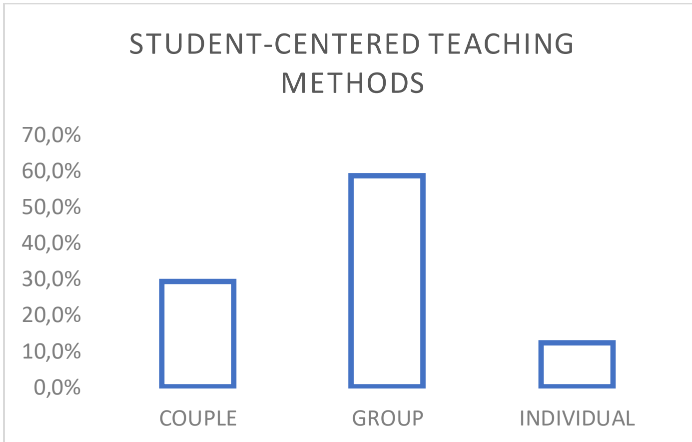

Figure 1 Student preferences in teaching methods

Table 3. Post – hoc Tukey HSD test – differences between three research groups

Groups defined according teaching method			
	P	*G*	*S*
Couple (P)		*0,07*	*0,33*
Team (G)	*0,07*		*0,01*
Individual (S)	*0,33*	*0,01*	

Panonnian dances are originally performed in circles of dancers who performed various types of 'shaking' steps, either in one place or in the moving in one direction or another. During performing of those characteristics steps in fast rhythm, it is important that whole body shakes as a unit from head to toe without being stiff. Therefore, it is not surprising that student most often choose the group teaching method. However, the most successful in performing dances were those students who chose individual teaching method. Probably, those students felt more competent to practice and perform dances alone. Further researches regarding level of performance and motivation climate are necessary to confirm those assumptions.

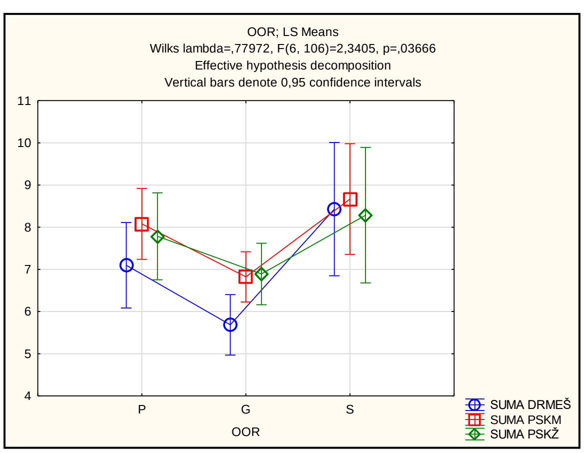

Figure 2. Differences between three student-centred teaching methods (individual-S, couple-P, or team - G) in the performance of Pannonian zone dances (Drmeš, Presjekača –M; Presjekača – F).

The student-centred learning method in PE assumes that students are active participants in their own learning and students can make decision about what and how they will learn. Possibility to choose their learning method in dance class could be the good example of student – centered learning approach. Also, the final result of dance education is student's capability to perform a dances independently with demonstration of authentic learning. The small sample of subjects can also be considered as the main limitation of this research. Therefore, it is recommended to use a larger sample in future research.

CONCLUSION

According to results presented and discussed, students have achieved the best results in the learning of the Pannonian dances in individual teaching method, and most students preferred to practice dances in group teaching method. Students' possibility to participate in the choosing of the teaching method contributes to the student-centred educational process as a whole. Performance of dance choreography is an unique way of student-centered demonstration of authentic learning. In this learning process, good metric characteristics of variables presenting Pannonian folk dances could be used in monitoring students own learning with aim to develop the most effective strategies of learning for implementation of student-centered approach on PE classes.

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The Effect of Biological Age in the Evaluation of Selected Motor Tests in Young Basketball Players

*Jakov Sanader[1], Ana Kezić[1], Tea Bešlija[1]

[1]University of Split, Faculty of Kinesiology, Split, Croatia

*Corresponding author

ABSTRACT

The assessment of motor skills in youth basketball is essential for identifying talent, developing training programs, and monitoring athlete progress. However, the varying biological ages of young athletes complicate the interpretation of motor tests. This study investigates the effect of biological age on the performance of selected strength motor tests in novice male basketball players aged 9 to 14. Using the SonicBone BAUSport™ device for non-invasive skeletal age assessment, we categorized participants into early, on-time, and late maturers. Our findings reveal that skeletal age is, on average, greater than chronological age, with early maturers predominating in basketball. Significant differences in hand grip strength were found between early and on-time maturers in the older age group (12-14 years), but not in the younger group (9-11 years). These results align with previous research indicating that early maturers exhibit superior strength performance due to advanced biological development. The absence of late maturers in our sample suggests that basketball may favor those with earlier physical development, potentially excluding late maturers. These findings underscore the importance of considering biological age in talent identification and training in youth basketball. Future research should continue to explore the long-term impacts of biological age on athletic performance and retention, ensuring that late maturers receive appropriate guidance and support to reach their full potential.

Keywords: SonicBone, ultrasound device, skeletal age, strength, talent identification

INTRODUCTION

In the domain of youth sports, particularly basketball, the assessment of motor skills is crucial for identifying talent, tailoring training programs, and monitoring athlete development. Motor tests are commonly used to evaluate abilities such as agility, speed, strength, and endurance. However, the interpretation of these tests can be complicated by the varying biological ages of young athletes. Biological age, which can differ significantly from chronological age due to factors like genetics and growth rates, plays a pivotal role in physical and motor development (Malina, 2001).

Research has consistently demonstrated that biological age can significantly influence physical performance outcomes. For example, athletes who mature earlier tend to perform better in strength and power tests due to their advanced physical development (Philippaerts et al., 2006). Conversely, late-maturing athletes might show superior skill development in the long term as they catch up physically and have more time to develop technical skills during their formative years (Figueiredo et al., 2009). It is crucial to recognize that in team sports like basketball, skill level often outweighs raw physical ability. This is particularly pertinent when considering the dominance of early maturers in youth sports, which can be a significant oversight in talent development. Emphasizing skill development over physical prowess can prevent the premature selection of early maturers based solely on temporary physical advantages, ensuring a more balanced and long-term approach to athlete development. Doležajová, Gallová, and Lednický (2019) examined the effect of biological age on physical indicators and motor test changes in young female basketball players, finding that biological age significantly influenced test performance outcomes. This study highlights the importance of considering biological age when evaluating youth athletes, as early and late maturers may show different physical and motor profiles. Similarly, Jakovljevic et al. (2016) investigated the relationship between biological maturity status and motor performance in 14-year-old basketball players, demonstrating that maturity status significantly affects motor abilities such as speed, agility, and strength. This research underscores the necessity of accounting for biological maturity when assessing and training young athletes to ensure fair and effective development practices. Further emphasizing this point, Gryko (2021) explored the impact of maturity timing on the physical performance of male Polish basketball players aged 13 to 15 years. The study found that early maturers generally outperformed their later-maturing peers in various physical tests, suggesting that biological maturity provides a temporary competitive advantage in youth sports. Guimarães et al. (2019) investigated how biological maturation and training experience impact the physical and technical performance of 11–14-year-old male basketball players. Their findings indicated that both factors significantly contribute to performance outcomes, with more mature and experienced players displaying superior physical and technical skills. In basketball, a sport that requires a blend of aerobic and anaerobic fitness, agility, and precise motor coordination, understanding the impact of biological age on motor performance is particularly important. Torres-Unda et al. (2013) examined the anthropometric, physiological, and maturational characteristics of elite and non-elite male adolescent basketball players, finding significant differences based on maturity status. This research suggests that early-maturing players often have a competitive advantage during adolescence due to their superior physical attributes, but this advantage may diminish as peers reach similar levels of biological maturity.

Various methods are used to determine biological age, each with its own strengths and weaknesses. Traditional radiographic methods, such as the assessment of skeletal age using hand and wrist x-rays, are highly accurate but involve exposure to radiation and require specialized training to interpret. In contrast, non-invasive methods like the SonicBone device use ultrasound technology to estimate bone maturity, offering a safer and more accessible alternative. These non-invasive methods can be advantageous in settings where quick, repeated assessments are necessary, though they may sometimes lack the precision of radiographic techniques. However, studies have shown that the BAUSport™ system is not only reliable but also offers unique advantages, such as being portable, user-friendly, and applicable to a diverse range of populations. Moreover, the device's ability to perform assessments quickly and non-invasively makes it an attractive alternative to traditional radiographic methods, addressing previous limitations of QUS systems (Brausch et al., 2022). Other methods for estimating biological age include dental age assessment, which evaluates the development and eruption of teeth, the Tanner-Whitehouse method assessing secondary sexual characteristics, genetic and hormonal analyses, measuring markers such as DNA methylation and hormone levels, etc. Each of these methods has its own applications and limitations, making the choice of method dependent on the specific context and requirements of the assessment.

Given these findings, it is clear that evaluating motor performance without considering biological age may lead to inaccurate assessments of an athlete's potential and development needs. The aforementioned studies have dealt with female populations and selected children, but not much attention has been given to novices in youth basketball that are yet to go through the talent identification process. This study aims to explore the effect of biological age on the evaluation of selected strength motor tests in young novice basketball players. By accounting for the variations in biological age, we seek to provide an understanding of motor performance in youth basketball and improve the accuracy of talent identification and development strategies.

METHODS

Participants

The sample for this study consisted of 28 novice male basketball players from one basketball club in Croatia. Their chronological age was from 9 to 14 years. For the purpose of this study, they were divided into two groups: 1st group 9–11-year-olds (N=14) and 2nd group 12–14-year-olds (N=14). The study included children with no health problems and significant motor disorders. The average height of children in the first group was 149.9±8.1 cm, while their average weight was 42.3±9.3 kg. The average height of children in the second group was 168.6±9.1 cm, and their average weight was 58.1±10.1 kg. Children didn't participate in other sports activities besides basketball. Their training experience was approximately one year. Prior to the research, each respondent had verbally been asked about the willingness to participate, and parents had signed a formal agreement so that the child could participate in the study.

Measurements

To measure the skeletal age of the participants, we employed the SonicBone device, specifically the BAUSport™ system (Rishon LeZion, Israel). This device utilizes quantitative ultrasound (QUS) technology to provide a non-invasive, reliable assessment of bone maturity. The SonicBone device operates by emitting ultrasound waves through selected bone sites (distal radius, ulna, carpals, phalanges) and measuring the speed at which these waves travel through the bone tissue. During the assessment, each participant's left hand was scanned at three specific sites: wrist, meta-carpals and third phalanx. Measurements were performed by the same trained examiner. The entire procedure for each individual took approximately four minutes, ensuring minimal disruption and discomfort. The device provided immediate digital results, displaying the estimated skeletal age in real time. Predicted adult height was also derived from the software. The difference between skeletal (SA) and chronological age (CA) was then used to classify participants whereby an SA younger than CA by >1.0 years defined late maturity status, an SA within ±1.0 years of CA defined ontime maturity status and an SA older than CA by >1.0 years defined early maturity status (Malina 2011).

To measure motor abilities, we utilized three specific tests: hand grip strength, the 2-kg standing medicine ball throw, and 60-second sit-ups. Each of these tests was selected to assess distinct aspects of motor performance. Hand grip strength, which assesses muscular strength, was measured using a Takei digital grip strength dynamometer. Each participant performed the test with both hands, squeezing the dynamometer with maximum effort for a few seconds. The best score out of three attempts for each hand was recorded in kilograms. The 2-kg standing medicine ball throw, which evaluates upper body power, was performed by having participants stand with their feet shoulder-width apart and throw a 2-kg medicine ball as far as possible from a standing position. They were instructed to use a chest pass technique and to keep their feet stationary during the throw. The distance from the starting line to the point where the ball first touched the ground was measured in centimeters. The best score out of three attempts was noted. Finally, the 60-second sit-ups test measured abdominal muscular endurance. Participants lay on a mat with their knees bent at a 90-degree angle and their feet flat on the ground, held by an assistant. They performed as many sit-ups as possible in 60 seconds, ensuring that their elbows touched their knees at the top of the movement and their shoulder blades touched the ground at the bottom. The total number of correctly executed sit-ups was recorded.

Statistical analysis

Data were analyzed using the Statistica for Windows 14.0 package and statistical significance was set at $P < 0.05$. Basic descriptive statistics were calculated for all the variables (mean values and standard deviations, as well as minimal and maximal result). Finally, in accordance with the basic aim of the research – effect of biological age on the evaluation of selected motor tests, t test for independent samples was applied to check for differences in motor tests between early maturers and those who mature on time.

RESULTS AND DISCUSION

In Table 1, both the chronological age and the skeletal age are presented. It is immediately apparent from the table and the average values of these variables that the skeletal age of the subjects is, on average, greater than their chronological age, both for the older and the younger basketball players. This does not mean that every individual subject had a greater skeletal age than chronological age, but it may serve as an indicator that children who are biologically older than their peers (and therefore possibly with greater longitudinal skeletal dimensions) may have physical attributes that are advantageous in basketball. This assumption, however, should be verified with further research.

Table 1. Descriptive statistics for all applied variables (mean values and standard deviations, and minimal and maximal result) in the two age groups of young basketball players

	Group 9–11-year-olds				*Group 12–14-year-olds*			
	N	*Mean±SD*	*Min*	*Max*	*N*	*Mean±SD*	*Min*	*Max*
Age	*14*	*10.08±0.92*	*8.63*	*11.34*	*14*	*13.12±0.81*	*11.61*	*14.29*
Skeletal Age	*14*	*11.64±1.10*	*9.99*	*14.28*	*14*	*14.23±1.04*	*12.29*	*15.91*
Hand grip R	*14*	*16.76±2.79*	*13.00*	*21.70*	*14*	*26.18±8.10*	*17.00*	*40.70*
Hand grip L	*14*	*15.16±3.61*	*11.40*	*22.30*	*14*	*26.46±7.99*	*16.10*	*39.90*
2kg ball throw R	*14*	*5.16±1.23*	*3.10*	*7.00*	*14*	*7.55±2.02*	*4.62*	*10.80*
2kg ball throw L	*14*	*4.36±0.94*	*3.10*	*6.47*	*14*	*6.45±1.63*	*4.79*	*9.85*
Sit-ups 60sec	*14*	*32.71±6.09*	*25.00*	*50.00*	*14*	*37.93±7.14*	*25.00*	*49.00*

Further evidence supporting this is provided by the results obtained from the SonicBone device, which, in addition to providing information about skeletal age, also indicates which subjects are accelerants (early maturers), retardants (late maturers), or those who mature at an average rate (on-time maturers). These results are shown in Figure 1 and, interestingly, reveal that neither younger nor older basketball players include late maturers. Therefore, it can be concluded that children who mature later are less likely to choose basketball as their sport. This is likely related to their later growth in height and the fact that shorter children are less inclined to choose basketball. Height is a significant advantage in basketball due to the nature of the game, which involves shooting, rebounding, and defending at elevated positions. As a result, taller individuals are often favored during the selection process, which can influence their decision to pursue the sport. This tendency highlights the importance of considering both current physical attributes and potential future growth in the talent identification and selection process in basketball. Ensuring that shorter children who may experience later growth spurts are not overlooked can help identify and develop talent more effectively. Among all the tested children in the younger group, 57% are early maturers, and 43% are on-time, whereas in the older group, the situation is reversed (43% early maturers and 57% on-time). This further confirms that a significant number of accelerant children participate in basketball.

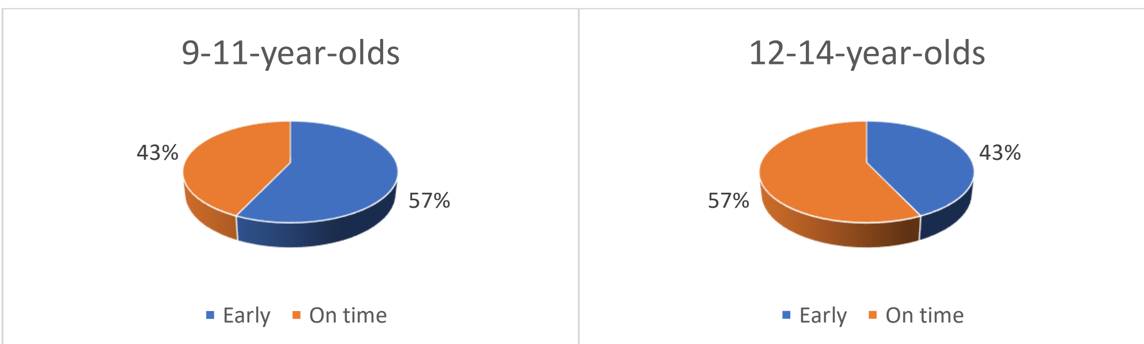

Figure 1. The ratio of maturation statuses in the two age groups (early and on time maturation)

Table 2. T test for independent samples between early and on time maturers in strength motor tests, separately for each age group

	Group 9–11-year-olds			*Group 12–14-year-olds*		
	Early	*On time*		*Early*	*On time*	
	Mean	*Mean*	*p*	*Mean*	*Mean*	*p*
Hand grip R	*17.52*	*16.20*	*0.40*	*30.15*	*23.20*	*0.05**
Hand grip L	*15.70*	*14.45*	*0.54*	*31.68*	*22.54*	*0.03**
2kg ball throw R	*5.29*	*5.06*	*0.74*	*8.53*	*6.82*	*0.12*
2kg ball throw L	*4.53*	*4.14*	*0.46*	*6.48*	*6.42*	*0.95*
Sit-ups 60sec	*33.00*	*32.33*	*0.85*	*38.75*	*36.83*	*0.64*

**Significant difference*

The analysis of the descriptive parameters of the motor strength and power tests shows that children in both groups generally have a stronger right side of the body compared to the left one. Additionally, older children have higher values in strength and power tests. Following the main objective of the study, which aimed to analyze the effects of skeletal age on strength tests, a t-test for independent samples was calculated, and the results are presented in Table 2. The early maturers subgroup and the on-time subgroup were compared in motor strength and power tests, separately for both groups of subjects (younger and older). In the younger group (ages 9 to 11), no statistically significant difference was found in the performance of any strength test. However, in the older group (ages 12 to 14), a significant difference between the accelerants and the on-time maturers was found in the hand grip test, for both the right and left hands ($p<0.05$). The results also show numerically higher values in all tests for early maturers, but a significant difference was only observed in the hand grip test among the older subjects.

An individual's growth and maturity are usually determined by chronological age and biological age. The chronological age is easily determined by the date of birth and the biological age is usually expressed by the skeletal age, which reflects the actual physical growth and maturity status (Ke et al., 2021). Our findings regarding the relationship between biological age and performance are consistent with previous research. For example, Doležajová, Gallová, and Lednický (2019) found that biological age significantly affects physical indicators and motoric test performance among young female basketball players. This aligns with our observation that early maturers demonstrate superior performance in strength and power tests, which can be attributed to their advanced biological development. Jakovljevic et al. (2016) also highlighted the importance of biological maturity in motor performance, showing that 14-year-old basketball players with advanced maturation tend to perform better in physical tests. Our study extends these findings to younger age groups, indicating that the advantage of early maturation is evident as early as 12 to 14 years of age, particularly in hand grip strength. However, it seems that this is not the case for children of younger age (younger than 12) since we didn’t get significant differences. It is possible that younger children have not yet reached an age where their biological advantage (which they certainly have) would manifest in a way that makes them superior in motor tests. Gryko (2021) reported that the timing of maturity significantly influences physical performance in male basketball players aged 13 to 15, which supports our conclusion that early maturers have better strength test results. This pattern underscores the role of biological age in selecting and excelling in sports that favor early physical development.

The implications of these findings are significant for talent identification and development in basketball. Coaches and trainers should consider biological age when assessing young athletes' potential, especially from 12 years of age onwards. Furthermore, the absence of late maturers among basketball players in our study echoes the findings of Figueiredo et al. (2009), who noted that late-maturing athletes are less likely to persist in sports that demand early physical advantages. This trend suggests that basketball, similar to other sports requiring early physical development, may inadvertently exclude late maturers.

CONCLUSION

In conclusion, our study confirms that biological age significantly influences the selection and performance of young basketball players. Early maturers are more likely to choose and excel in basketball, highlighting the need for age-appropriate training and consideration of biological maturity in talent development. However, late maturers should not be ignored or rejected. With proper guidance and encouragement, it may happen that once they biologically reach their peers, they could be motorically superior to their accelerant peers. It's important to acknowledge several limitations of the study that should be considered. While these findings provide valuable insights into this particular group, caution should be exercised when generalizing them to other age groups or sports contexts. While a useful indicator of biological maturity, skeletal age measurement should be accompanied with other measures of biological age, such as dental age, for better accuracy. Also, future studies could explore a broader range of performance metrics to provide a better understanding of the relationship between biological age and overall athletic performance in basketball.

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Balancing on Aqua Fitness Floating Mat: Women vs. Men

*Antonela Karmen Ivišić[1], Vladimir Pavlinović[1], Mia Perić[1]

[1]Faculty of Kinesiology, University of Split, Split, Croatia

*Corresponding author

ABSTRACT

This study aimed to determine the gender differences in performing balance in aqua fitness floating mat tests and Biodex Balance System (BBS) tests. The sample included 38 kinesiology students. Females: 23.21±1.99 years, body mass of 62.87±8.34 kg, and body height of 167.47±9.51 cm. Males: 23.95±3.14 years, body mass of 79.66 ±9.46 kg, and body height of 181.95 ±7.88 cm. The sample of variables included six aqua fitness floating mat tests (the Foot in front of the foot test (FF), Flamingo test (FLA), Circle test (C), Scissors test (SC), Skip (SK), and Jump test (JP)) and BBS tests. (Postural Stability test (PS) and Limits of Stability test (LST)). The tests were conducted before and after the training program. The results showed significant differences in both BBS tests, PS (before, $p=0.01$; after, $p<0.00$) and LST (before, $p=0.02$; after, $p=0.01$). Other variables did not show significant differences between genders. There were no significant gender differences in aqua fitness floating mat tests. Significant differences were found in the results of BBS tests, including better performance by females. Such findings confirm previous research on this topic. Conclusively, lack of differences in aqua fitness floating mat tests could implicate other factors (e.g. muscle strength) influence in balance performace.. Future studies should include different samples of participants. Finally, participants should be involved in a longer training program on an aqua floating fitness mat.

Keywords: aquatic activities, stability, gender differences, specific tests, Biodex

INTRODUCTION

Balance, as one of the essential motor abilities, plays a crucial role in maintaining the body's center of mass over its base of support. This skill is essential for maintaining postural control and executing complex movements in a dynamic environment. It involves complex interactions between sensory inputs from the visual, vestibular, and somatosensory systems and motor responses to maintain posture and orientation (Zech et al., 2010). There are two primary types of balance: static and dynamic. Static balance refers to maintaining equilibrium when stationary, while dynamic balance involves maintaining stability while in motion, such as walking and running. Dynamic balance requires continuous adjustments and coordination, whereas static balance focuses on controlling postural sway and minimizing movements to maintain balanced position. Both types of balance are essential for overall physical performance and injury prevention (Steffen et al., 2013).

To prevent injuries, balance training has become more popular in the fields of fitness and rehabilitation, focusing on improving proprioception and neuromuscular control. In a healthy population, increasing balance through exercise has a beneficial impact on reducing injury rates (DiStefano, Clark, & Padua, 2009). In athletes, those with superior balance are less likely to experience injuries, more capable of performing advanced motor skills, and overall better at optimizing performance in sports (Hrysomallis, 2011). In order to perform accurate movements, react to opponents, and maintain stability during difficult manoeuvres athletes rely on both static and dynamic balance (Zech et al., 2010). Therefore, the assessment of balance ability could be crucial in performance and training.

Accordingly, examination could be done with both field and laboratory testing. However, field tests tend to have low validity and applicability. Hence, golden standard tests could be useful tools. One of the ways for effective balance training and to perform balance diagnostics is through the BBS. The BBS is a multiaxial device used to evaluate postural balance. It objectively measures and records an individual's ability to stabilize the involved joint under dynamic stress using a circular platform that can move freely in both the anterior-posterior and medial-lateral axes simultaneously. The Biodex balance measures are reliable, making the system an effective tool for both balance training and diagnostics (Arifin, Osman, & Abas, 2014).

Nevertheless, balance can be trained using different equipment, supplementary exercises, or with engagement in new activities. In such training, the objective is to experiment with various unstable surfaces or body positions to enhance proprioceptive and neuromuscular adaptations. For example, this can be achieved by introducing new equipment, such as aqua fitness floating mat (AFFM), which was used for tests in this study. Balance on AFFM involves maintaining postural stability on an unstable surface while performing various exercises (Özcan, Irez, Saygin, Ceylan, & Dergisi, 2018). This activity challenges both static and dynamic balance, requiring constant adjustments to the shifting base of support. Training on a AFFM can improve core stability, proprioception, and overall balance, making it an effective exercise for enhancing these skills (Rudinica, 2022). The unstable water surface significantly challenges balance in any body position, making different types of training more effective. Additionally, there are possibility of different adaptations to balance training regarding gender.

Due to anthropometric indices (e.g. lower body mass), neuromuscular factors (i.e. flexibility), and neurophysiologic processing, females tend to have a better balance ability (Greve, Cuğ, Dülgeroğlu, Brech, & Alonso, 2013). Contrarily, some authors reported that men have better balance performance (Panzer, Bandinelli, & Hallett, 1995). Moreover, some studies indicate no significant gender difference in balance performance (Era, Heikkinen, Gause-Nilsson, & Schroll, 2002). These findings could be the results of differences in balance tasks, testing procedures, or subject groups. Considering that different studies present inconsistent findings, this study aimed to explore gender differences in balance performance using specific tests on AFFM and using the BBS.

METHODS

Participants

The sample of participants was 38 students (Females =19) from the Faculty of Kinesiology. Female chronological age was 23.21±1.99 years, body mass of 62.87±8.34 kg, and body height of 167.47±9.51 cm. Males chronological age was 23.95±3.14 years, body mass of 79.66 ±9.46 kg, and body height of 181.95 ±7.88 cm.

Variables and procedures

The sample of variables included an AFFM tests and Biodex Balance System tests (Biodex Medical Systems, NY, USA). AFFM tests consisted of six specific balance tests, including the Foot in front of the foot test (FF), Flamingo test (FLA), Circle test (C), Scissors test (SC), Skip (SK), and Jump test (JP). Biodex Balance tests included the Postural Stability test (PS) and Limits of Stability test (LST). Moreover, 4 (i.e. C, SC, SK, J) out of 6 tests were previously evaluated and considered reliable (Prgin, 2022).

Both batteries of the tests were performed before and after a training program. FF test was performed in an upright position, with one foot placed in front of another in the same line. Also, FLA test execution included the previously known Flamingo test position; one-leg stance with the other leg flexed and the foot positioned on the extended knee. In addition, the C test included the dynamic movement of rotation around the vertical body axis, by 360 degrees. Following, the SC test consisted of parallel jumping movements, starting in separated legs position with one foot in front and one foot behind. Furthermore, the SK test was performed with skipping movements on the aqua mat. The performance of JP test included jumping movements, forward and backward, with feet parallel positioned. Test execution included three trials, and the best result was obtained as the final result. For FF and FLA results were observed as the time of maintaining a specific positions, and both were measured by a stopwatch. Moreover, C, SC, SK, and JP results present a number of successfully performed movements in 30 seconds.

Additionally, PS and LST tests were evaluated as indexes derived from the BBS. PS was assessed on an unstable platform where the participant stood on two feet and maintained a static position for 30 seconds. The LST test was performed with a two-foot stance on an unstable platform, and the task included bringing the cursor to the blinking targets and returning the cursor as soon as possible with minimum oscillatory movements on screen. Both tests were executed on platform instability level 6.

Also, after the initial measurements of aqua mat tests and BBS tests were obtained, participants started attending training programs, aimed to develop balance ability. Six weeks of the training program with a duration of 45 minutes (two sessions per week), were described in the previous study (Perić, Kondrić, & Stanković, 2023).

Statistical analysis

Descriptive statistics were measured to assess arithmetic means and standard deviations (SDs). K-S (Kolmogorov-Smirnov) test was calculated to determine the normal distribution of data. Since data was not normally distributed, non-parametric analysis was performed. The Man-Whitney U test was used to determine the gender differences between the two observed groups.

All analyses were done in the statistical package Statistica ver. 13.5 (Tibco Inc., Palo Alto, Ca, USA), applying a p-level of 0.05.

RESULTS

Table 1 represents the gender differences in variables measured before the training program. The analysis demonstrates significant differences in both BBS tests, PS (p=0.01) and LST (p=0.02). Moreover, females performed better results in PS (males, 1.52±0.57; females, 1.11±0.45) and LST (males, 21.11±8.66; females, 29.42±10.48) variables.

Table 1. Gender differences in variables measured before the training program.

Variables	*Males (N=19)*		*Females (N=19)*		*Z*	*p*
	Mean	*SD*	*Mean*	*SD*		
FF	*2.31*	*3.06*	*2.92*	*2.77*	*-1.45*	*0.15*
FLA	*2.64*	*2.33*	*3.91*	*6.23*	*-0.67*	*0.50*
SC	*11.16*	*8.97*	*15.26*	*14.04*	*-0.98*	*0.33*
JP	*12.89*	*16.06*	*12.79*	*14.15*	*-0.25*	*0.80*

C	*14.32*	*8.10*	*18.58*	*9.60*	*-1.26*	*0.21*
SK	*19.42*	*12.00*	*19.26*	*11.87*	*0.04*	*0.97*
PS	*1.52*	*0.57*	*1.11*	*0.45*	*2.64*	*0.01**
LST	*21.11*	*8.66*	*29.42*	*10.48*	*-2.39*	*0.02**

*SD, standard deviation; Z, test value of Man-Whitney U test; p, level of significance set at p<0.05; *, significance*

Table 2 represents the gender differences in variables measured after the training program. The analysis demonstrates significant differences in both BBS tests, PS (p<0.00) and LST (p=0.01). Additionally, females performed better results in PS (males, 1.63±2.08; females, 0.75±0.27) and LST (males, 25.79±9.45; females, 37.00±13.05) variables.

Table 2. Gender differences in variables measured after the training program.

Variables	*Males (N=19)*		*Females (N=19)*		*Z*	*p*
	Mean	*SD*	*Mean*	*SD*		
FF	*6.36*	*5.61*	*11.13*	*19.84*	*-1.26*	*0.21*
FLA	*9.66*	*20.01*	*9.14*	*7.04*	*-1.07*	*0.29*
SC	*22.68*	*17.79*	*28.84*	*15.12*	*-1.50*	*0.13*
JP	*27.74*	*15.24*	*26.26*	*13.64*	*0.20*	*0.84*
C	*23.89*	*7.45*	*27.79*	*8.94*	*-1.01*	*0.31*
SK	*33.26*	*13.31*	*34.58*	*11.03*	*-0.60*	*0.55*
PS	*1.63*	*2.08*	*0.75*	*0.27*	*3.33*	*0.00**
LST	*25.79*	*9.45*	*37.00*	*13.05*	*-2.54*	*0.01**

*SD, standard deviation; Z, test value of Man-Whitney U test; p, level of significance set at p<0.05; *, significance*

DISCUSSION

Following the aim of this study, the results indicated few findings. Firstly, there are no significant differences between males and females results of AFFM tests, including before (initial) and after (final) the training program measurements. Secondly, significant gender differences were established in the initial and final measurements of PS and LST.

According to the presented analysis, results indicated no statistically significant differences between males and females performing on AFFM. Such results could be explained through the sample of participants. Therefore, participants in this study were students from the Faculty of Kinesiology, who were previously involved in different sports and sports activities. Similarly, in previous study gender differences in specific balance test were not established (Ivišić, Veršić, & Foretić, 2023). The authors explained that a possible reason for such results is the sports background of students.

Moreover, initial tests results, including males and females, showed low values. Yet, the results of both groups in final measurements indicate higher values. This trend could be explained through a six-week training program on an AFFM, including two sessions per week. Some authors reported that 11-12 week training program is most effective in improving balance ability (Lesinski, Hortobágyi, Muehlbauer, Gollhofer, & Granacher, 2015). Regarding the six-week training program, such a short period of training process and training volume are not adequate for significant improvement of balance motor ability.

In addition, results of non-significant gender differences in AFFM could be observed by the process of adaptation on a specific unstable surface. Both genders experienced new stimuli when performing in unusual conditions (i.e. aqua floating unstable surface). Moreover, a possible explanation for such results could be prolonged exhaustion of the nervous system (Wilkins, McLeod, Perrin, & Gansneder, 2004). In the first two weeks of the training program, participants were in the process of adapting to new environmental conditions.

As previously stated by some authors, females generally outperform males on balance tests, but males perform better than females in tests requiring greater muscle strength (Parker, Round, Sacco, & Jones, 1990). Furthermore, the BBS monitor shows every oscillatory movement while balancing on the platform. On the other hand, when performing AFFM tests, it is not clear how much muscle strength takes part in performing specific balance abilities.

Furthermore, statistically significant gender differences were found in PS and LST variables. More precisely, females performed better results in both tests, including initial and final measurements. Similarly, authors revealed a significant difference in the analysis of gender differences on BBS tests (Perić et al., 2023). Also, such results can be explained through anatomical and physiological differences in male and female. Even doe males have a greater body mass and body height, previously was shown that those anthropometric indices have a negative relation to balance (Şimşek & Arslan, 2019). Precisely, females tend to have better balance due to their lower body mass and body height. Lastly, one should be careful when interpretating these results, due to different body positions in tests. BBS tests involve “normal” two-feet stance, unlike the balance positions in specific tests.

CONCLUSION

This study aimed to determine the gender differences in balance performance in AFFM and BBS tests, before and after completing a six-week training program. Following, the results did not show a significant gender difference in AFFM tests. Nevertheless, significant differences were found in the results of BBS tests, including better performance by females. Such findings implicate that BBS is more sensitive in detecting oscillatory movements. Therefore, AFFM tests present field tests that can be executed with the possible influence of other factors (e.g. muscle strength) besides the balance mechanisms. Future studies should include different samples of participants. Finally, participants should be involved in a longer training program on an AFFM, to enhance higher adaptation in new environment and possibility of performing better results.

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External Load of Elite U12 And U13 Young Soccer Players During 30 Minutes of A Soccer Match

*Jakov Marasović[1], Ante Rađa[1,2], Marko Erceg[1], Antonio Sebežević[2], Josip Maleš[1,3]

[1]Faculty of Kinesiology, University of Split, Split, Croatia; [2]HNK Hajduk Split, Split, Croatia; [3]Hotel Management and Gastronomy, University of Split, Split, Croatia

*Corresponding author

ABSTRACT

There is a great need to quantify workloads in youth soccer in order to determine and monitor the progress of young soccer players. The main goal of this research was to determine the average external load of elite U12 and U13 soccer players during 30 min of play in a soccer match. The partial goal of this research was to determine the differences in external load parameters between U12 and U13 young elite soccer players. There were 15 different players per category and 5 games during one season were taken into consideration in this research. In total there were 65 observations of the U12 category and there were 64 observations of the U13 group. Respondents from both categories wore GPS playmaker 2.0 during each game A total of 8 variables were observed in the research, 4 of which were variables representing external load without ball (TD/30, SD/30, HID/30, ACC/DECC/30) and 4 variables represented external load with ball (POSS/30, TOU/30, RELEA/30, RATIO). Each match lasted for 60 minutes, and for the purposes of this research, the average external loads during 30 minutes of game, were taken. The program Statistica 13.5 was used for statistical analysis. Descriptive statistics parameters were calculated and the t-test for independent samples was used to analyze the differences between groups. This research shows average external load of elite U12 and U13 young soccer players during 30 minutes of a soccer match (Table 1 and Table 2). Statistically significant differences in the variables of average external load between the U12 and U13 categories were found in the HID/30 variable, where younger players showed significantly higher values than older ones (431.66 vs. 327.37m). Furthermore, in the sport-specific external load, the difference was only shown in the POSS/30 variable, where older players showed significantly higher results than younger players (19.10 vs. 15.99). Using this technology on football boots is particularly important because it can provide insight into sport-specific parameters like touches, releases, possessions and coaches can obtain the ratio between actions with dominant and non-dominant leg. Such knowledge is extremely important in order to have an insight into key facts both at the individual and at the team level and possible modifications in the training approach to improve the performance of their players.

Key words: external load, elite young players, GPS playmaker 2.0, sport-specific variables

INTRODUCTION

Today's soccer players need to be well trained to meet the physical demands of the game such as sprints, accelerations, decelerations, and various changes of direction that await during a soccer match (Mohr et al., 2005, Gualtieri et al., 2020). Sports science plays a major role in the analysis of sports load, and this has become one of its main tasks (Akubat et al., 2014). This type of data can help in decision-making and consideration of training and matches by sports scientific staff and bring new knowledge (Gualtieri et al., 2020). Sports load analysis is usually analyzed with the help of Global Navigation Satellite System (GNSS) (Cummins et al., 2013, Beato et al., 2018). Previous researches has provided evidence that the match is the most important session of the week and training loads must be as close as possible to those of the match (Morgans et al., 2018, Chmura et al., 2019). This information allows sports scientists and coaches to design an adequate stimulus in order to best meet both the physical and technical demands of matches (Konefal et al., 2019, Gualtieri et al., 2020). Unlike senior players, the loads of players in the academy are much less monitored and analyzed (Coutinho et al., 2015). There is a great need to quantify workloads for academy players in order to determine and monitor the progress of young players and to see when their workloads will reach at least approximate workloads of senior soccer players (Malone et al., 2015). A big problem when following the matches of young players is that conclusions are drawn exclusively on one team, so there is no generalization of evidence and comparison with other teams (Oliveira et al., 2021). There is a small number of researches that has investigated loads in young soccer players during matches, but some studies have looked at parameters such as distance run, high intensity running, number of accelerations and decelerations (Hannon et al., 2021, Coutinho et al., 2015). Oliveira et al., 2021 observed the differences between the categories (U14, U15, U16, U17, U18) in external load parameters without ball (total, distance, high intensity distance, top speed). Hannon et al., 2021 obtained differences in total distance and sprint distance parameters between the U12 and U13 generation of English soccer players but only in training. On the other hand, Contreras et al., 2022 obtained differences between two different categories in the top speed parameter. To the best of our knowledge, there were no works that observed differences in sport-specific variables (external load with ball). The main goal of this research was to determine the average external load of elite U12 and U13 soccer players during 30 min of a soccer match. The partial goal of this research was to determine the differences in external load parameters (with and without ball) between U12 and U13 young elite soccer players.

METHODS

Participants

There were 15 different players per category and 5 games during one season were taken into consideration in this research. In total there were 65 observations of the U12 category and there were 64 observations of the U13 group. Players of the U12 category were on average 146.81 cm tall and weighed 38.46 kg. Players of the U13 group were on average 158.67 cm tall and weighed 45.57 kg. Respondents from both categories GPS playmaker 2.0 during each game. Each match in these age groups lasts 60 minutes, and for the purposes of this research, the average external loads during 30 minutes spent in the game were taken due to the fact that in those ages players are most often changed in that period.

Variables

A total of 8 variables were observed in the research, of which 4 variables represented external load without ball and 4 variables represented external load with ball (sport-specific variables). The variables that represented external load without ball are: TD/30-average total distance in 30 min, SD/30 (>20 km/h)-average sprint distance in 30 min, HID/30 (>15km/h)-average high intensity distance in 30 min, ACC/DECC/30-average number of accelerations and decelerations in 30 min. The variables that represented external load with ball are: POSS/30-average number of possession in 30 min, TOU/30-average number of touches in 30 min, RELEA/30-average number of releases in 30 min, RATIO-average ratio between actions with dominant and non-dominant leg in 30 min.

Statistical analysis

Previously collected data were manually entered into Microsoft Excel tables and later processed in the "Statistica 13.5" program. Descriptive statistics parameters were calculated for all variables and all groups of respondents. Analysis of variance (T-test) was also used to determine statistical significance between all selected variables.

RESULTS

Table 1. Descriptive statistics of the average external load and basic anthropometry for the U12 category

VARIABLES	N	MEAN	MIN	MAX	SD
HEIGHT (cm)	65	146.81	136.9	156.1	5.32
WEIGHT (kg)	65	38.46	32.2	46.8	4.70
TD/30 (m)	65	3214.08	1270.61	4890.00	614.55
SD /30 (m)	65	43.13	1.00	190.38	44.36
HID/30 (m)	65	431.66	60.50	1093.84	179.63
ACC/DECC/30	65	22.68	2.00	52.50	9.49
POSS/30	65	15.99	4.44	35.50	7.26
TOU/30	65	44.42	17.53	93.60	18.86
RELEA/30	65	15.08	4.15	35.50	7.14
RATIO	65	4.39	0.29	24.00	3.53

Legend: N-number of cases, MEAN-arithmetic mean, MIN-minimum results, MAX-maximum results, SD-standard deviation, HEIGHT-body height, WEIGHT-body mass, TD/30-average total distance in 30 min, SD/30-average sprint distance in 30 min, HID/30-average high intensity distance in 30 min, ACC/DECC/30-average number of accelerations and decelerations in 30 min, POSS/30-average number of possession in 30 min, TOU/30-average number of touches in 30 min, RELEA/30-average number of releases in 30 min, RATIO-average ratio between actions with dominant and non-dominant leg in 30 min

Table 2. Descriptive statistics of the average external load and basic anthropometry for the U13 category

VARIABLES	N	MEAN	MIN	MAX	SD
HEIGHT (cm)	64	158.67	150.5	168.5	4.84
WEIGHT (kg)	64	45.57	39.5	54.9	4.37
TD/30 (m)	64	3082.97	2398.00	4274.00	317.76
SD/30 (m)	64	95.28	1.62	3567.00	441.64
HID/30 (m)	64	327.37	145.00	594.00	111.25
ACC/DECC/30	64	20.37	6.81	38.37	7.108
POSS/30	64	19.11	1.62	41.53	8.426
TOU/30	64	44.83	16.30	102.00	17.061
RELEA/30	64	15.03	1.30	36.00	7.05
RATIO	64	5.67	1.43	49.00	6.26

Legend: N-number of cases, MEAN-arithmetic mean, MIN-minimum results, MAX-maximum results, SD-standard deviation, HEIGHT-body height, WEIGHT-body mass, TD/30-average total distance in 30 min, SD/30-average sprint distance in 30 min, HID/30-average high intensity distance in 30 min, ACC/DECC/30-average number of accelerations and decelerations in 30 min, POSS/30-average number of possession in 30 min, TOU/30-average *number of touches in 30 min, RELEA/30-average number of releases in 30 min, RATIO-average ratio between actions with dominant and non-dominant leg in 30 min*

In Table 1 and Table 2 it can be seen that U13 category players are taller and heavier than U12 category players (158.47/45.57 vs. 146.81cm/38.46kg). On average, more meters while running (TD/30) was shown in the U12 category compared to those in the U13 category (3214.08 vs. 3082.97m). A greater number of meters run ran in the sprint (SD/30) was shown in the players of the U13 category compared to the players of the U12 category (95.28 vs. 43.13m). In high intensity running (HID/30) U12 players dominate over the one from the U13 category (431.66 vs. 327.37m). As for acceleration and deceleration, the players in the U12 category performed higher values, while the players in the U13 category were somewhat weaker (22.68 vs. 20.37). Furthermore, when observing at the sport-specific variables in the variable of possession (POSS/30), older players showed higher values than younger ones (19.11 vs. 15.99). Younger and older players showed approximately the same number of touches with the ball in the match (44.62 vs. 44.83). In terms of the number of released balls (RELEA/30), approximately equal results were obtained between younger and older players (15.08 vs. 15.03). Looking at the ratio of playing with the dominant and non-dominant leg, the players in the U13 category showed a higher ratio than the players in the U12 category (5.67 vs. 4.39).

Table 3. Differences in average external load parameters between U12 and U13 category

VARIABLES	*MEAN U12*	*MEAN U13*	*t-value*	*p*	*SD U12*	*SD U13*
TD/30	*3214.08*	*3082.97*	*1.51*	*0.131*	*614.55*	*317.76*
SD/30	*43.13*	*95.28*	*-0.94*	*0.345*	*44.36*	*441.64*
HID/30	*431.66*	*327.37*	*3.95*	*0.000*	*179.63*	*111.25*
ACC/DECC/30	*22.68*	*20.37*	*1.55*	*0.121*	*9.49*	*7.10*
POSS/30	*15.99*	*19.10*	*-2.24*	*0.026*	*7.26*	*8.42*
TOU/30	*44.42*	*44.83*	*-0.09*	*0.920*	*18.86*	*17.06*
RELEA/30	*15.07*	*15.03*	*0.02*	*0.977*	*7.140*	*7.058*
RATIO	*4.39*	*5.67*	*-1.49*	*0.153*	*3.532*	*6.269*

Legend: MEAN U12-arithmetic mean of the U12 age category, MEAN U13-arithmetic mean of the U13 age category, t-value, p value, SD U12-standard deviation of the U12 age category, SD U13-standard deviation of the U13 age category

Statistically significant differences in the variables of average external load between the U12 and U13 categories were found in the HID/30 variable, where younger players showed significantly higher values than older ones (t=3.95, p=0.000). Furthermore, in the sport-specific variables, the difference was only shown in the POSS/30 variable, where U13 category players showed significantly higher results than U12 category players (t=-2.24, p=0.026). As for the other variables, they did not show significant differences (p>0.05).

DISCUSSION

The main goal of this research was to determine the average external load of elite U12 and U13 soccer players during 30 min of play in a soccer match. The partial goal of this research was to determine the differences in external load parameters between U12 and U13 young elite soccer players.

Previous research has mostly dealt with training load in senior players and players of older age groups (Wrigley et al., 2012, Bourdon et al., 2017, Silva et al., 2018, Clemente et al., 2019). To the best of authors' knowledge, there was no research that observed differences between U12 and U13, except the research of Hannon et al., 2021, which observed differences between groups in the variables of average weekly external load without reference to the load in matches. From the table of descriptive statistics, it can be seen that U12 players covered slightly greater ($p>0.05$) total distances (TD/30) compared to players in the U13 category during 30 min of match (3214.08 vs. 3082.97m). Previous research mainly analyzed the differences between junior and senior players, and no significant differences were found in the variable of TD (Reynolds et al., 2021, Contreras et al., 2022). A slightly greater number ($p>0.05$) of meters ran in the sprint of this research (SD/30) was shown in the players of the U13 category compared to the players of the U12 category (95.28 vs. 43.13m). Reynolds et al., 2021 obtained small differences that did not prove to be significant in the sprint distance variable in favor of older players (142 vs. 110m). In the HID/30 variable of this research significant difference was shown and younger players had greater results than younger players (Table 3). Possible reasons why younger players ran more could be attributed to the demands of the coach, who may be looking for a high-pressing game. Furthermore, the U12 players are playing their first season on a full-size pitch, so there is a possibility that they make up for the lack of tactical skills by more extensive, unlike the older players, who already have a year of playing on full-size pitch experience. Also, afore mentioned U12 players play in county league against U13 players and that could potentially lead to greater running distances because of the biological and physical differences. The transition from a small to a large field is very sensitive for young players, and they often do not know how to control themselves and often run with greater intensity than they should. Reynolds et al., 2021 observed a similar variable (High speed running) and found that older players spent significantly more ($p=0.040$) time at higher running speed. This research monitored the differences between the U12 and U13 group in the variable of intensive deceleration and acceleration and did not obtain a significant difference between the two age groups (U12 and U13), but the younger players achieved a slightly higher result in this variable compared to the older players (22.68 vs. 20.37). Furthermore, in this research, the external load in the ball game was observed, which gives additional value and originality in the observation of the total load faced by young players. In variable of possession (POSS/30), older players showed significantly higher values than younger ones (19.11 vs. 15.99). The results obtained are to some extent expected because the older players very likely played against opponents who defended most of the game. On the other side, U12 players probably played against older and physically more dominant opponents, which resulted in a smaller number of possessions within that category during the 30 min of a soccer match. In the variable of TOU/30, older players had slightly more touches than younger players, and on the other side, younger players had slightly more released balls. The ratio of use of the dominant and non-dominant leg during the 30 minutes spent in the game was also investigated. It can be noticed that players control the ball with their dominant leg on average 4 to 6 times more, and the ratio is higher among older players compared to younger players (5.67 vs 4.39). The obtained results suggest that young players use both legs more equally.

CONCLUSION

Using GPS technology is extremely important because it can give an insight into the loads of players during a match or training session. Also, using this technology on football boots is particularly important because it can provide insight into sport-specific parameters like touches, releases, possessions and ratio between dominant and non-dominant leg. The results of the research showed the average workload of U12 and U13 elite young soccer players. Additionally, differences were shown in the variable high intensity distance in 30 min and in the sport-specific variable number of possessions in 30 min. Such knowledge is extremely important for coaches in order to have an insight into key facts both at the individual and at the team level and possible modifications in the training approach to improve the performance of their players.

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Body Image Satisfaction Among Adolescents

Klara Findrik[1,2], Danijela Kuna[1], *Mirela Šunda[1]

[1]Faculty of Kinesiology Osijek, University of J.J. Strossmayer in Osijek, Osijek, Croatia; [2]Faculty of Kinesiology, University of Zagreb, Zagreb, Croatia

*Corresponding author

ABSTRACT

Body image is a complex psychological construct that can be described as a personal assessment of oneself and others concerning body weight, shape, size, and appearance. Often, the ideal female body is presented as slim and thin, and the ideal male body as lean and muscular, which can lead to the development of fertile ground for the emergence of a distorted perception of young people's physical appearance. Methods: This study examined body image satisfaction among adolescents and investigated potential gender differences. Participants included 154 adolescents aged 14-18 years (88 girls). Variables included morphological anthropometric characteristics and satisfaction/dissatisfaction with one's physical appearance. Spearman's correlation coefficient was used to verify the association between body mass index and assessment of current physical appearance, and the Mann-Whitney U test was used to determine differences between male and female adolescents. Results: Complete satisfaction with body image was reported by 32.95% of girls and 34.85% of boys. Discussion: Body image satisfaction is a significant concern for Croatian adolescents. Promoting critical thinking about unrealistic beauty standards and fostering healthy attitudes toward body image are crucial. Conclusion: Educational programs and preventive social measures are necessary to maintain and improve the mental health and well-being of adolescents.

Keywords: body dissatisfaction, body mass index, youth, public health

INTRODUCTION

The period of adolescence is a period in which numerous and large psychophysical changes occur, but also healthy lifestyle habits are adopted (Kuzman, Pavić-Šimetin, & Pejnović Franelić, 2012). In this process, a young person feels, thinks, and makes decisions that can lead to conflicts with family and the environment, but also becomes aware of his own body, strives for independence, accepts responsibility, and searches for his identity (World Health Organization, 1984). Body image is a complex psychological construct that includes perception, thoughts, feelings, and behaviors toward one's own body and extends from healthy to unhealthy body perceptions (Fischetti et al., 2020). Also, body image can be described as a personal assessment of oneself and others about body weight, shape, size, and appearance of one's own body (Fischetti et al., 2020). According to Posavec and Posavec (2002), when it is talked about body image, it is talking about a conscious representation of our own body that results from a complex reconstruction of our mind and a complex interaction between perceptions, cognitions, and emotions. However, when there is a discrepancy between perceived and ideal body image, whether it is an internal ideal or a socially imposed standard, body image dissatisfaction occurs (Furnham and Greaves, 1994; Gleaves et al., 2000). Social networks, media, information from the environment, and society influence the care of body appearance and the creation of the perception of body image, which can change over time (Grogan, 2016; Dumas & Desroches, 2019). Through the media, the ideal female body is often portrayed as slim and thin, while the ideal male body is portrayed as lean and muscular. This idealization of the body and the imposition of standards can lead to the development of fertile ground for the emergence of a distorted perception of the youth's physical appearance (Groesz, Levine & Murnen, 2002). If we add to this that fatness and obesity are considered a serious public health problem, research carried out in Croatia shows that 65% of adults and 35% of children are overweight and that many people are stigmatized for being overweight, everything together can lead to dissatisfaction with the image of a thin body, bad mood and lack of self-esteem (Eurostat, 2021; Music Milanovic et al., 2021). Previous research shows that women and adolescent girls experience more dissatisfaction with their appearance (i.e. their body) than men and adolescents (Ata, Ludden, and Lally, 2007; Tiggemann, 2005). Also, women emphasize the dominant desire to lose weight (i.e. to reduce body weight), while men want to increase muscle mass (Petrie, Greenleaf & Martin, 2010). It is estimated that approximately 50% of adolescent girls express body dissatisfaction (Bearman et al., 2006). Dissatisfaction with body appearance can develop as early as five years of age, and research has shown that the problem exists among individuals of different body shapes and that girls who looked at magazines intended for adult women had greater dissatisfaction with their appearance (Dohnt & Tiggemann, 2006). Considering the above, the goal of this paper was to examine the satisfaction with the physical appearance of high school students from Osijek and to determine whether there are differences in satisfaction with their physical appearance about gender. It was assumed that male adolescents are more satisfied with their physical appearance than female adolescents.

METHODS

Participants and Study Design

The research was conducted with 154 adolescents (88 girls and 66 boys) aged 16.45 ± 1.04, body height 173.01 ± 9.60, and body mass 65.71 ± 13.17. All participants were attending high school in Osijek, Osijek-Baranja County, Republic of Croatia. The testing was conducted for 3 weeks in March 2024, during regular physical education classes. Before participating in the study, students had to sign a written consent form and parents had to give written permission. The Ethics Committee of the Faculty of Kinesiology in Osijek approved the research (classification number 029-01/24-01/05 and record number 2158-110-01-24-3), which was conducted by the current Helsinki Declaration.

Variables and Measurements

Body height was measured using a validated anthropometer (Seca 217 Stadiometer Mobile Height Measurement Scale), and body mass and body mass index were measured using an Omron diagnostic scale with an accuracy of 0.1 kg (Omron BF-511, Kyoto, Japan). The Body Appearance Perception Scale with Pictorial Stimuli was used to assess satisfaction with body appearance (Figure Rating Scale, FRS, Stunkard, Sørensen & Schulsinger, 1983), and consists of 9 illustrations of a male or female body ordered from the slimmest to the largest figure and marked with numbers from 1 to 9. The participant had to choose two figures, the first one showing his current appearance and the second one showing his desired appearance. The level of satisfaction/dissatisfaction with one's physical appearance is shown by the numerical difference between the assessment of the current and desired appearance, and the theoretical range of results from -8 to 8. A score of zero (0) indicates that the person is satisfied with their current physical appearance. A larger absolute difference indicates greater body dissatisfaction, with the sign indicating the direction of dissatisfaction (minus means that the person wants to increase body mass, while plus means that the person wants to decrease body mass).

Protocol

The testing began with the measurement of body height using an anthropometer, after which the body mass and body mass index were measured, and at the end of the test, the participants were given the Body Appearance Perception Scale with pictorial stimuli.

Statistical Analysis

The Tibco Statistica Enterprise program (version 14.0.1.25) was used for data analysis. The Shapiro-Wilk W test was used to assess the normality of the distribution, where it was determined that the variables were not normally distributed. The validity of the Body Appearance Perception Scale was calculated using Spearman's correlation coefficient, which checked the association between body mass index and assessment of current body appearance, and the Mann-Whitney U test was used to determine differences between male and female adolescents.

RESULTS

The results of the Spearman correlation coefficient confirm the validity of the Body Appearance Perception Scale used on the sample. A positive correlation was achieved between the body mass index and the current appearance assessment variable. Specifically, for adolescent girls the correlation is rs=0.69, while for adolescent boys it is rs=0.57. Based on the above, the used measuring instrument can be considered a reliable measuring instrument and suitable for assessing satisfaction with physical appearance in Croatian adolescents.

Table 1. Frequencies of assessments of the current and desired physical appearance of adolescent girls and boys

Figure	*Girls*		*Boys*	
	Current appearance Frequency (%)	*Desired appearance Frequency (%)*	*Current appearance Frequency (%)*	*Desired appearance Frequency (%)*
1	*1 (1.14)*	*0 (0.00)*	*0 (0.00)*	*0 (0.00)*
2	*17 (19.32)*	*14 (15.91)*	*8 (12.12)*	*2 (3.03)*
3	*26 (29.55)*	*39 (44.32)*	*19 (28. 79)*	*9 (13.64)*
4	*30 (34.09)*	*34 (38.64)*	*23 (34.85)*	*35 (53.03)*
5	*10 (11.36)*	*1 (1.14)*	*12 (18.18)*	*19 (28.79)*
6	*2 (2.27)*	*0 (0.00)*	*3 (4.55)*	*1 (1.52)*
7	*2 (2.27)*	*0 (0.00)*	*1 (1.52)*	*0 (0.00)*
8	*0 (0.00)*	*0 (0.00)*	*0 (0.00*	*0 (0.00)*
9	*0 (0.00)*	*0 (0.00)*	*0 (0.00*	*0 (0.00)*

Table 1 shows the perception of the current and desired appearance of adolescent girls and boys. Among girls in the current appearance, the most frequent figure is 4, which was chosen by 30 (34.09%) girls, and figures 8 and 9 were not chosen by girl. When it comes to the desired appearance, figure 3 is the most frequent, chosen by 39 (44.32%) girls, while figures 6, 7, 8, and 9 were not chosen by girl. The situation is the same for boys in the selection of figures of the current appearance, where the most frequent figure is 4, which was chosen by 23 (34.85%) boys, and figures 8 and 9 were not chosen by the boys, while for the desired appearance, boys did not choose figures 7, 8 and 9, and the most frequent is figure 4, chosen by 35 (53.03%) boys.

Table 2. Frequencies of satisfaction/dissatisfaction with one's physical appearance of adolescent girls and boys

Satisfaction/dissatisfaction with physical appearance	*Girls Frequency (%)*	*Boys Frequency (%)*
-4	*0 (0.00)*	*0 (0.00)*
-3	*0 (0.00)*	*0 (0.00)*
-2	*2 (2.27)*	*10 (15.15)*
-1	*20 (22.73)*	*20 (30.30)*
0	*29 (32.95)*	*23 (34.85)*
1	*29 (32.95)*	*9 (13.64)*
2	*6 (6.82)*	*3 (4.55)*
3	*2 (2.27)*	*1 (1.52)*
4	*0 (0.00)*	*0 (0.00)*

The level of satisfaction/dissatisfaction with physical appearance was calculated as the difference between the assessment of the current and desired appearance and is shown in Table 2. Complete satisfaction with physical appearance was present in 29 (32.95%) girls and 23 (34.85%) boys. 29 (32.95%) girls want to reduce their body mass for one figure, 6 (6.82%) for two figures, and 2 (2.27%) for three figures, while 20 (22.73%) girls, want to increase their body mass for one figure, and 2 (2.27%) girls for two figures. Among boys, 9 (13.64%) boys want to reduce their body mass by one figure, 3 (4.55%) boys want to reduce their body weight by two figures, and 1 (1.52%) boy wants to reduce his body mass by three figures. 20 (30.30%) boys want to increase their body mass by one figure, and 10 (15.15%) boys want to increase their body mass by two figures.

Table 3. Results of the Mann-Whitney U test to assess the statistical significance of the differences in results between gender in satisfaction with body appearance

	Girls	*Boys*	*Mann-Whitney U test*	
Variable	*Mean (SD)*		*p*	*Z*
Satisfaction with physical appearance	*0.26 (1.03)*	*-0.33 (1.13)*	*0.00*	*-3.24*

Table 3 shows the results of the Mann-Whitney U test for assessing the statistical significance of the differences between girls and boys in satisfaction with body appearance.

DISCUSSION

A statistically significant difference was found between teenage girls and boys in satisfaction with physical appearance, with the fact that boys were more satisfied. The obtained findings are consistent with the results of other studies conducted on a sample of adolescents (Calzo, Tylka & Burggraf., 2020; Ata et al., 2007; Tiggemann, 2005). Adolescent girls more often chose figures that showed a slimmer body for their current and desired appearance, while adolescent boys more often chose figures that showed a muscular body. It is assumed that the obtained differences in satisfaction between the genders were determined because girls and women are exposed to more pressure to be thin and have a perfectly slim body (Grabe and Hyde, 2019; Lindberg, Sun & Tobin, 2017), while boys and men are expected to be muscular and athletic physique (Pope, Gruber, & Collins, 2009; Slater, Henderson & Fields, 2016). Such social norms are promoted through the media, advertisements, and popular culture and can lead to adolescents who do not conform to these ideals feeling dissatisfied with their appearance (Tigger, Wheeler & and Goldenberg, 2004; Lindberg et al., 2017; Fredrickson & Roberts, 2019). In addition, there are biological factors that can affect satisfaction with body appearance. For example, research has shown that women have a higher body mass than men and that they tend to store fat in the abdominal area, which can be considered less attractive (Fredrickson & Roberts, 2019). Several individual characteristics can influence how adolescents feel about their bodies. For example, adolescents with low self-esteem or those who are more prone to perfectionism may be more prone to dissatisfaction with their appearance (McMahon and Lopez, 2005), which may negatively affect adolescent mental health (Grabe et al., 2008).

This research has several limitations, among others it is a relatively small, unrepresentative sample and the exclusion of the influence of other factors, such as family and peer influence, and the influence of the media on satisfaction with physical appearance. Despite the limitations, the research results have significant implications. The findings indicate that satisfaction with physical appearance is a significant issue for Croatian adolescents, as only a third are completely satisfied with their looks. They highlight notable differences among adolescents and emphasize that social norms regarding thinness and muscularity play an important role in the development of satisfaction with physical appearance.

Future research should focus on addressing the limitations of this study. A larger and representative sample, the use of objective measures of satisfaction with body appearance, and the assessment of the influence of other factors can provide a more complete picture of this problem.

CONCLUSION

The results of this research possibly indicate that satisfaction with physical appearance is an important problem for Croatian adolescents. It is necessary to encourage critical thinking about unrealistic standards of beauty and promote healthy attitudes about physical appearance. Educational programs and preventive social measures can play a key role in preserving and improving the mental health and well-being of adolescents.

Future research directions should be based on examining the impact of differences in satisfaction within different groups of adolescents, the long-term consequences of body image dissatisfaction, and the development and evaluation of interventions to promote healthy body attitudes in adolescents.

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Overview of Battery Tests for Measuring Physical Fitness in Primary and Secondary Education

Filip Sinković[1], *Krešimir Hrg[1], Dario Novak[1]

[1]Faculty of Kinesiology, University of Zagreb, Zagreb, Croatia

*Corresponding author

ABSTRACT

The primary purpose of physical fitness assessment tests is to gather feedback on the kinanthropological characteristics of children for the purpose of objectively diagnosing their condition and assessing their development. The aim of this paper is to provide an overview of battery tests for measuring physical fitness in primary and secondary education and to list their characteristics that affect feasibility. When listing battery tests, we refer to variables that have satisfactory metric characteristics. Specifically, for a test to be usable, it must have good metric characteristics, primarily reliability and validity. Although Croatia has a long tradition of measuring fitness in schools, unfortunately, there is no central system for collecting and processing such data. The most commonly used tests applied in physical education classes in primary and secondary schools are developed according to the methodology of monitoring and evaluating morphological characteristics, motor skills, and functional abilities, known as the CROFIT norms. In addition to them, EUROFIT norms are applied, as well as the newly designed FitBack online platform, to promote systematic monitoring and evaluation of youth fitness across all European Union member states. Discussion: Regular monitoring of children's physical fitness in schools holds broader societal significance as it contributes to healthier childhood development and promotes awareness of the importance of physical activity and self-care from the earliest age. The assessment of children's physical fitness has multiple and exceptional importance for their development and health.

Keywords: school, children, monitoring, evaluation, physical activity

INTRODUCTION

The primary purpose of fitness assessment tests is to collect feedback on the kinanthropological characteristics of children for the purpose of objective diagnosis and assessment of their development (Neljak et al., 2011). Until recently, measurements of motor skills and abilities in preschool and school-aged children were conducted only when there were suspected developmental issues. This approach allowed children with developmental difficulties to have better chances of improving basic movement skills through various forms of therapy and exercise from an early age (Pérez, 2013). Nowadays, measurements are conducted for preschool and school-aged children to monitor health, educate about the importance of physical activity, tailor exercise programs to their needs, and track progress to promote a healthier lifestyle.

Additionally, for school-aged children, it is important to note that tests are administered at the beginning of the school year for more objective work programming and at the end of the school year to assess achieved results (Findak et al., 1992). Besides testing, regular monitoring throughout the school year is very important and is divided into initial, ongoing, transitional, and final assessments. All these types of assessments must be regularly recorded and analyzed with students to achieve maximum effort and motivation in physical education classes (Pejčić, 2005).

Various battery tests are used to assess the kinanthropological status of children.

When listing battery tests, we refer to variables that have satisfactory metric characteristics. Specifically, for a test to be usable, it must have good metric characteristics, primarily reliability and validity (Hoffman, 2012). To gain insight into the current state of development of students' kinanthropological characteristics, it is necessary to apply a measurement procedure using appropriate tests for a specific population. According to Dizdar (2006), a measuring instrument (test) is an appropriate operator used to determine the position of the measurement object on a scale that assesses the subject of measurement. The result of the measuring instrument indicates the degree of development of the measured subject. Determining the value of the development of the measured characteristic is not sufficient for planning physical and health education lessons; it is also essential to determine the position of the measurement results relative to the average values of the population to which it belongs, i.e., to compare the obtained result with reference values.

In line with all of the above, the aim of this paper is to provide an overview of battery tests for measuring physical fitness in primary and secondary education and to list their characteristics that affect feasibility.

BATTERY TESTS FOR ASSESSING PHYSICAL FITNESS

Motor fitness assessment tests are designed to evaluate various aspects of physical performance and motor skills. These tests measure components such as strength, speed, agility, balance, and coordination. Although Croatia has a long tradition of measuring fitness in schools, there is unfortunately no central system for collecting and processing such data. The most commonly used tests in physical education classes in primary and secondary schools are based on the methodology of monitoring and evaluating morphological characteristics, motor skills, and functional abilities, known as CROFIT norms (Neljak et al., 2011). The authors of these norms focused on the appropriateness, reliability, and feasibility of the measures, resulting in a wide range of abilities and characteristics that allow teachers to assess their students' status and plan physical education lessons accordingly. The proposed tests have demonstrated satisfactory metric characteristics of factorial validity and reliability. In addition to the aforementioned CROFIT norms, since 1988, the EUROFIT battery of measures and tests for assessing kinanthropological characteristics of primary and secondary school students has been used in Europe, following the recommendation of the Council of Europe. The EUROFIT battery provides deeper insights into an individual's health status, evaluates performance in standard exercises, and promotes habits related to sports activities (Neljak et al., 2011). These tests have confirmed satisfactory metric characteristics of reliability and validity, thereby allowing the development of rules and norms for school-aged children (Marinac, 2018). Alongside CROFIT and EUROFIT norms, an international group of highly qualified experts led by the University of Ljubljana and co-funded by the Erasmus+: Sport program has designed a unique multilingual FitBack online platform to promote systematic monitoring and evaluation of youth fitness across all European Union member states. This free web platform offers two very practical tools aimed at different target groups: a unique fitness report for children intended for youth, their teachers, parents, coaches, and doctors, and a practical guide for developing and implementing a national, regional, or local system for monitoring the fitness of children and adolescents aimed at policymakers. More than 10 million data points describing the fitness of children and adolescents aged 6 to 19 have been collected. These standards are implemented in the FitBack reporting system, which is now available to all European teachers. Such a report contributes to empowering students to monitor their own physical characteristics and abilities, which is one of the fundamental educational goals of the physical and health education curriculum.

TESTS FOR ASSESSING THE MORPHOLOGICAL COMPONENT OF PHYSICAL FITNESS

The factors of the morphological component can be associated with various diseases and mortality in the adult population, as well as in children, and therefore need to be systematically monitored. Increased body weight and high body mass index represent risks for the development of cardiovascular diseases, respiratory diseases, diabetes, high blood pressure, and cancer (Mišigoj-Duraković, 2008). When assessing risk factors of the morphological component, it is important to monitor the proportion and distribution of body fat in the organism (Mišigoj-Duraković, 2008). One method of measuring factors of morphological fitness is anthropometry. According to Findak (2003), anthropometric characteristics are part of anthropological features defined as traits responsible for the dynamics of growth and development and the structural characteristics of morphological features, including bone growth in length (longitudinal dimensionality) and width (transversal dimensionality), muscle mass (voluminousness), and subcutaneous fat tissue. Neljak et al. (2011) argue that the transversal and longitudinal dimensionality of the skeleton cannot be influenced by exercise, so exercise is mainly focused on optimizing muscles and regulating subcutaneous fat tissue. Height cannot be changed either, as it is determined by genetics. Measuring these morphological components of physical fitness is necessary to create a high-quality plan and program and to guide the child toward further activities, according to Breslauer et al. (2014).

Body Height

Body height is a measure of the longitudinal dimensionality of the skeleton, which, according to previous interpretations, is responsible for bone growth in length (Findak et al., 1996). To measure height according to CROFIT norms, a stadiometer or Martin's anthropometer is used. The student stands on a flat, firm surface, barefoot and in an upright position, with the head positioned according to the Frankfurt horizontal plane. The examiner, standing to the left of the student, places the stadiometer vertically and immediately along the back, lowering the slider to the crown of the head. The result is read on the measuring scale to an accuracy of 0.5 centimeters and recorded in the data entry sheet. The measurement, including the recording of results, usually takes up to 30 seconds per student and is repeated three times alternately to ensure measurement accuracy (Neljak et al., 2011). A very similar height measurement is conducted according to EUROFIT norms, where a stadiometer or Martin's anthropometer is also used. The subject stands barefoot on a flat, firm surface, with the head positioned to meet the Frankfurt horizontal plane condition. The measurer stands to the left of the subject and carefully controls the placement of the anthropometer, positioning it vertically and immediately along the back. The slider is then lowered to the crown of the subject's head, and the result is read on the measuring scale, typically at the level of the top edge of the triangular notch of the slider ring. The precision of reading the result is 0.1 or 0.5 centimeters, and the results are recorded in millimeters. According to the FitBack platform, a telescopic height measurement instrument is used to measure height. During the measurement, the student stands on the stadiometer with bare feet positioned shoulder-width apart, while the back of the head, shoulder blades, calves, and heels touch the vertical plate. The legs are fully extended, and as with the previous norms, the head is positioned to meet the Frankfurt horizontal plane condition. Two measurements are typically taken, with the average value retained.

Body Weight

Body weight is a measure of the total mass of the body (Neljak et al., 2011). According to the guidelines of CROFIT norms, the Omron BF500 Body Composition Monitor, using the bioelectrical impedance method, is used to measure body weight. During the measurement, the examiner places the device on a flat and firm surface and turns it on. Subsequently, they enter the student's reference data, such as age, gender, and body height. The subject stands barefoot and minimally clothed, typically wearing sportswear, and adopts an upright position. Holding the handles connected to the device, with arms extended and at a 45-degree angle to the body, the examiner reads the body weight. The result is read with an accuracy of 0.1 kilograms and recorded in the data entry sheet. The estimated duration of measurement per student, including recording the results, is up to 60 seconds, and the measurement is performed 3 times alternately for accuracy (Neljak et al., 2011). In contrast to CROFIT norms, EUROFIT uses a medical decimal or household scale with an auxiliary weight to measure body weight. The subject stands barefoot on the scale until the weight settles completely. It is important that the scale is placed on a horizontal surface, and after every tenth measurement, it is necessary to check if the pointer position is exactly on 0 kg. The result is recorded with the smallest accuracy of 0.1 or 0.5 kg. According to the FitBack platform, an electronic scale is used to measure body weight. The subject must stand on the scale platform without support. The child stands still above the center with body weight evenly distributed between both feet. They may wear lightweight underwear but no footwear. Two measurements of body weight are typically taken, retaining the average value.

After measuring body height and body weight, the body mass index can be calculated, which is expressed by dividing body weight in kilograms by the square of height in meters (kg/m2). A higher body mass index is associated with a poorer cardiovascular profile (Neljak et al., 2011).

Percentage of Body Fat

The percentage of body fat is a measure of the proportion of subcutaneous fat tissue in the body mass (Neljak et al., 2011). It is most commonly estimated using modern body composition measurement devices (bioelectrical impedance method) or by measuring skinfold thickness. According to CROFIT norms, the Omron BF500 Body Composition Monitor, using the bioelectrical impedance method, is used to measure body fat percentage. During the measurement, the examiner places the device on a flat and firm surface and turns it on. Subsequently, the student's reference data, such as age, gender, and body height, are entered. The student stands barefoot, minimally clothed in sportswear, and assumes an upright position. Holding the handles connected to the device with arms extended, in a firm grip and at a 45-degree angle to the body, the student raises the handles to a 90-degree position and waits for about 2 seconds until the body fat percentage measurement appears on the screen. The estimated duration of measurement per student, including recording the results, is up to 60 seconds, and the measurement is performed 3 times alternately. It is important to read the device instructions to correctly enter the reference data for each student. In contrast to CROFIT norms, EUROFIT uses a caliper to measure body fat percentage, taking skinfold thickness as the measure. Specifically, the measurement includes skinfolds at the triceps, biceps, subscapular, suprailiac, and calf areas. The measurement procedure involves firmly grasping the skinfold and subcutaneous tissue between the thumb and index finger of the left hand and separating it from the underlying muscle. Then, the ends of the caliper are placed 1 cm below the left hand's fingers, allowing full pressure before reading the fold thickness. It is important to note that it does not matter which side of the body the skinfold thickness is taken from, but all folds must be measured on the same side of the body. The subject stands relaxed, except for the calf fold measurement, which is taken while the subject is seated. The measurement is taken to the nearest tenth of a millimeter (0.1 mm). The same body fat percentage measurement procedure is described on the FitBack platform, but only the thickness of the triceps and subscapular skinfolds is taken as the measure. Two measurements are taken, but not consecutively, and the analysis uses the average value expressed to 0.1 millimeters.

ASSESSMENT TESTS OF MOTOR FITNESS

Motor skills are defined as latent motor structures responsible for countless motor reactions and can be measured and described (Findak, 2003). If motor skills do not develop to the objectively achievable level considering genetic limitations, there is a high probability that such an individual will not be able to effectively and easily perform various everyday tasks, nor will the development of other traits and abilities associated with motor skills be encouraged. Accordingly, it can be concluded that motor skills are not important only for themselves, but also for the development of other traits and abilities. Thus, each specific motor skill is regulated by appropriate mechanisms of the central nervous system that control it and is associated with other human abilities (Pejčić, 2005). Nowadays, there is a large number of different tests for assessing motor skills. According to CROFIT norms, coordination is measured through tests such as the backward shuttle run, rolling a ball with the non-dominant hand, and the turn around test. Agility is assessed through tests such as side steps, bending figure eights, and shuttle run. Flexibility is tested through the sit and reach, sit and reach on the bench, and narrow sit and reach tests. Explosive strength is evaluated through tests such as the standing long jump, 20-meter sprint from a standing start, and medicine ball throw (1kg) from a supine position. Endurance strength is measured through tests such as sit-ups, modified sit-ups, and squats. According to EUROFIT norms, the first test that is always performed is the Flamingo balance test, followed by other tests such as hand tapping, sit and reach, standing long jump, handgrip strength, and bent arm hang. When it comes to the FitBack platform, the tests used to measure motor skills are standing long jump and handgrip strength.

Standing Long Jump

The purpose of this test is to assess the explosive power of the lower extremities in terms of horizontal jumping ability, which indicates the ability to activate the maximum number of motor units in a unit of time during the execution of simple motor movements, with resistance proportional to body mass (Neljak et al., 2011). According to CROFIT norms, to perform this test, 3-4 thin ropes, a jumping board, and a centimeter tape are required. The test is conducted on a flat and solid surface with minimum dimensions of

8x2 meters, either indoors or outdoors. The student stands barefoot on the jumping board with a shoulder-width stance, with the tips of the feet reaching the edge of the board. They perform a two-footed jump forward, and the task is considered completed when, after the takeoff, the student touches the rope with their feet. The test is repeated 3 times consecutively, and measurement is taken from the zero mark on the centimeter tape to the footprint on the rope closest to the takeoff point. The result is recorded in centimeters, and all three measurements are recorded accordingly. The examiner ensures the correct execution of the test and monitors compliance with the instructions to ensure the accuracy of the results. The estimated duration of testing per participant, including recording the results, is up to 30 seconds. According to EUROFIT norms, the same test is performed with the participant performing a two-footed jump from the opposite end of the jumping board, with the higher end of the board facing backward. The goal is for the participant to jump as far as possible and land on both feet on the rope. Before takeoff, arm swings and rising onto the toes are permitted, while double bouncing is not allowed. The participant must jump barefoot, and the takeoff and landing points must be in the same plane. The takeoff point is marked with a line, and it is recommended to place a measuring tape from 0 to 300 cm next to the landing area for easier measurement of the jump length. The result is recorded in centimeters and described in a pre-prepared form. For conducting this test according to the FitBack platform, a hard surface, a stick, and a measuring tape are required. The execution of the jump is the same as in the CROFIT and EUROFIT norms. The distance is measured from the takeoff line to the point where the back of the heel closest to that line touches the ground. An additional attempt is allowed if the child falls backward or touches the ground with another part of the body. The result is expressed in centimeters and entered into the form. Two jumps are performed, and only the best attempt is recorded.

Hand Grip Strength

According to EUROFIT norms, to perform this test, a calibrated hand dynamometer with an adjustable grip is required. The participant should take the dynamometer in the chosen hand and squeeze it as hard as possible, keeping it away from the body. The dynamometer must not touch the body during the test. The grip should be maintained gradually and without interruption for at least two seconds. The test is conducted twice, and the better result of the two attempts is recorded. Before each test, the measurer should reset the dynamometer to zero and ensure that the dial of the dynamometer is facing the participant. The participant should use the hand of their choice, adjusting the grip so that two bars correspond to the first phalanx of the middle finger. The test score is expressed as the better result in kilograms with an accuracy of 1 kg. According to the FitBack platform, a hand dynamometer with an adjustable grip (TKK 5101 Grip D; Takey, Tokyo, Japan) is used as an aid in performing this test. The child gradually and continuously squeezes the dynamometer for at least 2 seconds, performing the test twice (alternating between both hands) with an optimal grip width (previously calculated according to hand size) and allowing for a short rest between measurements. For each measurement, the tested hand is first randomly selected. The elbow must be fully extended and contact with any other part of the body except the measured hand should be avoided. The maximum duration of the test is 3-5 seconds, and the measurement accuracy is 0.5 cm. The results of hand size should be rounded to the nearest whole centimeter.

CONCLUSION

The assessment of children's physical fitness holds manifold and exceptional importance for their development and health. Regular monitoring of their kinanthropological status allows for the early detection of potential developmental issues, enabling faster intervention and tailored therapies according to their needs. Children facing developmental challenges can benefit from early intervention through therapies and exercises aimed at improving basic motor skills. Testing contributes to parental education on the importance of physical activity from an early age and fosters awareness of a healthy lifestyle. Based on test results, teachers can adapt exercise programs to meet children's individual needs and promote their development. Testing at the beginning and end of the school year enables teachers to objectively plan educational programs and assess students' achievements. Regular monitoring throughout different phases of the school year facilitates systematic tracking of children's progress and identification of areas requiring additional support or attention. Ultimately, regular monitoring of children's physical fitness in schools holds broader societal significance as it contributes to healthier childhood development and promotes awareness of the importance of physical activity and self-care from the earliest age.

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Priority Te-Ta Structures in Kickboxing Fights According to K1 Rules

*Dino Belošević[1], Matej Babić[1], Matijas Barić[2]

[1]Education and Student Committee, World Association of Kickboxing Organisations, Switzerland; [2]Faculty of Kinesiology, University of Split, Split, Croatia

*Corresponding author

ABSTRACT

Kickboxing is a way of fighting that requires the application of fast and efficient technical-tactical complexes. Technical and tactical structures (te-ta structures in the following text) that are used in combat depend on the discipline. They are directly related to the physical preparation of the fighter and his anthropological features. Successful fighters can apply more attacking te-ta structures with frequency and efficiency. This study aims to resolve the problem of the priority of te-ta structures in the kickboxing fights on the top level in K1 rules. It gives us an insight into what the world's best kickboxing athletes did the most. Certain methods from the methodological system are used to learn and perfect these structures. The sample consisted of 108 fighters who participated in 96 matches under K1 rules at a high level of competition (final K-1 tournament between 1995-2012). The structure of the K1 fight is defined through 56 basic variables. All variables were described, explained, and recorded according to a specially defined protocol and entered into the interactive software State Analyzer 1.0, which determined which variables were the most frequent. The structure of the K1 fight is defined through 56 basic variables. The results show the occurrence and thus the importance of these structures as follows: 1. Jab to the head with the front hand, 2. Hand block of the hand strike, 3. Cross to the head with the back hand, 4. Hook to the head with the front hand and 5. Hook to the head with the back hand. Jab to the head with the front hand is one of the most common strikes used in fights according to the previous literature. Hand blocks are the basis of every starting guard stance. More successful fighters applied better rear cross in research and it is noted that our sample showed it to be one of the most used te-ta structures. The front hook is proving to be one of the key variables for success in kickboxing. Fighters perform a hook to the head with the back hand from the basic stance, shifting the weight and rotating the hip towards the opponent. This work will enable trainers to determine which structures should be paid more attention to in the training process, but also to better understand them and use methods for the training process.

Keywords: kickboxing, K1, te-ta analysis, te-ta structure, te-ta priorities.

INTRODUCTION

Kickboxing as a form of fighting using hands and feet dates back to before our era, but several sources date the origin of kickboxing as an organized activity to the sixteenth century with the appearance of the activities of soldiers in Indochina who trained the disciplines of fighting with all limbs for defensive purposes (Anderson, 1989). The matches involved two competitors who fought with fists, elbows, knees, shins, and feet. The rules became standardized in the twentieth century with the emergence of numerous organizations, first in Japan (Deša, 2018) and later in the West (WAKO). Japanese kickboxing, also known as kickboxing with international rules, gained popularity in the 1960s and its development in Japan was probably directly influenced by Thai kickboxing (Harris, 2001). Karatekas from Japan combined the techniques of Thai boxing with international strikes of boxing style and karate. Japanese fighters, however, did not adhere to the traditions and rituals associated with the discipline practiced in Thailand. The discipline then spread throughout Europe and the Western Hemisphere (Green & Svinth, 2010). Kickboxing is a modern contact martial sport created based on many traditional martial arts and sports and was a unique Western response to many Eastern fighting arts (WAKO).

Structural analysis: kickboxing belongs to the group of poly-structural acyclic sports in which acyclic movements and symbolic destruction of the opponent dominate (Malacko & Radjo, 2004). According to the dominance of energy processes, kickboxing belongs to the group of sports of high intensity and duration. In kickboxing, all three basic ways of obtaining energy are represented (anaerobic-alactic, anaerobic-lactic, and aerobic), and the anaerobic-lactic form of energy generation is used significantly (Karninčić, Baić, & Belošević, 2010). Kickboxing is 60% anaerobic and 40% aerobic, aerobic capacity is necessary for energy recovery, i.e. recovery between high-intensity te-ta structures during the activity, between rounds, and after it as well (S. Kapo & Cikatić, 2011).

Te-ta structures: te-ta structures that are used in combat depend of course on the discipline and are directly related to the physical preparedness of the fighter and his anthropological characteristics. Successful fighters can apply more attacking te-ta structures with frequency as well as efficiency (Belosevic, Karnincic, & Jelaska, 2017; Ibrahim Ouergui et al., 2019; I. Ouergui et al., 2021). Kickboxing is a way of fighting that requires the application of fast and efficient technical-tactical complexes (I. Ouergui, Hssin, Franchini, Gmada, & Bouhlel, 2013). Training programs need to be adapted to the specific requirements of the kickboxer's weight categories and gender to develop technical-tactical abilities that increase the chances of winning (Slimani, Chaabene, Miarka, & Chamari, 2017). To learn and perfect these structures, certain methods from the methodology system are used. Methodology is a set of procedures to adopt certain movement structures, it is based on learning principles. The methods of training work in sports form a unique complex with organizational forms of work, they apply work methods according to the method of transmitting information (verbal method, motor method or demonstration method, visual method, problem method, combined method) and according to the method of learning - acquiring information (synthetic method, analytical method or presentation of the technique in parts, situational method, ideomotor method, complex method) (Milanović, Jukić & Šimek, 2003).

Aim of the study: this study aims to resolve the problem of priority of technical and tactical structures in the kickboxing fights on the top level in K1 rules. It gives us an insight into what the world's best kickboxing athletes did the most and the possibility to draw conclusions about the challenges and implement these aspects in training and competition. For the development of kickboxing as a discipline, it is very important to define the practical space of structures that appear, as well as their frequency and applicability in fights, so that coaches can pay attention to them in the development of the training process and preparation for fights. Also, the aim was to define the technical requirements set by top-level kickboxers.

METHODS

For the analysis of technical-tactical structures in top kickboxing, a descriptive-analytical approach was used. Situational specification of non-standard variables in kickboxing has been observed and detected to the extent that the technical-tactical structure of the activity itself has been explained.

Data were analyzed using the software State Analyzer 1.0. Based on the obtained results, data interpretation was performed to identify key technical-tactical structures that are most used in top kickboxing, which enables further application in the training process and tactics of fighters. The sample includes 108 fighters who participated in 96 matches of 15 qualifying tournaments to enter the final K-1 tournaments that took place between the years 1995-2012. The years 2000, 2001, and 2011 were not taken into account because qualifying tournaments did not take place in those years for reasons known to organizers only. 56 basic variables were used that indicate the structure of the competition in K-1.

Table 1. System of the te-ta structure of K1 fight

V_1: straight punch, jab	*V_29: roundhouse low kick with the front leg to the back leg*
V_2: straight punch, cross	*V_30: roundhouse low kick with the back leg to the front leg*
V_3: jab to the body	*V_31: roundhouse low kick with the back leg to the back leg*
V_4: cross to the body	*V_32: roundhouse middle kick with the front leg*
V_5: front hand uppercut to the head	*V_33: roundhouse middle kick with the back leg*
V_6: back hand uppercut to the head	*V_34: roundhouse high kick with the front leg*
V_7: front hand uppercut to the body	*V_35: roundhouse high kick with the back leg*
V_8: back hand uppercut to the body	*V_36: front leg side kick to the body*
V_9: front hand hook to the head	*V_37: back leg side kick to the body*
V_10: back hand hook to the head	*V_38: front leg side kick to the head*
V_11: front hook to the body	*V_39: back leg side kick to the head*
V_12: back hand hook to the body	*V_40: turning back kick to the body*
V_13: backfist punch	*V_41: turning back kick to the head*
V_14: spinning backfist	*V_42: spinning back heel kick to the head*
V_15: hand block from a leg kick	*V_43: spinning back heel kick to the body*
V_16: hand block from punch	*V_44: spinning back heel kick to the leg*
V_17: hand block from knee kick	*V_45: front leg knee kick to the head*
V_18: low kick block with front leg	*V_46: back leg knee kick to the head*
V_19: low kick block with the back leg	*V_47: front leg knee kick to the body*
V_20: middle kick block with front leg	*V_48: back leg knee kick to the body*
V_21: middle kick block with the back leg	*V_49: front leg knee kick to the leg*
V_22: outside clinching	*V_50: back leg knee kick to the leg*
V_23: inside clinching	*V_51: axe kick with front leg*
V_24: front kick with front leg to the head	*V_52: axe kick with the back leg*
V_25: front kick with back leg to the head	*V_53: bob and wave to the left*
V_26: front kick with front leg to the body	*V_54: bob and wave to the right*
V_27: front kick with back leg to the body	*V_55: left deflection*
V_28: roundhouse low kick with the front leg	*V_56: right deflection*

Table 1. presents the detected fight structure system in kickboxing according to K1 rules.

In the first phase of the research, experts in kickboxing collected high-quality videos of all the matches included in the study. In the second phase, interviewers watched these videos to identify and record various techniques and their frequencies. They began by reviewing notes taken during numerous consultations. Each variable was clearly defined, described, and recorded according to a specific protocol.

In the third phase, the identified technical and tactical structures were entered into a text file using a predefined protocol. These were then analyzed with the software State

Analyzer 1.0 to determine the most frequent techniques. All combat events were meticulously documented and transferred to the final data matrix following a strict recording protocol. This detailed protocol ensured accurate detection and data entry for each match, allowing for direct observation and analysis of the fight's elements.

RESULTS

In a sample of 96 matches, 3,688 jabs, punches to the head with the front hand, 3,568 hands blocking from the punches, 2,321 cross punches to the head with the back hand, 1,955 hooks to the head with the front hand, 1,551 hooks to the head with the back hand were detected. All the variables listed together represent the 5 most frequent te-ta structures that appeared in the considered sample.

Table 2. The most frequent te-ta structures

1. Straight punch, jab	*2. Hand block from punch*	*3. Straight punch, cross*	*4. Front hand hook to the head*	*5. Back hand hook to the head*
3688	*3568*	*2321*	*1955*	*1551*

Table 2. shows the 5 most frequently detected variables that represent the most important part of the te-ta structure of a kickboxing fight according to K1 rules.

Figure 1. Graphic representation of the te-ta structure frequencies

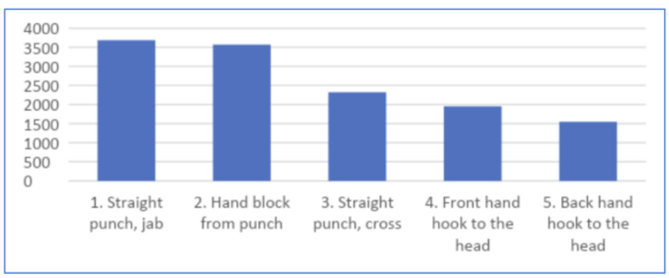

Figure 1. shows the 5 most frequently detected variables that represent the most important part of the te-ta structure of a kickboxing fight according to the K1 rules in graphic form.

DISCUSSION

The results of this study confirm the importance of technical-tactical structures such as the jab (straight punch) in the success of elite kickboxers. According to Belošević et al. (2017), the jab is one of the most frequently used punches, as supported by the literature (I. Ouergui et al., 2013). Our findings indicate that the jab is crucial not only due to its frequency but also because of its role in maintaining balance and setting up further actions. Straight punch, jab with the front hand is a strike that is performed from the basic stance where fighters shift the weight of the body to the front, i.e. fighters step forward with it on the front leg and rotate the hip, extend the front hand in addition, the right leg follows to maintain the balance and stability of the "guard". Effective execution of the jab requires coordination between the front foot, hip, and the front hand. The rear hand stays by the chin all the time to defend from a counterstrike (Barić, 2023). It is often characterized in the literature as one of the most frequently used and important punches (S. Kapo et al., 2008; I. Ouergui et al., 2013).

Blocking punches also proved to be a critical component of defensive strategy. Barić (2023) detailed various blocking techniques. Our results show that these techniques are essential for minimizing damage from opponent strikes and allowing fighters to maintain defensive stability. An increased frequency of successful blocks was significantly associated with better fight outcomes, highlighting the importance of both offensive and defensive skills. Similar results that show the importance of blocking with both hands as part of basic defense strategy in boxing matches are shown in the literature (Safet Kapo, Kajmovic, Ćutuk, & Beriša, 2008). The hand block is a basic guard concept in kickboxing, varying by punch type. Fighters use a "double deck" guard, keeping hands close to the body and head, requiring strong hands to absorb blows on the glove and forearms (Barić, 2023).

The cross and hook punches were identified as key to success in kickboxing. Cappai et al. (2012) and El Ashker (2011) noted that more successful fighters have better cross-punch techniques, which our research corroborated. The accuracy, power, and speed of this punch significantly contribute to its effectiveness. (Cappai et al., 2012; El Ashker, 2011). Our analysis showed that executing this punch from the basic stance, with proper hip and foot rotation, is vital for generating power and protecting against counterstrikes. The same biomechanical structure is described in the literature (Barić, 2023).

Hook the head with the front hand fighters perform from the basic position by shifting the center of gravity of the body to the front leg, making a deflection to the front-hand side, our rear shoulder goes a little inward, rotate the hip, fighters rotate the foot of the front leg on the toes so that our heel goes out and the knee inwards, fighters throw the hand towards the opponent's head, the elbow and shoulder are in the same plane, the angle in the elbow is 90 degrees, thus protecting the head from counter blows (Barić, 2023). The front hook proves to be one of the key variables for the success of kickboxing fights because it has a good angle and distance from the opponent. Biomechanical characteristics make it a good offensive and counter-strike. (Belosevic et al., 2017; Belošević, 2021).

Performing hook the head with the back hand from the basic stance fighters shift the weight with a slight deviation to the back lateral side onto the back leg, rotate the back foot on the toes so that our heel goes outward, our knee goes in, fighters rotate the hip towards the opponent inward and throw out the arm. The elbow and shoulder are in the same plane, and the angle in the elbow is 90 degrees. For a lot of fighters this is considered to be one of the most devastating strikes (Barić, 2023) so it is not a surprise that this strike is frequently applied in the top kickboxers sample taken in this paper.

CONCLUSION

On a sample of 108 fighters who participated in 96 matches according to K1 rules at a high level of competition (the final K-1 tournament between 1995-2012), the structure of the K1 fight was defined through 56 basic variables. This study aimed to resolve the problem of the priority of technical and tactical structures in the kickboxing fights on the top level in K1 rules. It gives us an insight into what the world's best kickboxing athletes did the most and the possibility to draw conclusions about the challenges and implement these aspects in training and competition. To develop kickboxing as a discipline, it is essential to define the practical space of te-ta structures that appear, as well as their frequency and applicability in fights, so that coaches can pay attention to them in developing the training process and preparation for fights. Also, the aim was to define the technical requirements set by top-level kickboxers. The results show that the most frequent and important structures are: 1. Jab to the head with the front hand, 2. Hand blocking of the punches, 3. Cross to the head with the back hand, 4. Hook to the head with the front hand and 5. Hook to the head with the back hand. This study emphasizes the importance of integrating technical-tactical elements into the training process of kickboxers. Coaches should focus on perfecting the techniques of the jab cross and hooks as well as various blocking techniques, to optimize their fighters' performance. Further research could examine the impact of specific training programs on improving these technical skills and their influence on long-term competitive success. It is necessary to define the structures of other kickboxing disciplines and other weight categories. This paper will enable trainers to determine which te-ta structures should be paid more attention to in the training process and better understand them and use methods for their training.

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Differences In Physical Literacy According To Physical Activity Levels In Adults From Croatia

Mia Lučin[1], Bruno Majić[1], Barbara Gilić[1]

[1] University of Split, Faculty of Kinesiology, Split, Croatia

* Corresponding author

ABSTRACT

Physical literacy (PL) is a foundation for lifelong participation in physical activity (PA) and is a cornerstone of achieving optimal PA levels. The studies which investigated PL in adults with regard to PA status are lacking, especially in Croatian adults. This research included the International Physical Activity Questionnaire (IPAQ-SF) for assessing PA, while PL was assessed using the Perceived Physical Literacy Questionnaire for adults in the Croatian language. The participants were categorized into low-PA and high-PA groups. The Mann-Whittney U test and Reciever Operating Characteristics were used for determining the differences between the groups, and Spearmans' correlation coefficients were used for investigating the associations between the study's variables. The high-PA group had higher scores in physical competence ($Z=-7.96$, $p<0.001$, Area Under the Curve (AUC)=0.74), and motivation ($Z=-6.42$, $p=-0.001$, AUC=0.70). The moderate-to-vigorous PA was associated with physical competence ($r=0.44$, $p<0.001$), motivation ($r=0.38$, $p<0.01$), and confidence ($r=0.30$, $p<0.01$). The higher PL scores in the high PA group suggest that regular and intense PA positively influences overall PL, potentially leading to sustained engagement in PA, healthier lifestyles, and reduced sedentary behavior. The results of this study support the theory that PL is associated with higher PA, as adults with higher levels of PA reached better PL levels in several PL components. However, this study included mostly physically active participants and future studies should investigate similar topic in the general population.

Keywords: exercise, grown-ups, fitness, lifestyle medicine, recreation

INTRODUCTION

Physical literacy (PL) is defined as "Motivation, confidence, physical competence, knowledge and understanding that individuals develop in order to maintain physical activity at an appropriate level throughout their life" (Whitehead, 1993). The notion of PL has garnered global recognition over the past twenty years, being widely regarded as the key to fostering continuous lifelong engagement in physical activity (PA) (Whitehead, 2019). Encouraging PL has been recognized as a crucial strategy for achieving substantial health benefits in both kids and adults (Edwards et al., 2017). According to Warburton et al. (2006) there is undeniable evidence that regular PA is effective in the primary and secondary prevention of numerous chronic diseases, such as cardiovascular disease, diabetes, cancer, hypertension, obesity, depression, osteoporosis, and in reducing the risk of premature death. Certainly, a comprehensive review study reported that PA is the most effective prevention strategy for over 25 chronic medical conditions, offering a 20-30% risk reduction (Rhodes et al., 2017).

Despite the suggested standard of engaging in at least 150 minutes of moderate PA weekly, a considerable portion (i.e., 30%) of the adult population falls short of meeting these guidelines, potentially resulting in adverse impacts on their health and overall well-being (Guthold et al., 2018). However, across all age groups globally, including children, adolescents and adults, there exists a strikingly low level of PA, highlighting the critical need to explore PL in the context of enhancing lifelong PA (Reiner et al., 2013). Indeed, PL has emerged as a key concept in understanding and promoting pa across different populations. A study conducted by Stodden et al. (2008) examined the relationship between participation in sports activities and PL among children and adolescents. Their analysis revealed that children and adolescents who engaged in sports demonstrated significantly higher levels of PL compared to those who were not involved in sports activities. Also, a study from Croatia came to a similar conclusion, indicating that children and adolescents involved in sports exhibited higher levels of PL compared to their non-sporting counterparts (Sunda et al., 2022). Additionally, this relationship was indirectly indicated in a study demonstrating that children and adolescents engaged in sports activities were more inclined to continue participating in sports into adulthood (Perkins et al., 2004).

However, there is a noticeable gap in research specifically addressing the correlation between organized PA and PL in adults. The majority of research exploring the association between PL and PA has primarily focused on younger individuals, with limited research focusing on adults. Nonetheless, this population is also very important, as PL plays a pivotal role in shaping lifelong habits and activities (Reiner et al., 2013). Therefore, the aim of this study was to investigate the potential variations in PL among adults based on their levels of PA in the Croatian population.

METHODS

The participants in this research were 561 adult individuals from Croatia of which (321 females and 240 were males). The variables included PL questionnaire, PA questionnaire, and sociodemographic characteristics.

The Perceived Physical Literacy Questionnaire, Croatian version (PPLQ-Cro) evaluates perceived PL levels and its six domains: Physical competence, Understanding, Motivation, Confidence, Knowledge and Physical activity behavior. 6-point Likert scale (5 to 0) was used for responses of the first four domains. The knowledge domain did not yield satisfactory results and, therefore, is not included in this study. Domain scores range from 0 to 100, with higher scores indicating greater competency. The questionnaire was sent through social media to the participants and answers were collected using online platform SurveyMonkey.

International Physical Activity Questionnaire (IPAQ-SF) was used for assessing PA behavior. The participants were categorized into low-moderate-PA and high-PA groups according to IPAQ-SF classifications. The PA behavior domain score is derived from a theory-driven nonlinear saturation function, with 300 minutes of MVPA per week equating to a score of 100.

The statistical analysis included descriptive statistics with means and standard deviations. Due to all variables being non-normally distributed, the Mann-Whitney U Test was used to determine the differences between the groups. The group differences were further supported by the Reciever Operating Characteristics curve (ROC) with the value of Area under the curve (AUC) greater than 0.70 showing significant group differences (Nahm et al., 2022). Spearman R correlation coefficients were used for determining the correlations between all study variables. The program Statistica 13 with a p-level of 0.05 was used for analysis.

RESULTS and DISCUSSION

Table 1 presents descriptive statistics and differences between low and high PA groups. It is visible that the low PA group has lower scores in all PL variables (physical competence, understanding, motivation, and confidence domains) compared with high PA group.

Table 1: descriptive statistics and differences between low and high PA groups

Variable	Low and moderate PA (n=131)		High PA (n=427)		Mann-Whitney U Test		
	Mean	SD	Mean	SD	U	Z	p-value
Age (years)	28.79	12.36	27.17	11.57	26108.00	1.15	0.249
Years of organized PA	6.18	8.82	10.75	9.99	18406.00	-5.92	0.001
Sitting time (min)	416.72	361.99	347.11	329.19	22492.50	3.43	0.001
Physical competence	50.44	23.43	69.63	21.73	13867.50	-7.96	0.001
Understanding	88.64	17.27	91.85	15.51	21623.50	-2.92	0.01
Motivation	73.17	20.32	84.32	17.83	16195.00	-6.42	0.001
Confidence	60.76	25.34	73.32	24.93	17949.00	-5.28	0.001
MVPA (METs)	972.92	698.02	4345.35	2707.44	2781.50	-15.05	0.001

Note: PA – physical activity, MVPA – moderate-to-vigorous physical activity

These group differences were further supported by ROC analysis shown in Figure 1. However, only variables Physical competence (AUC=76, 95% CI=0.69-0.79) and Motivation (AUC=70, 95% CI=0.64-0.74) are considered significant in differentiating the PA groups.

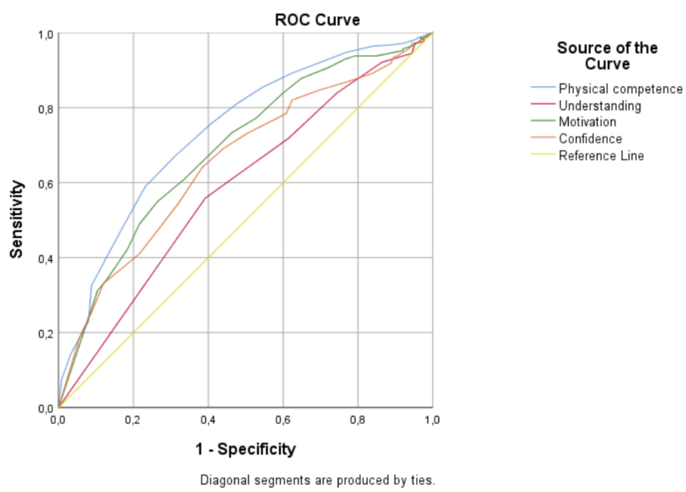

Figure 1. Reciever operating characteristics curve.

Spearman R correlation coefficients are presented in Table 2. MVPA has the highest correlation with Physical competence and Motivation domains in the total sample, as well as stratified for PA groups.

Table 2. Correlation coefficients between all study variables.

	Total sample			
Variable	Physical competence	Understanding	Motivation	Confidence
Physical competence	1.00			

Understanding	*0.29***	*1.00*		
Motivation	*0.51****	*0.49****	*1.00*	
Confidence	*0.40****	*0.26***	*0.5***1*	*1.00*
MVPA (METs)	*0.44****	*0.17**	*0.38***	*0.30***
	High physical activity			
	Physical competence	*Understanding*	*Motivation*	*Confidence*
Physical competence	*1.00*			
Understanding	*0.27**	*1.00*		
Motivation	*0.30***	*0.54****	*1.00*	
Confidence	*0.28***	*0.31***	*0.49****	*1.00*
MVPA (METs)	*0.20**	*0.20**	*0.28**	*0.23**
	Low and moderate physical activity			
	Physical competence	*Understanding*	*Motivation*	*Confidence*
Physical competence	*1.00*			
Understanding	*0.25**	*1.00*		
Motivation	*0.48***	*0.46****	*1.00*	
Confidence	*0.37**	*0.24***	*0.49****	*1.00*
MVPA (METs)	*0.33***	*0.11**	*0.29***	*0.22**

Note: * denotes $p<0.05$, ** denotes $p<0.01$, *** denotes $p<0.001$

The possible explanations for the finding that high PA group has higher scores in all PL variables (physical competence, understanding, motivation, and confidence domains) compared with low PA group are as follows. The higher PL scores in the high PA group suggest that regular and intense PA can positively influence overall PL, potentially leading to sustained engagement in PA and healthier lifestyles. Higher PL scores in the high PA group suggest that engaging in regular and intense PA has a positive effect on overall PL. Indeed, regular intense PA helps Supportively, the correlations between moderate-to-vigorous physical activity (MVPA) and physical competence and motivation domains can be explained by the fact that engaging in more PA leads to higher physical competence and higher motivation to continue participating in PA. The correlation analysis demonstrates that MVPA has the highest correlations with physical competence and motivation domains across the total sample. This pattern holds true when the data is stratified by PA levels. These results suggest that engaging in higher levels of PA not only improves physical capabilities individuals become more physically capable, which boosts their confidence and motivation to stay active. This creates a positive cycle where improved abilities lead to continued engagement in PA. It was supported in a study which highlighted that higher PA levels correlate with increased PL, encompassing enhanced physical competence, motivation, and overall health outcomes, which fosters continued participation in PA and promotes long-term healthy behaviors (Cornish et al., 2020).

but also boosts motivation to participate in such activities (Yan et al., 2023). Cyclical relationship highlights the importance of fostering an environment that encourages regular PA to enhance these key aspects of PL.

Interestingly, the study also revealed that the high PA group had significantly lower sitting times compared to the low PA group. This finding aligns with the notion that higher PA levels are inversely related to sedentary behavior. The lower sitting times in the high PA group may contribute to their higher physical literacy scores, suggesting that reducing sedentary behavior could be an important component of interventions aimed at improving PL. Encouraging individuals to engage in more dynamic and less sedentary activities could thus be a strategic approach to enhance their PL and overall health. Moreover, integrating physical activity into daily routines, such as active transportation to work or active breaks, can help reduce overall sedentary time (Carson et al., 2016).

CONCLUSION

The results of this study highlight the strong link between PL and PA levels among Croatian adults. Participants with higher PA levels showed more physical competence, comprehension, motivation, and confidence than those with lower PA levels. This shows that regular and vigorous PA has a favourable impact on PL, promoting long-term participation and healthy lifestyle choices. The study also emphasises the cyclical nature of PA and PL, in which greater physical skill and drive encourage ongoing engagement in PA. Furthermore, the negative association between PA levels and sedentary behaviour highlights the need for treatments that promote more active and less sedentary lives.

These findings indicate that programmes aimed at increasing PA levels should focus on improving both physical ability and motivation in order to be effective. Future studies should look into focused measures to enhance these specific domains, which might lead to more significant gains in PA and decreases in sedentary behaviour among adults. Moreover, future studies should extend to encompass a more varied population to better evaluate these findings and investigate targeted approaches to enhance PL and PA across different demographic groups.

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Hypermobile Knee Joint and Anthropometric Indices in Non-Injured Athletes

*Barbara Gilić[1], Saša Baščevan[2]

[1]University of Split, Faculty of Kinesiology, Split, Croatia; [2]Clinic Patella, Zagreb, Croatia

*Corresponding author

ABSTRACT

Knee hypermobility, characterized by an increased range of motion beyond normal limits, is common among athletes and can influence performance and injury risk. This study investigated the relationship between knee hypermobility and anthropometric indices in non-injured athletes, aiming to provide insights into how body composition and structure impact joint function and stability. A cohort of non-injured athletes (n=47) was assessed for knee hypermobility using standardized clinical measurements. Anthropometric indices including leg length, shin length, body mass, body height, and body mass index (BMI) were recorded. Statistical analyses, including t-tests and correlation coefficients, were performed to identify significant differences and relationships between knee hypermobility and these anthropometric variables. The results indicated that athletes with hyperextended knees had significantly shorter leg lengths (t=-2.58, p=0.03) and shin lengths (t=-2.25, p=0.01) compared to those without hyperextended knees. No significant differences were found in body mass, body height, or BMI between the two groups. The findings suggest that shorter legs may contribute to a larger cross-sectional area of the quadriceps muscle, leading to greater force exerted on the knee joint and potentially increased hypermobility. This biomechanical advantage emphasizes the need for balanced strength training and joint stabilization exercises to prevent hyperextension injuries. This study highlights the complex interaction between anthropometric indices and knee hypermobility in athletes. Understanding the link between anthropometric indices and knee hypermobility can inform the development of personalized training and rehabilitation programs. Further research is necessary to explore these relationships in larger and more diverse athletic populations.

Keywords: Anthropometric characteristics, knee hypermobility, athletes, joint stability, kinesitherapy

INTRODUCTION

Athletes frequently exhibit knee hypermobility, which is defined as an expanded range of motion in the knee joint above normal limits (Junge et al., 2019). Depending on the sport and an athlete's level of control over joint motions, this condition can be both advantageous and risky. Knee hypermobility is common due to the demands of their sports, which often require a high degree of flexibility, agility, and dynamic movement. Hypermobility in the knees allows for an extended range of motion, which can be advantageous in activities such as gymnastics, dance, and certain types of athletics that require extreme flexibility and rapid directional changes. While hypermobility can improve flexibility and performance in sports that require a lot of joint movement, it also increases the risk of injuries, such as ligament tears and joint instability (Lamari & Beighton, 2023). Understanding the mechanisms that contribute to knee hypermobility is critical for designing tailored therapies to improve sports performance and avoid injuries. Anthropometric indices, which include measures such as body mass index, limb length, and body fat percentage, are important criteria in the study of athletic performance and health. These indices not only give information about an athlete's physical fitness, but also impact their susceptibility to disorders such as knee hypermobility (Bascevan et al., 2024). Body composition (i.e., muscle mass) distribution, for example, can have a big impact on joint mobility and stability (Ponti et al., 2020). As a result, investigating the link between anthropometric indices and knee hypermobility can provide important insights into how body form influences joint function and injury risk.

Athletes with hypermobile knees frequently have a greater range of motion in the knee joint, which, although useful for some activities that require flexibility, may also contribute to instability and an increased risk of injuries such as ligament tears, dislocations, and meniscus damage (Schmidt et al., 2017). Injuries can aggravate hypermobility by weakening the knee's supporting tissues, resulting in a vicious cycle of instability and damage (Wolf et al., 2011). However, healthy athletes are not frequently studied on this issue. Healthy athletes, who are often in excellent physical shape, provide a good cohort for studying the relationship between knee hypermobility and anthropometric indices. This population is frequently subjected to strenuous training programmes that might have an impact on both their body composition and joint mobility. Recent research has emphasised the necessity of personalised methods in sports medicine, acknowledging that individual differences in body shape can significantly influence athletic performance and injury risk (DiStefano et al., 2009).

However, most studies investigating the associations between anthropometric indices and hypermobility were conducted on injured athletes, while such studies are lacking on healthy athletes. This study aimed to investigate the complex interaction between knee hypermobility and anthropometric indices, leading to a better knowledge of athletic health and performance optimisation. By considering each athlete's individual physical features, these programmes can improve performance while lowering the risk of injury.

METHODS

The sample included 47 healthy athletes without knee injuries, aged 23.48±3.54 years. Athletes from numerous sports were included, primarily from football, handball, track and field, rowing, swimming. The variables included the degree of knee hypermobility, and anthropometric indices (body height, body mass, leg and shin length). The degree of hypermobility was measured while sitting on the floor with the Pasco Xplorer GLX goniometer. The group with hypermobility was classified as having more than 10 degrees of the extension of the knee.

The descriptive statistics included means and standard deviations. Differences between athletes with hyperextended and athletes without hyperextended knees were determined using the Student’s t-test for independent samples. Correlations between anthropometric indices and mobility degree were calculated by Pearson’s R correlation coefficients. Statistical package Statistica v13 (Tibco, CA, USA) with a p-level lower than 0.05 applied for all analysis.

RESULTS and DISCUSSION

Descriptive statistics and anthropometric differences between athletes with hyperextended and non-hyperextended knees are shown in Table 1. The group of hypermobile subjects had an average of 2.5 cm shorter legs than the non-hypermobile subjects, and there was also a difference in shin-length (approx. 2 cm). Participants did not differ in body mass or body height.

Table 1. Descriptive statistics and anthropometric differences between athletes with hyperextended and non-hyperextended knees.

Variable	*Hyperextended (n=22)*		*Non-hyperextended (n=25)*		*T-test*	
	Mean	*SD*	*Mean*	*SD*	*t-value*	*p-value*
Leg length Right	*87.11*	*4.11*	*90.26*	*5.35*	*-2.23*	*0.03*
Leg length Left	*87.26*	*4.20*	*90.39*	*5.18*	*-2.25*	*0.03*
Leg length mean	*87.19*	*4.15*	*90.32*	*5.26*	*-2.25*	*0.03*
Shin length Right	*40.10*	*2.89*	*42.94*	*4.54*	*-2.52*	*0.02*
Shin length Left	*39.98*	*2.92*	*43.01*	*4.64*	*-2.64*	*0.01*
Shin length mean	*40.04*	*2.90*	*42.98*	*4.59*	*-2.58*	*0.01*
Body mass	*80.40*	*9.53*	*79.40*	*11.88*	*0.32*	*0.75*
Body height	*180.86*	*7.24*	*182.28*	*6.90*	*-0.69*	*0.50*
BMI	*24.52*	*1.88*	*23.79*	*2.33*	*1.18*	*0.25*

Pearson's R correlation coefficients between anthropometric indices and mobility degree are presented in Table 2. There were no statistically significant associations between any of the variables.

Table 2. Correlations between anthropometric indices and mobility degree.

Variable	*Degree Right*	*Degree Left*
Leg length Right	*-0.26*	*-0.20*
Leg length Left	*-0.25*	*-0.20*
Shin length Right	*-0.20*	*-0.20*
Shin length Left	*-0.21*	*-0.20*
Body mass	*0.11*	*0.07*
Body height	*-0.02*	*-0.03*

By analyzing the differences between the two groups of subjects, it was determined that they differ in the variable of leg length and shin length, in such a way that the group of hypermobile subjects has shorter legs than the non-hypermobile subjects, and that there is also a difference in shin length. Such data are in contradiction with physical postulates in which the assumption is that a longer leg will have greater leverage, i.e. greater hypermobility or, in this case, that the groups will differ statistically significantly, but that the group of hypermobile subjects will have on average higher values than other groups. The possible explanation of this finding is that a shorter leg can mean a larger cross-section of the quadriceps muscle, thus a greater partial strength of the same that acts on the knee by overextending it. The force generated by these muscles is directly related to their cross-sectional area, as larger muscle fibers can produce greater force (Kojic et al., 2021). In individuals with shorter legs, the muscle fibres may be more densely packed over a shorter bone length, potentially leading to a greater cross-sectional area relative to individuals with longer legs. This biomechanical advantage could mean that individuals with shorter legs have a greater capacity for generating force during knee extension.

Moreover, the interplay between muscle strength and joint stability is crucial. While a larger quadriceps muscle can generate more force, it also requires a corresponding increase in the strength and coordination of the stabilizing muscles and ligaments around the knee (He, 2021). Without enough support from the hamstrings, gluteal muscles, and joint ligaments, the quadriceps' increased effort can cause an imbalance, making the knee more prone to hyperextension injuries (Harris-Hayes et al., 2011). Athletes with shorter legs may benefit from tailored training programmes that emphasise quadriceps strength, knee joint stability, and coordination. Exercises that enhance proprioception, balance, hamstring and gluteal muscle strength might reduce the risk of hyperextension by giving the knee more control and support during high-force exercises.

One of the premises of this work was to determine whether there is an influence of anthropometric characteristics on knee hypermobility. More specifically, is there a relationship between leg length, and shin length with the degree of knee hypermobility. The expected outcome was that a longer leg and lower leg and lower leg to upper leg ratio due to greater leverage on the knee itself would result in a greater degree of hypermobility of the knee. However, no statistically significant correlations were found. However, such issue should further be investigated on other samples. Despite these results, it is important to recognize that the absence of significant correlations in this study does not entirely rule out the potential influence of anthropometric characteristics on knee hypermobility. It is possible that a larger, more diverse sample or different methodological approaches could yield different results. Therefore, further research on this issue is warranted. Future studies should consider exploring other populations and incorporating additional variables that might interact with anthropometric factors to affect knee hypermobility. Such investigations could provide a more comprehensive understanding of the underlying mechanisms contributing to knee hypermobility in athletes and other individuals (Remvig et al., 2007).

CONCLUSION

In conclusion, this study sheds light on the complicated link between knee hypermobility and anthropometric indices in non-injured athletes. Contrary to early predictions, the study found that athletes with hypermobile knees have shorter leg and shin lengths than their non-hypermobile counterparts. This shows that shorter legs may contribute to a bigger cross-sectional area of the quadriceps muscle, perhaps leading to increased partial strength applied on the knee joint and hyperextension. These findings emphasise the need to consider individual anthropometric parameters when assessing the risk of knee hypermobility and developing training and rehabilitation programmes. By personalising these programmes to improve both muscular strength and joint stability, athletes may improve their performance while lowering their risk of injury. Future studies should investigate these relationships in broader and more varied sporting groups to improve our understanding and approaches to sports medicine. Future studies should aim to include larger and more diverse samples to validate these findings. Additionally, longitudinal studies could provide insights into the long-term effects of knee hypermobility and its interaction with anthropometric indices over an athlete's career.

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Physical Load During Recreational Activities in Kinesiology Students

Paola Petek[1], *Hrvoje Karninčić[1], Goran Gabrilo[1]

[1]Faculty of Kinesiology, University of Split, Split, Croatia

*Corresponding author

ABSTRACT

Recreational activities are important in physical activity because they are healthier than competitive sports. Outdoor leisure activities (in nature) are crucial because, in addition to the physical benefits, we also have mental benefits. The activities are very diverse, as are the participants, and the problem is to determine in detail which activity is suitable for whom. 47 kinesiology students participated in 5 recreational trips (two mountaineering trips, rafting, kayaking, and canyoning). After each tour, they completed the Rate of Perceived Exertion - RPE questionnaire. Students perceived Mosor and Canyoning as the most difficult. Women did not differ from men in terms of perceived exertion, but they perceived kayaking as more difficult (MWU, Z=1.7, p=0.09). The most difficult section (mountaineering Mosor) was the easiest for active athletes, while non-athletes and ex-athletes perceived it significantly harder (MWU, Z=103.5, p<0.01). Climbing Mosor is the longest tour and canyoning the most demanding, and the respondents perceived them as such. Kayaking is more strenuous for women because of the frequent changes in aerobic and anaerobic energy systems and because of the strong endurance of the upper body. Unlike sports, recreation should be in the comfort zone, and when choosing an activity, care should be taken that the activity is appropriate for the participants.

Keywords: Borg scale, Athletes, Recreationists, Mountain climbing, Rafting

INTRODUCTION

Recreation is an important part of physical activity, especially because competitive, elite or commercial sports bring more health problems than benefits (Dohlsten, Barker-Ruchti, & Lindgren, 2021). Recreational activities related to nature are particularly interesting because, in addition to numerous physical benefits, they also have a positive impact on an individual's mental health (Thomsen, Powell, & Monz, 2018). The group of such activities includes various hiking or biking tours, kayaking, rafting, canyoning, various forms of rowing and sailing. Given the breadth of this content, different skills are required of participants depending on the type of leisure activity. It is very important that the content suits the participants, as research shows that exertion is closely linked to motivation for leisure activities (Balamutova, 2014). Additionally, the health aspect of physical activity is most pronounced in moderate-intensity physical activity (Lee & Paffenbarger, 2000). The question arises as to what would be the optimal loads during recreational activities.

Kinesiology students are a specific sample, they should be associated with sports, but they come from different sports and play sports at different levels (beginners, active, former, elite...). This problem was noticed way back in 1977 when the standards of recreational activities were being developed in the USA (Carter, 1977). The question arises as to which recreational activities would be suitable for students and whether this could apply to all students. Measuring load in sports activities is very complex, there are numerous sophisticated methods (Gómez-Carmona, Bastida-Castillo, Ibáñez,

& Pino-Ortega, 2020; Nigg, Denoth, & Neukomm, 1981). Most of these methods are expensive or cannot be carried out in nature, but they can be successfully replaced by a subjective assessment of the perceived load, the so-called Borg scale (Foster et al., 2021) or Rate of perceived exertion - RPE.

Borg's scale is a very simple tool in which, on a scale from 6 to 20, participants have to circle the exact number that best corresponds to the perceived load. The smallest number 6 corresponds to 60 heartbeats, which is otherwise the frequency at rest (without effort), on the other hand, the number 20 is equivalent to 200 heartbeats per minute (maximum effort). The scale is very reliable for different types of exertion (Katsanos & Moffatt, 2005), it has been used on various samples, from athletes to recreational people (Lagally, McCaw, Young, Medema, & Thomas, 2004). The Perceived Effort Scale was designed in 1970 and is a good indicator of physical stress and work capacity (Borg, 1970). The scale is highly reliable for activities such as walking (Katsanos & Moffatt, 2005), hiking (Hagiwara & Yamamoto, 2011), and rowing (Connolly & Janelle, 2003; Marriott & Lamb, 1996). Borg's scale can easily be completed on a mountain, in a canyon, at sea or on a river. This paper aims to determine the level of perceived exertion of kinesiology students using the Borg scale on various recreational activities (mountaineering tours, rafting, kayaking and canyoning), and to analyze differences by gender and sports status. With this research, we should get a better insight into the load of recreational activities among kinesiology students, which can be useful in planning them.

METHODS

Participants

The sample of respondents are students of the Faculty of Kinesiology who enrolled in the Recreation course in the academic year 2023-2024. Of the 56 students who enrolled, those who did not go on at least two trips and those who did not fill out the surveys were excluded from the sample, resulting in a final sample of 47 students. Sports background of the respondents: rowing n=1, swimming n=1, athletics n=1, football n=15, basketball n=1, rhythmic gymnastics n=1, dance n=2, boxing n=2, judo n=1, MMA n=1, taekwondo n=1, kickboxing n=1, free climbing n=1, recreation n=4, fitness n=4, gym n=5, running in nature n=2.Respondents were divided into groups based on gender (women n=19 and men n=28), and sports status (former athlete/recreational athlete n=30 and active athlete/representative athlete n=17). All students participated in the research voluntarily and anonymously, a detailed description of the sample can be found in Table 1.

Variables

As part of the course, students were supposed to go on five different recreational activities: hiking Mosor (10 km, height 950 m), hiking Fortica (5.8 km, height 355 m), rafting (8 km), kayaking (13.4 km) and canyoning (2.7 km). Immediately after the activity, they were invited to fill out a short questionnaire on the level of perceived exertion (RPE - Rating scale of Perceived Exertion, Borg, 1970). In addition to sports and professional needs, the RPE scale is also used to assess the load of various recreational activities (Mangona, Brasil, Prista, & Farinatti, 2024).

The original Borg scale:

6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
No effort	*Extremely light*		*Very light*		*Light*		*Somewhat hard*		*Hard*		*Very hard*		*Extremely hard*	*Maximum effort*

Based on the aforementioned 5 variables in the research are: RPE Mosor, RPE Fortica, RPE Rafting, RPE Kayaking, RPE Kanjoning and the variables that describe the sample are: age of the subject (years), body mass (kg), body height (cm), body mass index mass BMI.

Data processing methods

The variables that describe the sample were processed with descriptive statistics (arithmetic mean - mean, standard deviation - SD), and the differences between them *were tested with the T test. Due to the small sample of some groups, the normality of the distribution was tested with the Shapiro-Wilk W test. Since most variables do not have a normal data distribution, further processing was performed using non-parametric statistical methods. Descriptive statistical parameters (median, mode, and mode frequency) were calculated for all groups, and differences by gender and sports status were tested with the Mann-Whitney U test. The level of statistical significance was set at $p < 0.05$. Data processing was done with the help of the software package Statistica 13 for Windows.*

RESULTS and DISCUSION

Table 1. Descriptive statistical parameters (arithmetic mean – Mean, Standard deviation – SD) for variables describing the sample (age, body height, body mass and body mass index BMI) for all groups and differences between groups (T test)

	Female n=19		*Male n=28*		*T test*	
	Mean	*SD*	*Mean*	*SD*	*t-value*	*p*
Age	*20.58*	*1.39*	*20.68*	*1.12*	*-0.27*	*0.79*
Body height (cm)	*167.26*	*6.00*	*184.04*	*7.21*	*-8.36*	*<0.01*
Body weight (kg)	*61.21*	*6.88*	*81.00*	*9.58*	*-7.74*	*<0.01*
BMI	*21.89*	*2.32*	*23.84*	*1.60*	*-3.41*	*<0.01*
Former athletes/recreationists n=30			*Active athletes n=17*			
	Mean	*SD*	*Mean*	*SD*	*t-value*	*p*
Age	*20.70*	*1.24*	*20.53*	*1.23*	*0.46*	*0.65*
Body height (cm)	*175.80*	*10.65*	*179.82*	*10.53*	*0.24*	*0.81*
Body weight (kg)	*71.60*	*14.12*	*75.47*	*10.68*	*0.41*	*0.68*
BMI	*22.95*	*2.42*	*23.23*	*1.55*	*0.82*	*0.42*

From Table 1, we see that men and women differ statistically significantly in terms of body height, body weight and body mass index (BMI).

It is interesting that out of 47 kinesiology students, almost two-thirds of the students (n=30) are not active athletes. When asked what kind of sport they do, 15 students wrote: recreation n=4, fitness n=3, gym, and running in nature. Although it has nothing to do with the topic, it is important to note that almost two-thirds of kinesiology students are not active athletes, and one-third do not know the difference between sports and recreation. One of the ideas in this paper was to separate groups of sports: aerobic, anaerobic, and combined, the idea could not be implemented due to the small number of athletes, the only possible division was by sports status (recreationist, former athlete, active athlete, national team member).

Table 2. Descriptive statistical parameters (median, mode and mode frequency) for all groups together and for groups separated by gender and sports status, normality of distribution (Shapiro-Wilk W test) and differences between these groups (Mann-Whitney U test).

	All groups n=47						*Shapiro-Wilk W test*	
Variables	*n*	*Median*		*Mode*		*F mode*	*W*	*p*
*RPE mosor**	*43*	*very hard*		*very hard*		*14*	*0.94*	*0.04*
*RPE fortica**	*24*	*light*		*light*		*12*	*0.88*	*0.01*
*RPE rafting**	*25*	*light*		*light*		*10*	*0.91*	*0.03*
*RPE kayaking**	*26*	*light*		*light*		*9*	*0.92*	*0.04*
RPE canyoning	*11*	*very hard*		*very hard*		*5*	*0.87*	*0.07*
	Female n=19			*Male n=28*			*MWU*	
	Median	*Mode*	*F mode*	*Median*	*Mode*	*F mode*	*Z*	*p*
RPE mosor	*somewhat hard*	*somewhat hard*	*7*	*hard*	*very hard*	*9*	*-0.27*	*0.78*
RPE fortica	*light*	*light*	*9*	*somewhat hard*	*Multiple*	*3*	*-0.67*	*0.51*
RPE rafting	*light*	*light*	*6*	*light*	*light*	*4*	*-0.87*	*0.38*
RPE kayaking	*somewhat hard*	*light*	*4*	*light*	*light*	*5*	*1.7*	*0.09*
RPE canyoning	*light*	*Multiple*	*1*	*somewhat hard*	*somewhat hard*	*4*	*-1.02*	*0.31*
	Former athletes/recreationists n=30			*Active athletes n=17*			*Z*	*p*
*RPE mosor**	*hard*	*very hard*	*9*	*somewhat hard*	*somewhat hard*	*6*	*103.5*	*<0.01*
RPE fortica	*light*	*light*	*11*	*light*	*Multiple*	*1*	*24.5*	*0.57*
RPE rafting	*light*	*light*	*6*	*light*	*light*	*4*	*44*	*0.26*
RPE kayaking	*light*	*light*	*7*	*light*	*somewhat hard*	*3*	*79.5*	*1.00*
RPE canyoning	*light*	*light*	*2*	*somewhat hard*	*somewhat hard*	*4*	*12*	*0.78*

**Statistically significant difference p<0.01; Multiple - there are more answers with the highest frequency*

From table 2 we see that all variables except canyoning (p=0.07) do not have normally distributed data, there are no statistically significant differences between men and women in the level of perceived effort, only in the kayaking variable the difference is almost statistically significant (p=0.09). Active athletes perceived a lower load when hiking on Mosor (p<0.01) in contrast to non-athletes and recreational athletes.

Recreational activities in this paper are very different. In addition to the environment (mountain, sea, river...) the activities differ in the type of activity (rowing, walking), the extent and intensity of the activity itself. It is interesting that in the total sample, hiking Mosor (10 km) and canyoning (2.7 km) were perceived as very hard (17 on Borg's scale), while the other activities were perceived as light (11 on Borg's scale). Mountaineering Mosor is the most difficult in terms of the distance traveled and the altitude overcome, but canyoning is not. Other studies classify canyoning between light activity and moderate activity (Loureiro, Pereira, Martins, & Brandao, 2023; Matos et al., 2019). We can assume that it is about the difficulty of the route (climbing, descending, swimming...) because the distance covered is only 2.7 km. We found significant differences in the perceived burden between the sexes, but the only variable that was almost significant (p=0.09) was kayaking. This finding is not surprising because men in kayaks show greater strength and efficiency while having lower heart rates (Gomes et al., 2012). The author further explains that energy consumption will be the same, but for women it will be more strenuous due to poorer adaptation to constant changes in aerobic and anaerobic regimes (Gomes et al., 2012). Another possible reason is the fact that men are better than women in terms of strength and endurance (Ryman Augustsson et al., 2009), and these abilities are essential in kayaking. From the aspect of sports status, a statistically significant difference is evident only in the most difficult activity, Mountaineering Mosor, which is logical. Active athletes perceived this effort as somewhat hard (Borg scale 13) and former athletes as hard and very hard (Borg scale 15 – 17). As the most difficult activity offered, hiking Mosor requires serious physical fitness, physical fitness must be considered when planning such tours. People engage in recreational activities to improve their physical condition but also for pleasure. The motivation for recreational activities can be reduced if the feeling of comfort is compromised due to the perceived burden.

CONCLUSION

Most recreational activities are perceived as light to somewhat hard (Borg scale 11) in terms of workload, which is good since it is recreation. Strenuous and long-lasting activities are more appropriate for active athletes, while people with poor physical condition may perceive it as very hard (Borg scale 17), which can lead to a drop of motivation for further recreation. When planning kayaking tours for women it is important to be careful and consider that these activities require upper body strength and endurance, and longer tours can be too strenuous for them. Future research should include a larger population with some objective measures of workload to better suggest the type of recreation.

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Injury Incidence and Characteristics in Senior Football – One Season Analysis of Croatian First Division Club

*Šime Veršić[1]

[1]Faculty of Kinesiology, University of Split, Split, Croatia

*Corresponding author

ABSTRACT

Football is a very demanding sport and is highly affected by injuries. Although some improvements in injury reduction have been noted, injury rates are still considerably high. There is a significant amount of studies on injuries in football but there is a clear lack of scientific knowledge on this topic among Croatian clubs. Therefore, this study aimed to identify injury incidence in professional senior football team and to provide details on injuries regarding their type, character, injured body part and similar. A total of 38 players were included in this study. All injuries were diagnosed and evidenced by the club's medical staff and were classified by the consensus statement on football injuries. The injury incidence rate was calculated as the number of injuries per 1000 hours of exposure and all injuries were described by type, injured body site, occurrence and recurrence character. On average 1.9 injuries per player were recorded with 9.4 injuries per 1000 hours of exposure. Muscle injuries were most common and represented 52% of all injuries, with the majority of them occurring on the thigh, particularly the hamstrings (20%). The reinjury rate was low, with only 1 out of 10 injuries characterized as recurrence. The second part of each half-season showed a higher number of injuries. These findings can help football practitioners in the implementation of preventive strategies. Future studies should focus on factors associated with specific types of injuries.

Keywords: soccer; trauma; overuse; reinjuries; muscles

INTRODUCTION

Football is one of the most demanding team sports games with a high load imposed on the player's body in terms of extensity and intensity (Modric, Versic, Sekulic, & Liposek, 2019). During a football game, players cover between 10 and 13 kilometers, depending on playing position and other contextual variables, with numerous highly intensive actions with and without the ball in the offensive and defensive parts of the game (Modric et al., 2022). This load represents a significant risk for injuries among football players. Apart from the fact that the players need to progress in their technical-tactical abilities and fitness capacities through training, the task of the coaches is to preserve their health in order to have the most complete squad available for the matches. Studies have confirmed that the number and severity of injuries are strongly correlated with the team's success, as the teams with fewer injuries are more likely to achieve better results (Hägglund et al., 2013). For this reason, the incidence and risk factors of football injuries are increasingly being investigated.

Scientific knowledge has led to improvements in training methodology, equipment and recovery techniques, and caused a general reduction in the number of injuries in the recent period (Ekstrand, Spreco, Bengtsson, & Bahr, 2021). However, injury rates are still high, especially when it comes to muscle injuries, and it is affecting clubs in terms of sports success and finances. Football scientists assume that the crucial factors for maintaining high injury rates are the growing number of training sessions and matches and the increased intensity of playing (Ekstrand et al., 2023). Studies performed on elite European football showed that during the last 18 years, total injury incidence was 6.6 injuries on 1000 hours of exposure, with relatively more injuries occurring in the games (23.8/1000 hours) compared to training (3.4/1000 hours) (Ekstrand et al., 2021). Regarding injury characteristics, traumatic ones occur more than overuse and the majority of them are located on the lower body with the tigh being the most affected body part (López-Valenciano et al., 2020). Muscles, tendons and ligaments sustain the highest numbers of injuries, in particular ruptures and strains (López-Valenciano et al., 2020).

In order to create optimal and effective injury reduction programs, the first step is to analyze in detail the characteristics of injuries. Although injuries in professional football are being extensively investigated, there are very few studies conducted on Croatian players and clubs. Therefore, the main aim of this study was to identify injury incidence in professional senior football team competing at the highest level in Croatia. Additionally, the authors aimed to provide details on injuries regarding their type, character, injured body part and similar.

METHODS

The sample in this study consisted of 38 players (26.4±4.9 years old on average) who participated for HNK Hajduk senior team on training and/or matches during the 2023/2024 season. All playing positions were analyzed in this study and to avoid potential bias in the results, players who participated in less than one half-season were excluded (e.g. players who were transferred, players from the academy that participated only in a few trainings). During the 48 weeks, the team performed 226 team trainings and 51 games. The injury data was extracted from the club database and all players were notified about the scope and purpose of this study. This study was performed in accordance with the Declaration of Helsinki and was approved by the Ethics Committee of the Faculty of Kinesiology (Ethical Approval Number: 2181-205-02-05-23-0007).

All injuries were diagnosed and classified by the club's medical professionals in accordance with the consensus statement on injuries in football (Fuller et al., 2006). An injury was defined as any physical complaint sustained by a player that was a result of a football match or game and resulted in time loss from active participation in football activities. Injuries were diagnosed and classified by type, character, injured body part and side, if they occur as new or recurrence injuries and the type of activity when they occurred (i.e. training or match). The relative injury incidence rate was calculated as the number of injuries sustained per 1000 hours of exposure. Descriptive data on injury characteristics were calculated as counts and presented graphically.

Statistical analysis, calculations and graphical presentation were conducted with MS Excel (Microsoft, Redmond, Washington, USA) and GraphPad Prisma 5 (GraphPad Software Inc.; San Diego, CA, USA) software.

RESULTS and DISCUSSION

In the sample of 38 players, 32 of them sustained at least one injury during the 2023/2024 season which represents an incidence of 84%, and on average 1.9 injuries per player which is comparable with the previous findings of the UEFA Elite Club Injury Study (Ekstrand, Hägglund, & Waldén, 2011b). Injury severity was also in accordance with previous studies as each injury resulted in 36 days of absence on average (Ekstrand et al., 2021).

Table 1. General information about injuries

Injuries	*72*
Injured players	*32*
Uninjured players	*6*
Injury incidence	*0.84*
Players with multiple injuries	*21*
Total days out	*2594*
Average days out per injury	*36*
Average days out per player	*92*

Results presented in Table 2. showed that the majority of injuries were traumatic (62,5% compared to 27.5% overuse, chronic injuries). In absolute terms, more injuries occurred during training sessions, but considering exposure time, injuries occurred significantly more often during the games (5.8/1000h on training compared to 39.2/1000h during games). The reinjury rate was 11% with approximately 1 of 10 sustained injuries being classified as the same type at the same body site as an index injury. These results are on the same level as the latest data on the top European level where this number decreased between 3%-7% in the last 18 years and is considered a low rate compared to other samples in football and other sports (Ekstrand et al., 2021).

Table 2. Occurrence and character of injuries

	Yes	*No*
Reinjury	*8*	*64*
	Overuse	*Trauma*
Character	*27*	*45*
	Training	*Game*
Occurrence	*39*	*33*

The overall injury incidence rate of 9.4 injuries per 1000 hours of exposure is considerably higher compared with the other studies on elite senior football where rates between 6.6 and 8.1 were found (Aiello et al., 2024; Ekstrand et al., 2021). Considering that the author of this study was actively involved in the training process of the team observed here, the reasons for the high number of injuries can be discussed speculatively as there is no clear cause-and-effect evidence. First of all, a significant number of injuries had mechanical mechanisms, due to contact with the opponent. Furthermore, the extremely poor surface of the training ground certainly had an impact on injuries, both chronic and traumatic. The effect of the training surfaces has been previously discussed as a significant injury risk factor (Dragoo & Braun, 2010). Finally, a majority of the players already sustained the same or similar injuries in their recent history which has been constantly highlighted as the most significant predictive factor for injuries (Hägglund, Waldén, & Ekstrand, 2006). However, the reasons for the large number of injuries should certainly be sought in the implementation of the training process and load control, and these results must be analyzed in detail by the club staff in order to reduce the incidence of injuries in the future.

Table 3. Injury incidence per 1000 hours of exposure

	Overall	Training	Game
Injury incidence	9.4	5.8	39.2

Regarding types of injuries, the majority were associated with soft tissues as structural (ruptures) and functional (DOMS) muscle injuries included 52% of all injuries. Although studies regularly find muscle injuries as the most frequent (between 30%-40%) this high rate needs to be taken into consideration as these types of injuries are the ones that are affected by a significant number of controllable factors (Ekstrand, Hägglund, & Waldén, 2011a; Robles-Palazón et al., 2022). As expected, the thigh was the most injured body site with the hamstring as the most injured muscle (20% of all injuries). This finding is in accordance with the recent studies that report that every fourth injury in football is a hamstring injury (Ekstrand et al., 2023). This represents a big issue in modern football as the number of hamstring injuries increased in recent period (Ekstrand et al., 2023). Lower body muscles included 92% of all muscle injuries, but in contrast to previous studies, calf injuries were more frequent than quadriceps and adductors (Ekstrand et al., 2011a).

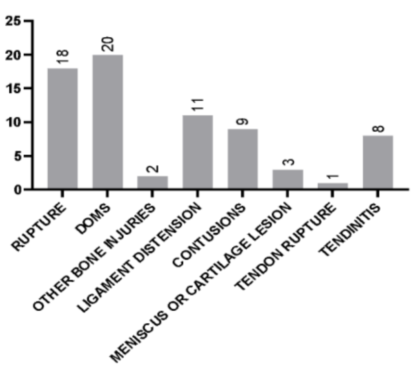

Figure 1. Injuries by type

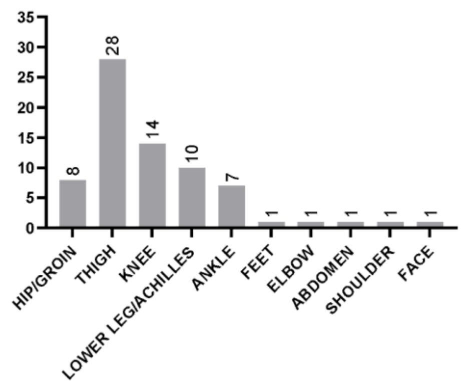

Figure 2. Injuries by body site

Injury distribution through the season is presented in Figure 4. where can be seen that the injury trend increases in the later stage of each half-season, after the accumulation of training and games which follows previous findings (Ekstrand et al., 2011b).

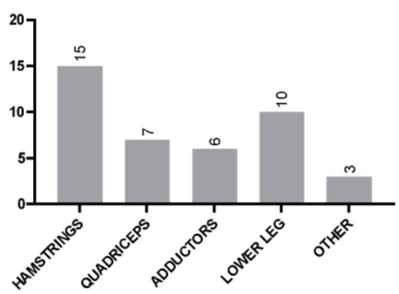

Figure 3. Injured muscles

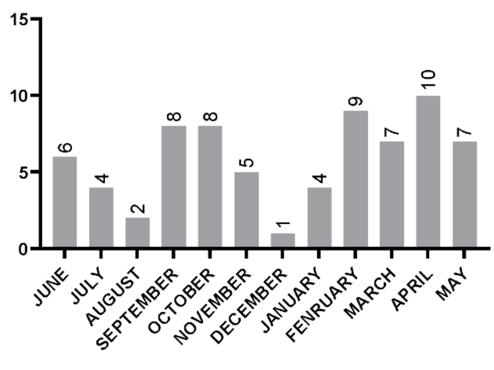

Figure 4. Injury distribution by months

CONCLUSION

This study aimed to analyze injury incidence and characteristics of injuries at the elite senior football level in Croatia. Findings showed higher relative injury incidence rates compared to similar samples. Regarding injury characteristics, muscle structural and functional injuries were most common, with the majority of them occurring on the thigh, particularly the hamstrings. These findings can have significant importance for football practitioners, and the first step in the development of preventive strategies. Future studies should include longitudinal analysis on longer observed periods and investigate injury correlates.

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Enhancing Football Performance Through Agility Training

Toni Babic[1], Iva Sklempe Kokic[1], *Ivan Peric[1]

[1]Josip Juraj Strossmayer, University of Osijek, Faculty of Kinesiology

Corresponding author:

ABSTRACT

Agility in football has become the subject of intense scientific and practical research, as it is recognized as a key ability that allows players to adapt to dynamic changes on the field, such as changing direction, avoiding opponents, and reacting quickly. That ability is integrated into the larger framework of multidirectional speed, a concept that unifies different aspects of movement in game. Football is a sport in which players need a high level of physical preparation, and at the heart of that preparation is agility. Biomechanics provides insight into how the body uses different muscle groups to optimize agile movements, while physiological aspects explore the energy systems that support these movements. At the same time, proprioceptive training, which focuses on the development of balance and stability, becomes crucial for the development of agility. The psychological dimension of agility should not be neglected. A player's cognitive abilities, such as decision-making speed, can have a significant impact on their ability to change direction quickly and efficiently. The mental readiness of players, especially after returning from injury, further emphasizes the importance of integrating psychological training into preparations. In order for players to develop optimal agility, it is necessary to apply a combination of traditional and innovative training methods systems. In essence, achieving top results requires coaches to meticulously plan and execute agility training, encompassing biomechanical, physiological, and psychological aspects. This comprehensive approach ensures that players perform at their peak on the field, adeptly adapting to the dynamic nature of the game.

Keywords*: Training methods, Specific exercises, Training aids*

INTRODUCTION

Agility is the ability to change the direction of movement without losing balance, strength, speed, or control over the body. By developing agility, we improve the timeliness of rhythm and movement (Banovac, 2021). According to Sheppard and Young (2006), agility is defined as the ability to quickly and efficiently change direction or accelerate the body in response to a stimulus. Scientific research in this field has shown that there are two relatively independent types of agility: reactive and pre-planned agility, depending on whether the movement is predetermined or a reaction to an external stimulus (Pojskic et al., 2018). Where the reactive component of agility represents action and movement that occur as a result of some kind of external stimulus (e.g. the movement of an opponent, a ball, etc.). While the other independent form, pre-planned agility, is determined by movements of rapid change of direction and direction of movement, but which are already known in advance (Sekulic et.al., 2014). Agility is a crucial component of physical preparation in football due to the dynamic nature of the game, where players must quickly respond to changes, make rapid decisions, and change movement direction in a very short time. A high level of agility allows players to quickly adapt to new situations in the game, whether it involves avoiding opponents, changing the direction of the ball, or reacting to unexpected situations (Carling, 2013). Agility is a complex motor skill that includes various aspects such as biomechanics, physiology, and psychology. Understanding these aspects can contribute to a deeper understanding of agility and ways to improve it.

IMPORTANCE OF AGILITY IN FOOTBALL

Agility, often linked with coordination and balance, is frequently a crucial skill that determines success in sports, particularly in football (Banovac, 2021). Training methods such as speed, agility, quickness and explosiveness have become essential in developing these abilities in players (Banovac, 2021). Research indicates that players with higher levels of agility often perform better in games, especially in situations requiring rapid changes in direction and speed. Agile players are typically more effective in dribbling, avoiding opponents, and quickly responding to changes in the game. Additionally, agility can help players avoid injuries by enabling them to react swiftly to unexpected situations and avoid potentially dangerous scenarios (Abdullah et al., 2017).

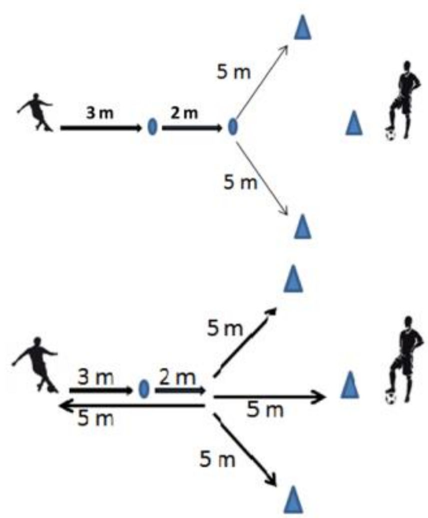
AGILITY TRAINING METHODS IN FOOTBALL

Agility training in football can involve various methods, including specific exercises to improve agility and integrating agility training into general football training. Different methods and approaches include plyometric exercises, speed and strength training, and specific exercises to enhance coordination and balance (Bonavolontà et al., 2021). Agility training can be tailored to the specific needs and goals of football players, with diverse methods and approaches used to improve different aspects of agility. It is important to note that agility training should be part of a comprehensive training program that also includes other key aspects of physical preparation, such as strength, speed, and endurance. In professional football, agility training often combines various methods. For instance, one study showed that combining plyometric training with short sprints involving changes of direction can enhance jumping, sprinting, agility, and balance abilities in soccer players (Aloui et al., 2021). Additionally, there is increasing research into the role of neurofeedback training in sports, including football. Neurofeedback training involves indirect training of brain waves and appears to affect the physical fitness of professional athletes, including football players (Rydzik et al., 2023). This method can help improve many variables critical to sports success, such as reducing stress levels, enhancing the ability to control physiological factors, improving behavioral efficiency, and increasing reaction speed to stimuli. Specific exercises to improve agility often simulate movements and situations that occur in football games. For example, exercises may involve quick changes of direction, avoiding "opponents" (e.g., cones), and quickly responding to visual or auditory signals, especially when applied in realistic conditions. Research has shown that combining plyometric training and agility training can be particularly effective in improving agility in young football players (Makhlouf et al., 2018). Integrating agility training into general football training can be crucial for developing agility in the context of actual gameplay. This can include incorporating agility exercises into warm-ups, using drills that combine agility with other key skills (e.g., dribbling, shooting), or including agility exercises in tactical drills. Research involving the combination of agility training and repeated sprints has shown significant improvements in agility and sprint speed among professional soccer players (Chtara et al., 2017).

AIDS IN AGILITY TRAINING DEVELOPMENT

Equipment for agility training can include various tools that help develop this skill, such as agility ladders, cones, hurdles, and other similar aids. These tools can be used to create specific exercises targeting different aspects of agility, including change of direction speed, reaction speed, and movement precision. Neuromuscular training, which involves using various agility training equipment to provoke a response to specific stimuli, has shown significant improvements in agility performance among elite football players (Zouhal et al., 2019). Some of the drills are represented in figure below.

Figure 1. Agility drills 1 and 2 (Chaalali, et. al., 2016)



Exercise 1: Drill starts with coach's visual signal: ball touched with the insole of the coach's foot. The player accelerates towards the 5 m cone. As the player passes the 3 m distance the coach slightly moves the ball (around 20 cm aside) in the direction of the left or right cone. Upon this "second visual signal" the player quickly changes direction towards the indicated cone and continues his sprint until reaching the cone.

Exercise 2: The starting procedure is the same as in exercise 1. As the player passes the 3-meter mark, the coach moves the ball in a random direction, and the player must immediately sprint to the nearest cone without losing speed, with four possible directions: forward, backward, left, or right. Only the forward direction does not require a change in direction (Chaalali, et. al., 2016).

CONCLUSION

Football, one of the most popular sports globally, demands exceptional physical and mental abilities from its players, with agility standing out as a key component enabling players to dominate on the field. Agility, with all its nuances and complexities, has been the central focus of this paper. When discussing agility, we often overlook that it is not merely a physical skill. Research indicates that agility spans several dimensions. From a biomechanical perspective, understanding how the body utilizes muscle groups to perform agile movements can provide insights into optimal training methods. Physiology teaches us about the energy systems powering these movements. Proprioceptive training, increasingly utilized in modern training approaches, ensures the development of crucial balance and stability skills. Without these foundational abilities, players would not achieve peak agility. However, to fully grasp agility, we must not neglect its psychological aspect. A player's ability to make quick decisions, react to stressful situations, and mentally prepare, especially after traumatic injuries, are integral parts of their agility. Training methods have evolved over the years to adapt to this multidimensional understanding of agility. While traditional methods like plyometric exercises remain fundamental, innovative approaches utilizing modern technology add a new dimension to player preparation. Agility is much more than rapid changes in direction on the field. It is a symbiosis of physical and mental readiness that must be carefully nurtured and developed through well-designed training programs. For coaches and players alike, understanding and applying this knowledge will be crucial for achieving top-tier results and dominance in football.

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Relations of Anxiety, Self-Confidence, Gender and Lifting Performance at Amateur Olympic Weightlifting Competition

*Ivan Perasović[1], Mia Perić[1], Nikola Foretić[1]

[1]University of Split, Faculty of Kinesiology, Split, Croatia

*Corresponding author

ABSTRACT

The primary objective of this research was to investigate the impact of stress on athletes' performance during competitions, specifically exploring potential differences between male and female Olympic weightlifters. The study involved 42 weightlifters, with 25 males and 17 females. The male weightlifters had an average age of 27.04 years, height of 181.12 cm, weight of 95.12 kg, and training experience of 6.92 years. On the other hand, the female weightlifters' averages were 25.35 years, 164.65 cm, 64.60 kg, and 3.84 years of training, respectively. Various variables were analysed, including anthropometric measurements, age, training experience, performance metrics, and responses from the CSAI-2 questionnaire (focusing on cognitive anxiety, somatic anxiety, and self-confidence). The results indicated no significant correlation between the CSAI-2 responses and performance indicators. Males tended to achieve higher personal bests in the snatch and jerk & clean categories compared to females. Snatch results were notably better for males, although there was less disparity in the jerk & clean category. The analysis also revealed distinct correlations among the CSAI-2 factors, showing negative relationships between self-confidence and anxiety levels for both male and female participants. Additionally, there were positive correlations between somatic and cognitive anxiety levels within each gender group. Overall, the findings suggest that male and female athletes differ in body composition and the weight they lift in competitions. Female athletes exhibited higher levels of anxiety and lower self-esteem compared to male athletes, who displayed more confidence and lower anxiety levels. The primary limitations of our study include not conducting it in the context of national individual competitions, where athletes aim for personal bests. Our semi-professional participants' lower experience levels compared to professionals may have influenced observed gender differences in anxiety and self-confidence. Additionally, the team-based competition structure may not have pushed lifters to their limits.

Keywords: stress, CSAI, female lifters, power, strength

INTRODUCTION

Weightlifting (often known as Olympic weightlifting (OW)) is a sport in which athletes compete in lifting a loaded bar with weight plates from the ground to overhead, to successfully lift the heaviest weights. Athletes compete in two specific ways lifting the barbell overhead. The two disciplines are the snatch (S) and the clean and jerk (CJ). Each weightlifter gets three attempts at both the snatch and the clean and jerk, with the snatch attempted first. An athlete's score is the combined total of the highest successfully lifted weight in kilograms for each lift. Athletes compete in various weight classes, which are different for each sex and have changed over time. Olympic weightlifting is a very explosive and technically driving sport that requires athletes to have precise and technically accurate movements to achieve the lifts. This means it is very stressful to achieve good results in a competition and to max out your personal best, especially in the competition phase. The concept of stress has been a subject of scientific debate ever since its first use in physiological and biomedical research by Selye (1950). The inability to cope with acute stressors during contests can hurt psychological processes such as concentration, attentional focus, and arousal. Lower concentration or attention can lead to lower sports performance. In case the athlete can cope with the stressful demands, the crucial processes and the performance stay unaffected (Anshel, 1990; Smith 1986). So, stress was originally defined as the non-specific response of the body to any noxious stimulus. Later, the concept was refined by distinguishing between 'stressor' and 'stress response'. A stressor is considered a stimulus that threatens homeostasis, and the stress response is the reaction of the organism aimed to regain homeostasis (Chrousos, 2009). An inherent aspect of competitive athletics is the need for athletes to meet the demands of competition and to perform well under pressure. Depending on how the athlete perceives the demands of competition, he or she may interpret pressure situations in a variety of ways. For example, they may be perceived as a natural part of athletic competition, or they may invoke heightened levels of stress. "Stress is the process that involves the perception of a substantial imbalance between environmental demand and response capabilities under conditions in which a failure to meet demands is perceived as having important consequences and is responded to with increased levels of cognitive and somatic state anxiety" (Martens, Vealey, & Burton, 1990a, p. 10).

In the context of OW and stress, there is a notable difference between male and female athletes, biologically and psychologically. Males generally tend to have a higher muscle mass and greater overall muscle strength due to higher testosterone levels, which promotes muscle growth. While females typically have a higher percentage of body fat and less lean muscle mass than men. Hormonal differences where males have higher testosterone levels contribute to greater muscle hypertrophy (muscle growth) and strength. Unlike females, while testosterone is present, levels are significantly lower. Estrogen, which is more prevalent in women, can influence body composition, fat distribution, and muscle recovery. Male athletes often exhibit higher confidence in physical abilities and may take more risks in training and competition. While female athletes sometimes demonstrate a more cautious approach and may experience higher anxiety levels, proper mental conditioning can offset these trends (SELYE H.).

Stress, on the other hand, in sports is a significant and complex issue that can affect athletes at all levels, from amateurs to elite professional athletes. Understanding and addressing stress in sports are crucial for optimal performance, mental health, and overall well-being. In sports stress can come in many ways, our main concern in this study was the performance pressure what do athletes feel stressed about when they're entering a competition their expectations the expectations of coaches' teammates, and self-imposed pressure can also lead to significant increases in stress levels. And measuring stress in sports requires a multifaceted approach that encompasses both subjective and objective assessments and various tools and methods can be used to make these measurements depending on the specific context and needs of the athletes. The way we can measure stress in sports is either through subjective measurements via questionnaires, physiological measurements, or behaviour and performance assessments.

Hence, the main goal of this study was to see how stress affects the performance of athletes during competition and whether is there a difference between the performance of male and female OW lifters. Also, to establish relations between anxiety and self-confidence in amateur weightlifters in an official competition.

MATERIALS AND METHODS

Participants

The sample of participants included 42 weightlifters, divided according to the gender. 25 male weightlifters (chronological age of 27.04 ± 8.03 years, average body height of 181.12 ± 8.65 cm, body mass of 95.12 ± 20.34 kg, and training age 6.92 ± 6.24 years), and 17 female weightlifters (25.35 ± 5.84 years, 164.65 ± 9.28 cm, 64.60 ± 12.24 kg, 3.84 ± 3.34 years, respectively). The study was conducted during the competitive season. Participants who took part in this study volunteered and were informed about the purpose of the study. Experimental procedures were completed following the Declaration of Helsinki, and they were approved by the corresponding author's institutional research ethics board (Ethics Board Approval No. 2181-205-02-05-18-002).

Procedure and variables

The sample of variables included: anthropometric indices, training and chronological age, performance indicators, and the CSAI-2 questionnaire (cognitive state anxiety, somatic state anxiety, and self-confidence).

Anthropometric indices included: body height and body mass of the athletes. The self-report defined body height, whereas body mass was measured by the scale. Performance indicators were personal best results and best results in competition. Personal best was self-reported by the athletes, in both jerk & clean and snatch. The best results in the competition were collected after the competition. The CSAI-2 is a 27-item inventory that measures cognitive state anxiety, somatic state anxiety, and self-confidence in a competitive setting. Each item on the CSAI-2 is anchored by a 4-point Likert scale (1 = not at all, 2 = somewhat, 3 = moderately so, 4 = very much so). Item 14, a reverse-scored item, was reflected before data analysis.

The study was carried out during an official competition during the course of one day. The athletes were asked to fill out the questionnaire and were asked to self-report their personal best results in two weightlifting disciplines (snatch and jerk & clean). After that, their anthropometric indices were recorded. For the performance parameters, the statistics from the competition were used to define their best score in both disciplines.

Statistical analysis

Statistical analyses included a normality test using the Kolmogorov–Smirnov test procedure. Firstly, descriptive statistics were calculated for both groups of participants. Secondly, using Pearson's r analysis the possible correlation was determined between performance indicators and CSAI-2 results, and between three factors of the CSAI-2 questionnaire. Thirdly, a t-test for independent samples was calculated to define possible differences between two groups of participants in factors of CSAI-2 and other measured variables. The software Statistica ver. 13.0 (Dell Inc., Tulsa, OK, USA) was used for all analyses, and a p-level of 95% ($p < 0.05$) was applied.

RESULTS AND DISCUSSION

Table 1 presents the descriptive statistics parameters in all measured variables (chronological age, training age, anthropometric indices, performance indicators, and CSAI-2) seance indicators with an r coefficient between -0.26 and 0.31. Kolmogorov-Smirnov test showed that all measured variables have a normal distribution, with p>.20. The results in S and CJ are presented as relative values according to the body mass of the athletes to have a better representation in groups. The sample that we had for measurements was semi-professional and they weren't full-time weightlifters, although they were the best in the country. And comparing them to world-class weightlifters who won the World Championships or have been among the best in their category the difference is not that big. ‘The various body dimensions for the men and women who won the World Weightlifting Championships from 1993 to 1997. Heights and weights lifted for these champions approached plateaus for both men and women. Only one male champion was higher than 183 cm, and no female champion was higher than 175 cm.’ (Ford, Lincoln E., 2000).

Table 1. Descriptive statistics for all measured variables, in both groups of participants.

Variable	*Mean*	*Minimum*	*Maximum*	*SD*
	Male (N=25)			
Age (years)	*27.04*	*18.00*	*44.00*	*8.03*
Body height (cm)	*181.12*	*165.00*	*197.00*	*8.65*
Training age (years)	*6.92*	*1.00*	*25.00*	*6.24*
Body mass (kg)	*95.12*	*53.05*	*135.20*	*20.34*
Snatch personal best (kg/kg)	*1.28*	*0.78*	*1.70*	*0.22*
Jerk & clean personal best (kg/kg)	*1.56*	*1.04*	*2.00*	*0.26*
Snatch (kg/kg)	*1.18*	*0.69*	*1.55*	*0.19*
Jerk & clean (kg/kg)	*1.39*	*0.00*	*1.97*	*0.39*
Cognitive state anxiety	*16.28*	*9.00*	*31.00*	*6.22*
Somatic state anxiety	*17.48*	*9.00*	*37.00*	*6.54*
Self-confidence	*35.72*	*26.00*	*44.00*	*5.30*
	Female (N=17)			
Age (years)	*25.35*	*19.00*	*38.00*	*5.84*
Body height (cm)	*164.65*	*150.00*	*190.00*	*9.28*
Training age (years)	*3.84*	*0.20*	*14.00*	*3.34*
Body mass (kg)	*64.60*	*46.75*	*97.25*	*12.24*
Snatch personal best (kg/kg)	*1.08*	*0.47*	*1.42*	*0.23*
Jerk & clean personal best (kg/kg)	*1.33*	*0.67*	*1.78*	*0.27*
Snatch (kg/kg)	*1.02*	*0.51*	*1.29*	*0.19*
Jerk & clean (kg/kg)	*1.19*	*0.00*	*1.57*	*0.38*
Cognitive state anxiety	*25.53*	*10.00*	*43.00*	*9.68*
Somatic state anxiety	*27.24*	*14.00*	*36.00*	*7.33*
Self-confidence	*28.65*	*14.00*	*43.00*	*7.62*

SD, standard deviation

Table 2 shows correlations between CSAI-2 factors and performance indicators. The analysis of the results showed there is no significant correlation between CSAI-2 and any of the measured performance variables. It should be noted that this was a team competition, where it was not demanded of them to lift their full records. They were just meant to lift as much weight so that the whole team would have enough points to move on to the next phase of the competition. So basically, stress should not have impacted that much on the result, because the weights that they were lifting were weights that they were very comfortable with and that they could always lift on the training sessions. As opposed to if it was an individual competition where they would go head-on and compete on their max lifts. Also, to be noted that sometimes this can occur in the team competition, but rarely then it occurs in the individual competition.

Table 2. Correlations between CSAI-2 factors and performance indicators, in both groups of participants

Variable	*Cognitive state anxiety*	*Somatic state anxiety*	*Self-confidence*
		Male (N=25)	
Snatch personal best (kg/kg)	*0.23*	*0.12*	*0.14*
Jerk & clean personal best (kg/kg)	*0.23*	*0.10*	*0.12*
Snatch (kg/kg)	*0.31*	*0.11*	*0.17*
Jerk & clean (kg/kg)	*0.02*	*-0.03*	*0.20*
		Female (N=17)	
Snatch personal best (kg/kg)	*-0.08*	*-0.03*	*-0.12*
Jerk & clean personal best (kg/kg)	*-0.07*	*0.07*	*-0.07*
Snatch (kg/kg)	*-0.22*	*-0.25*	*0.01*
Jerk & clean (kg/kg)	*-0.26*	*-0.19*	*0.10*

Analysis of differences in anthropometric indices, age, and performance indicators demonstrates statistically significant differences between groups in some variables. Males have significantly higher body mass (95.12±20.34 kg) and body height (181.12±8.65 cm) than females (64.60±12.24 kg, 164.65±9.28 cm, respectively). Furthermore, the males have higher relative values in snatch personal best (1.28±0.22) and jerk & clean personal best (1.56±0.26) than females (1.08±0.23; 1.33±0.27, respectively). Similarly, higher values in snatch results are presented by males (p=0.01). However, jerk & clean are somewhat similar for the groups (p=0.11). This was to be expected because males, in general, are heavier and taller. Also, their body composition is different since males have much more muscle mass than females thus, generating more power and have heavier lifts in both snatch and clean and jerk than women have (Bartolomei, S.; Grillone, G. 2021.)

Table 3. Independent sample t-test between groups of participants, for anthropometric indices and performance indicators.

Variable	*Male (N=25)*		*Female (N=17)*		*t*	*p*
	Mean	*SD*	*Mean*	*SD*		
Age (years)	*27.04*	*8.03*	*25.35*	*5.84*	*0.74*	*0.46*
Body height (cm)	*181.12*	*8.65*	*164.65*	*9.28*	*5.88*	*0.00**
Body mass (kg)	*95.12*	*20.34*	*64.60*	*12.24*	*5.53*	*0.00**

Training age (years)	*6.92*	*6.24*	*3.84*	*3.34*	*1.86*	*0.07*
Snatch personal best (kg/kg)	*1.28*	*0.22*	*1.08*	*0.23*	*2.94*	*0.01**
Jerk & clean personal best (kg/kg)	*1.56*	*0.26*	*1.33*	*0.27*	*2.74*	*0.01**
Snatch (kg/kg)	*1.18*	*0.19*	*1.02*	*0.19*	*2.71*	*0.01**
Jerk & clean (kg/kg)	*1.39*	*0.39*	*1.19*	*0.38*	*1.64*	*0.11*

*SD, standard deviation; t, test value of t-test; p, level of significance; *, significant level at p<0.05.*

Moreover, the differences between CSAI-2 factors are also significant between the groups. Precisely, females show higher values in cognitive (25.53±9.68) and somatic state anxiety (27.24±7.33), than males (16.28±6.22; 17.48±6.54, respectively). Whereas males show higher values of self-confidence (males, 35.72±5.30; females, 28.65±7.62), (see Figure 1). Female weightlifters on the other hand also exhibited high levels of the two aspects of anxiety tested in this study, as opposed to male weightlifters. They were more anxious and less self-confident. This could be since females, have less testosterone than male weightlifters and or are generally more anxious (Vipene, J. B. 2014.)

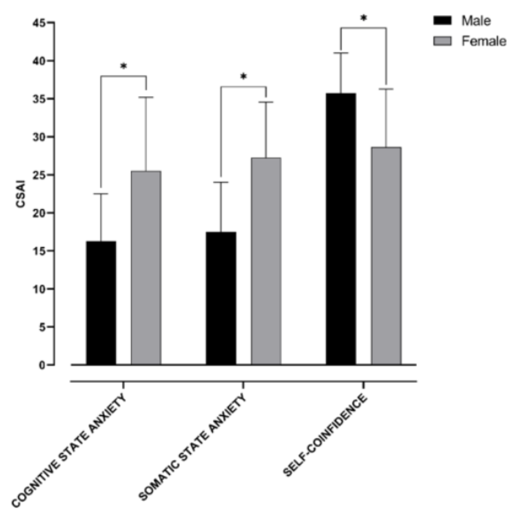

*Figure 1. Differences between groups of participants in factors of CSAI-2, with significant differences indicated with *.*

The correlations among CSAI-2 factors are presented in Figure 2 there are significant negative correlations between self-confidence and somatic anxiety in both groups of participants (male, -0.67; females, -0.70). Similarly, a negative correlation can be observed between self-confidence and cognitive anxiety levels (male, -0.72; females, -0.84). However, somatic anxiety and cognitive anxiety are positively correlated (males, 0.65; females, 0.65).

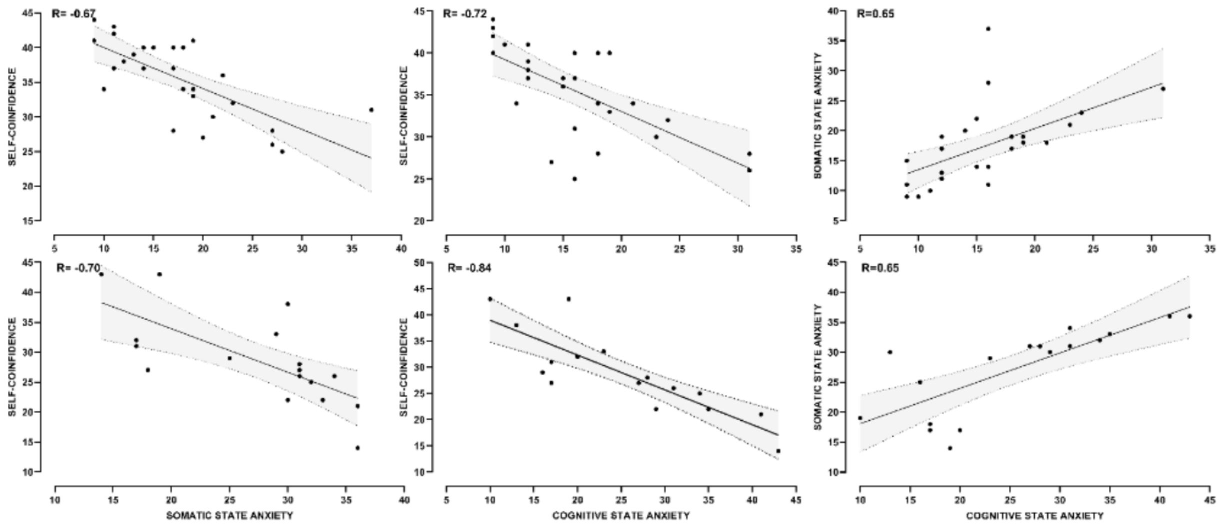

Figure 2. Correlations between factors of CSAI-2, for both groups of participants (male-upper row; female-lower row).

Based on the results that we have gathered we can say that female athletes have a higher percentage of anxiety and low self-esteem compared to male athletes who had less anxiety and overall, more confidence in their self-esteem. In individual sports, females much more than males rely on social support and physical preparedness as important sources of their self-confidence. On the other hand, males show a higher level of belief in presenting their skills. Research indicates that comparison and winning make considerable driving force in building self-confidence with male athletes, and personal goals and standards are an important driving force for female weightlifters (Elona Plakona, 2014.). This can be mainly attributed to the differences in female and male biology as is shows that males usually have higher levels of testosterone and more self-confidence than female weightlifters (Van der Meij, 2010.).

CONCLUSION

Based on our findings, it is evident that there are distinct differences in body composition and the amount of weight lifted between female and male athletes in competition. Notably, there were no significant correlations observed between stress levels, self-confidence, and weightlifting performance during the team competition. This lack of correlation can be attributed to the familiarity and comfort level of the athletes with the weights they were lifting, as they were well within their capabilities and liked what they routinely practiced in training sessions. In contrast, if the competition had been an individual championship, the dynamics and outcomes might have been different. Furthermore, our study highlighted that female weightlifter generally exhibited higher levels of anxiety and lower self-esteem compared to their male counterparts. Despite these differences, these variations did not significantly affect their overall performance. It is worth noting that biological factors could play a role in shaping these disparities between male and female athletes. One of the primary limitations of our study is that it was not conducted in the context of a national individual competition, where athletes typically aim for their personal best lifts. Our participants were semi-professional athletes with less experience compared to professionals, which could have influenced the observed gender differences in anxiety and self-confidence levels. Additionally, the team-based structure of the competition meant that the weights lifted, while challenging, may not have pushed the lifters to their absolute limits. The results emphasize the importance of focusing on mental preparation, particularly for female Olympic weightlifters, to address anxiety and bolster self-confidence before competitions.

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Comparison of The Morphological Features and Motoric Abilities Results of The Junior and Senior Futsal Players

*Hrvoje Ajman[1], Zoran Špoljarić[1], Antonio Čađavčan[1]

Faculty of Kinesiology Osijek, Josip Juraj Strossmayer University of Osijek, Osijek, Croatia

*Corresponding author

ABSTRACT

This study aimed to compare the results in the morphological characteristics and motor abilities of junior and senior futsal players. The sample of respondents consists of 20 players of the futsal club Osijek, 10 seniors and 10 juniors each. The measured morphological characteristics were: body height, body weight, percentage of subcutaneous fat and percentage of muscle mass. The tested motoric abilities were: 10m sprint, agility and speed endurance. The explosive power of the sprint type was measured by the 10-meter sprint test. Agility was measured by the agility t-test. Speed endurance was measured with a 300-meter anaerobic test. The collected data were processed in the Statistica 12, all statistical tests were performed at a significance level of 5%. The differences between the junior and senior players were analyzed using the t-test for independent samples. Regarding morphological characteristics, significant differences were found in subcutaneous fat tissue (p=0,00) and muscle mass percentage (p=0,00), while body weight (p=0,07) and height (p=0,98) did not differ significantly. Juniors had a significantly lower percentage of subcutaneous fat (18,06 vs 23,99) and a significantly higher percentage of muscle mass (40,75 vs 36,04). In the area of motoric abilities, senior players had significantly better results in agility (p=0,04), while no significant differences were found in sprint and speed endurance. Senior players had a significantly better result in the agility. The body composition of senior players is almost fully formed at junior age and better agility is the main motor skill that differentiates junior from senior players.

Keywords: **anthropological analysis, futsal, youth players**

INTRODUCTION

Futsal is an excellent form of physical activity for recreational players and children. Through futsal training, motor abilities and skills are developed that will be useful in further participating in sport (Diaz- Rincon, 2000). Futsal is a relatively young sport which popularity is rising, which indicates the growing interest of people, as well as the inclusion of national teams in FIFA and UEFA competitions. Futsal is characterized by a high complexity of motor actions and high physical demands, and includes numerous skills and abilities that are essential for success and performance quality. Functional and motor abilities such as agility, strength, speed, aerobic and anaerobic endurance are crucial for performance due to the high demands during a game that is highly dynamic and exhausting (Hruškar, 2006).

Morphological features are an important factor for the quality of performance in futsal. This especially applies to morphological characteristics such as percentage of muscle mass, percentage of subcutaneous fat and body weight (Mišigoj-Duraković, 2008). Body height, do not significantly affect performance in futsal (Ayarra et al., 2018).

In a few studies, authors tested futsal players to determine physiological demands (Makaje et al., 2012; Pedro et al., 2013) or distance covered in futsal matches in professional and non-professional players (Barbero-Alvarez et al., 2008; De Oliveira et al., 2014). The study focusing on the morphological characteristics of the players, performance differences in acceleration and cardiovascular tests in futsal players of different competitive levels is lacking (Naser and Ali, 2016).

The aim of this paper is to determine the differences and compare the values of the results in the morphological characteristics and motor skills of junior and senior futsal players.

This is a cross-sectional study, for a more precise analysis effect of age on the study variables, longitudinal analyses are needed and a greater number of study participants.

METHODS

A total of 20 respondents participated in this research. Ten senior and ten junior players, all players of Futsal club Osijek. The age of the junior players varied from 15 to 18 years, and the age of the senior players was from 19 to 34 years. Among the morphological characteristics, body height, body weight, percentage of subcutaneous fat and percentage of muscle mass were measured. Seca 213 Portable Stadiometer was used for measure body height, Omron body composition monitor with scale for body weight and Skinfold caliper Harpenden for percentage of subcutaneous fat. In order to determine motor skills, the next tests were performed using Microgate Witty system: 10 meter sprint, t-test and 300 meter test.

The collected data were processed in the program Statistica 12 for Windows. All statistical tests were performed at the 5% significance level. Arithmetic mean (AS), maximum score (MAX), minimum score (MIN) and standard deviation (SD) are descriptive parameters that were calculated. T test for independent samples were used to test the statistical significance of the differences in results between the senior and junior team.

RESULTS

In table 1. the results of descriptive statistic for all study participants are presented.

Table 1: Descriptive parameters of all participants in study variables

	N	*MEAN*	*MIN*	*MAX*	*SD*
BH	*20*	*178.22*	*165.60*	*189.60*	*6.83*
BW	*20*	*74.79*	*55.30*	*92.00*	*10.60*
%fat	*20*	*21.02*	*12.70*	*29.60*	*5.06*
%musc	*20*	*38.39*	*30.20*	*43.20*	*3.78*
10m	*20*	*1.61*	*1.43*	*1.90*	*0.10*
T-test	*20*	*10.06*	*9.00*	*11.09*	*0.55*
300m	*20*	*63.75*	*57.12*	*69.70*	*3.63*

N – number of participants, MEAN – aritmetic mean, MIN – minimal result, MAX – maximal result, SD – standard deviation, BH – body height, BW – body weight, %fat – percentage of body fat, %musc – percentage of muscle mass, 10m – 10m sprint, t-test – agility test, 300m – 12x25m test

In table 2. the results of descriptive statistic for all study participants are presented.

Table 2: Results of t-test for independent samples

	MEAN (S)	*MEAN (J)*	*t-value*	*df*	*p*

Age	*26.50*	*16.90*	*5.77*	*18*	*0.00**
BH	*178.25*	*178.19*	*0.02*	*18*	*0.98*
BW	*79.01*	*70.58*	*1.89*	*18*	*0.07*
%fat	*23.99*	*18.06*	*3.19*	*18*	*0.00**
%musc	*36.04*	*40.75*	*-3.53*	*18*	*0.00**
10m	*1.58*	*1.65*	*-1.53*	*18*	*0.14*
T-test	*9.81*	*10.32*	*-2.25*	*18*	*0.04**
300m	*64.19*	*63.30*	*0.54*	*18*	*0.60*

p – statistical significant differences on the 5% level p<,0,05, MEAN (S) – aritmetic mean of senior team, MEAN (J) – aritmetic mean of junior team, Age – chronoligical age, p – p value

The results of the descriptive statistics present a more detailed insight into the differences between the junior and senior team (Table 2). The average age of seniors was 26.5, while the average age of juniors was 16.9. The body height of senior and junior players was almost identical, for seniors the average height was 178.25cm, and for juniors 178.19cm. The average body weight of senior was 79.01kg, and junior players was 70.58kg. The percentage of subcutaneous fat in senior was 23.99%, and in junior players was 18.06%. The percentage of muscle mass of senior was 36.04%, and that of junior players was 40.75%. The average time at the 10-meter sprint test for senior was 1.58 seconds, and for junior players 1.648 seconds. The average time on the agility t-test for senior was 9.813 seconds, and for junior players 10.318 seconds. The anaerobic endurance test of 300 meters present the average results of 64.192 seconds for senior and 63.3 seconds for junior players.

DISCUSSION

The research results are interesting and a detailed interpretation is needed, there is no significant difference in variable body height. The junior team players have almost the same body height as senior team players with a result of 178cm, which indicates that futsal players are at the peak of the body height already in junior age. Study results in variable body weight do not indicate significant differences between junior and senior players. According to study results it can be concluded that the body weight of senior futsal players is almost fully formed in junior age. The percentage of body fat is significantly lower in junior players which is expected because of younger age. Also because of the lower body fat percentage a higher rate of muscle mass is detected in junior players which was also expected.

The juniors and seniors of the futsal club Osijek partially coincide with the results of the research by Junior et al. (2017). The results in morphological characteristics are completely opposite and different. In the research on juniors and seniors of the futsal club Osijek, no statistically significant difference in body height was found, while in the research by Junior et al. (2017) body height was statistically significantly different, that is, the players of the U17 team was a significantly higher than the seniors. The result in the percentage of subcutaneous fat in both studies was statistically significantly different, but completely opposite. Juniors in a study of futsal club Osijek players had a statistically significantly lower percentage of subcutaneous fat, while seniors in a study by Junior et al. (2017) had a statistically significantly lower percentage of subcutaneous fat. The results in tests of the anaerobic capacity of the players match in both studies, that is, there was no statistically significant difference between seniors and juniors in these characteristics.

The results of the research on the players of the futsal club Osijek do not match the results of the research by Nakamura et al. (2015). In the research on futsal club Osijek players, no statistically significant difference in the anaerobic endurance of juniors and seniors was confirmed, while in the research conducted by Nakamura et al. (2015) a statistically significant difference was confirmed, that is, the seniors had better results in the anaerobic endurance test than the U20 team. In the research on the players of the futsal club Osijek, no statistically significant difference was confirmed in the sprint-type explosive strength test, while in the research conducted by Nakamura et al. (2015). a statistically significant difference was confirmed, i.e. the U20 team had a better result in the sprint-type explosive power test than the seniors. In the agility test that was conducted on the players of the Osijek futsal club, a statistically significant difference was confirmed, that is, the seniors had statistically significantly better results than the juniors in the agility test. In the agility test conducted in the research of Nakamura et al. a statistically significant difference was confirmed, but the U20 team achieved a statistically significantly better result in the agility test than the seniors.

CONCLUSIONS

In this paper, the differences between senior and junior futsal players in morphological characteristics and motor skills were determined. Junior players had significantly better results in the area of morphological characteristics (percentage of subcutaneous fat tissue and percentage of muscle mass), which are very important, while no significant difference was found in motor abilities, except in the agility test where seniors had a significantly better result. Although morphological features and motor skills are not the only factors for success in futsal, it can be concluded that they have a certain importance. A planned and programmed training process with clearly defined goals and tasks in a specific cycle under the guidance of an expert is of key importance for the development of young players.

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Development and Validation of a Sports Nutrition Questionnaire and Mediterranean Diet Adherence among Young Football Players – Pilot study

*Marta Tomljanović[1], Ana Kezić[1], Mario Tomljanović[1]

[1]University of Split, Faculty of Kinesiology, Split, Croatia

*Corresponding author

ABSTRACT

This pilot study aimed to develop and validate a questionnaire assessing sports nutrition knowledge and adherence to the Mediterranean diet among young football players. Participants were recruited from a football academy in Dalmatia, with 23 male players aged 10 to 20 years completing the questionnaire. The instrument comprised three sections: demographic information, nutrition knowledge, and Mediterranean diet adherence. Questions were adapted from validated tools such as the ULTRA-Q and GNKQ questionnaires for nutrition knowledge, and the MedQ for Mediterranean diet adherence. Pilot testing indicated good reliability in test-retest assessments for Likert scale variables, supported by within subjects t-tests and Cronbach's alpha coefficient of 0.75, suggesting strong internal consistency. However, nominal variables showed poor agreement, necessitating modification for future iterations. The study underscores the significance of validated tools in assessing dietary behaviors among athletes, offering insights into types of questions (variables) needed for achieving the best possible reliability. Further research is recommended to validate the questionnaire in larger samples and explore its broader application in sports nutrition research.

Keywords: dietary behavior, nutritional education, young athletes, eating habits, youth sports

INTRODUCTION

Nutrition knowledge consists of basic understanding in macronutrients to sport specific nutritional strategies, and it is modifiable determinant of dietary behavior (Trakman et al., 2018). The role of nutrition in optimizing athletic performance, particularly among young athletes, has brought significant attention in recent years. There are indications that better nutritional knowledge can lead to incorporation of healthier food patterns and better food choices (Worsley, 2022). Greater nutrition knowledge is linked to more frequent purchases of healthy foods, better overall food choices, and reduced consumption of nutrient-poor, energy-dense foods (Wardle et al., 2000). Therefore, development of validated nutritional questionnaires for specific sports and specific groups are crucial for assessment. Nowdays, athletes begin their professional journey at a very young age which makes them a target for poor nutritional choices and unhealthy eating habits (Heaney et al., 2011).

The validation of general nutrition knowledge and sports nutrition questionnaires has been a critical area of research, aiming to develop reliable tools for assessing individuals' understanding and practices related to nutrition. Parmenter and Wardle (1999) were pioneers in this field with the development of the General Nutrition Knowledge Questionnaire (GNKQ). Their work demonstrated that a well-validated questionnaire could effectively measure general nutrition knowledge across different populations. In the realm of sports nutrition, Rosenbloom et al. (2002) developed and validated the Nutrition Knowledge Questionnaire for athletes. This tool was specifically designed to address the unique dietary needs and challenges faced by athletes. Additionally, Zinn et al. (2005) validated the Sports Nutrition Knowledge Questionnaire (SNKQ) for coaches and athletes, which included specific questions on macronutrient needs, hydration, and supplementation. Proper validation of these tools is essential for dietitians and coaches to effectively influence athlete behavior and performance. Validated questionnaires ensure accurate assessments of nutritional knowledge, forming a reliable basis for personalized interventions. Without thorough validation, tools may produce misleading results and ineffective dietary advice. Therefore, adequate validation processes are crucial for effective nutritional education and behavior change in athletes (Trakman et al., 2018).

Among the various dietary patterns, the Mediterranean diet is renowned for its health benefits, including cardiovascular protection, anti-inflammatory properties, and support for overall well-being (D'Angelo et al., 2020; Helvacı et al., 2023). Despite its recognized benefits, the extent of adherence to the Mediterranean diet and the level of nutritional knowledge among young athletes, especially football players, remains underexplored.

To address this gap, it is essential to develop and validate an instrument capable of accurately assessing nutrition knowledge and adherence to the Mediterranean diet in this demographic. The purpose of this study was to develop and validate a new questionnaire designed to evaluate nutritional knowledge and adherence to the Mediterranean diet among young football players in order to connect adherence to the Mediterranean diet with nutritional knowledge, determine if better knowledge leads to greater adherence, and ultimately assess its impact on sports performance.

METHODS

Participants

Participants were recruited from one football academy in Dalmatia. Inclusion criteria were: (1) male football players aged 10-20 years, (2) active participation in competitive football, and (3) willingness to provide informed consent. This pilot study involved a younger cohort of soccer players from the pioneer, cadet, and senior selections to investigate their thought processes and dietary habits. This research aims to gather insights on how these group of athletes think and eat, providing valuable information for the upcoming examination of the doctoral thesis. A total of 23 football players, ages 10 to 20 years, completed the questionnaire. Consent for participation in the study was obtained from the players and, in the case of minors, from their parents or guardians.

Questionnaire Development

The questionnaire was developed based on existing validated instruments and guidelines on nutritional knowledge and Mediterranean diet adherence. It comprised three sections: (1) demographic information (11 questions), (2) nutrition knowledge (11 questions), and (3) Mediterranean diet adherence (8 questions). The nutrition knowledge section included questions on general nutrition and sports nutrition. Questions were taken from pre-existing questionnaires: ULTRA-Q questionnaire (Blennerhassett et al., 2018) and GNKQ questionnaire (Parmenter and Wardle, 1999), while the adherence section was based on a Mediterranean Diet Score (MedQ). MedQ questionnaire is a good instrument for evaluation of adherence to Mediterranean diet because it is short and provides an advantage in execution (Ruggeri et al., 2022). Most of the variables from the demographic information and Mediterranean diet adherence sections are nominal in nature, while most variables from the nutrition knowledge section are presented on a Likert scale from 1 to 5.

This pilot testing was administered in person using Google Forms, allowing participants to raise any doubts or questions they had. The questionnaire ultimately contained 30 questions, and the time required to complete the questionnaire was approximately 10 minutes. Test-retest reliability was evaluated by giving the same questionnaire to the same participants within a four-week interval.

Statistical analysis

For all variables which have been measured on a Likert scale from 1 to 5, within subjects t-test has been used to examine reliability. Additionally, for those variables, basic descriptive statistics were calculated (mean values and standard deviations). As an internal consistency indicator, Cronbach-alpha coefficient was calculated for the questionnaire. Finally, for each nominal variable, as a measure of reliability, a number of consistently answered questions divided by sample size was taken. Statistical significance was set at $P < 0.05$. All data were analyzed with the use of the Statistica for Windows 14.0 package.

RESULTS AND DISCUSION

Concerning the demographic data of the participants, five respondents were between 10 and 14 years old, four were over 18 years old, while the majority, fourteen respondents, were between 15 and 18 years old. When looking at the categories in which young football players compete, five were in the pioneers category, eight in the cadets, eight in the juniors, and two in the seniors. Regarding playing positions, there were 9 defenders, 8 midfielders, and 6 forwards among the respondents. Almost all (n=21) had a training experience of more than 5 years, while only two had between 3 and 5 years of experience. As many as 56% of the total number of respondents stated that they have prior knowledge of sports nutrition.

Within subjects t-test (t-test for dependent samples) was used to inspect differences between test and retest for questions (statements) which were measured on a Likert scale. It has been shown that all variables have satisfied reliability due to the fact that significance of differences between test and retest was inside interval of 0.15 to 1.00. No significant differences were observed between the test and retest scores; however, an increase in scores during the retest was noted, consistent with the findings of Vázquez-Espino et al. (2020) (Table 1).

Table 1. Descriptive statistics for variables statement1 to statement11 (S1-S11) (mean values and standard deviations) and the results of within subjects t-test (t, df, p)

Variable	*Mean*	*SD*	*N*	*t*	*df*	*p*
S1_test	*3.30*	*0.88*	*23.00*	*0.87*	*22.00*	*0.40*
S1_retest	*3.09*	*0.95*				
S2_test	*3.30*	*0.76*	*23.00*	*0.00*	*22.00*	*1.00*
S2_retest	*3.30*	*1.11*				
S3_test	*3.22*	*0.52*	*23.00*	*0.68*	*22.00*	*0.50*
S3_retest	*3.09*	*0.90*				

S4_test	*2.30*	*1.29*	*23.00*	*0.12*	*22.00*	*0.91*
S4_retest	*2.26*	*1.05*				
S5_test	*3.17*	*1.11*	*23.00*	*1.50*	*22.00*	*0.15*
S5_retest	*2.70*	*1.15*				
S6_test	*2.91*	*1.28*	*23.00*	*-0.30*	*22.00*	*0.77*
S6_retest	*3.00*	*1.09*				
S7_test	*3.43*	*0.73*	*23.00*	*0.00*	*22.00*	*1.00*
S7_retest	*3.43*	*1.04*				
S8_test	*3.48*	*0.90*	*23.00*	*-0.72*	*22.00*	*0.48*
S8_retest	*3.70*	*1.02*				
S9_test	*3.39*	*0.72*	*23.00*	*-1.23*	*22.00*	*0.23*
S9_retest	*3.70*	*0.82*				
S10_test	*3.65*	*0.93*	*23.00*	*-0.37*	*22.00*	*0.71*
S10_retest	*3.74*	*0.81*				
S11_test	*3.74*	*0.86*	*23.00*	*0.44*	*22.00*	*0.66*
S11_retest	*3,65*	*0,78*				

Cronbach's alpha was calculated for all items in the questionnaire and was 0.75, indicating good internal consistency, similar to results found in previous research (Vázquez-Espino et al., 2020; Trakman et al., 2018; Parmenter & Wardle, 2000). Although the minimum recommended internal consistency is often cited as 0.7 (Parmenter & Wardle, 2000), some studies also suggest that a Cronbach's alpha exceeding 0.6 can be considered acceptable (Taber, 2018). Therefore, the value of internal consistency for this questionnaire could indeed be indicated as good.

Regarding the nominal variables in the questionnaire, which were chosen to see how respondents would react to them, the overlap between test and retest responses was only 60%, indicating neither good agreement nor validity. In this context, it is not advisable to use nominal variables in the further development of the questionnaire. Instead, in the next phase these iterations will be modified so that the variables are distributed on a Likert scale.

Based on communication with a range of experts and previously validated questionnaires, a battery of questions was developed to address the issues of sports nutrition knowledge and adherence to the Mediterranean diet. The questionnaire was created in several iterations, with some questions being revised. It can be determined a priori that the questions assess what they were designed to measure, namely knowledge of sports nutrition and adherence to the Mediterranean diet. To further confirm validity, the constructed and modified questionnaire needs to be applied to a larger sample of young football players, and its validity should be verified through factor analysis.

Limitations

This study focused on a group of young football players from lower league teams who typically have limited access to nutritional advice or support. Given their age, there was a potential issue with comprehending some questions, which we aimed to avoid by administering the questionnaire in person to address any uncertainties. Another limitation was that some questions were not clearly phrased and could have been better interpreted using a Likert scale. To gain a more comprehensive understanding of this group's responses, a larger participant pool is needed.

CONCLUSION

In conclusion, this study developed and piloted a questionnaire aimed at assessing sports nutritional knowledge and adherence to the Mediterranean diet among young football players. The instrument, comprising sections on demographic information, nutrition knowledge, and Mediterranean diet adherence, showed good reliability in test-retest assessments and internal consistency. However, nominal variables did not demonstrate adequate reliability, suggesting the need for further refinement. The findings highlight the importance of validated tools in evaluating dietary behaviors among athletes, which can inform targeted interventions to enhance nutritional practices and optimize performance outcomes. Future research should focus on expanding the sample size and conducting factor analyses to confirm the questionnaire's validity and utility in sports nutrition research.

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Differences in the Body Mass Index of Primary-School Fourth-Graders From the City of Split, Croatia, in Regards to Extracurricular and Sports Activities: A Cross-Sectional Study

Tonči Bavčević[1*], Damir Bavčević[1] and Luka Androja[2, 3]

[1]Faculty of Kinesiology, University of Split, Split, Croatia; [2]University of Applied Sciences Aspira, Split, Croatia; [3]School of Medicine, University of Split, Split, Croatia

*Corresponding author

ABSTRACT

Children in Croatia are among the most obese in the European Union. Extracurricular and physical activities of students are a decisive factor that influences this. The aim of this research was to examine the differences in BMI between four groups of students. The first group participated in extracurricular activities, the second in sports activities, the third in both extracurricular and sports activities and the fourth group did not participate in any activities. The participants were children who attended the fourth grade of primary schools in the city of Split, Croatia. This study indicated that children who participated in both, extracurricular and sports activities, tended to have lower BMI compared to their peers who did not engage in such activities. It is possible that not only physical activity affects BMI, but also any other extracurricular activity. Such findings were confirmed by other relevant studies. Children in Croatia in urban areas mostly walk to various activities, which additionally affects the prevention of obesity. Findings of this study emphasized the importance of addressing adiposity in students, as it helps to prevent unhealthy lifestyle patterns. Planning and programming of teaching process in kinesiological education should be in synergy with other subjects and extracurricular activities in order to have a positive effect on the reduction of BMI. Results of this study can help PE teachers, public health, and other stakeholders in the education system for planning new policies to prevent the biggest 21st-century pandemic.

Keywords: body mass index, extracurricular activities, sports activities, physical education

INTRODUCTION

Over the past decade, childhood obesity has become a significant public health concern in Croatia (Juresa et al., 2012). Research has shown that body mass index (BMI) among Croatian schoolchildren have been on the rise, with concerning implications for their overall health and well-being (Musić Milanović et al., 2021). A recent study found that BMI increased significantly among primary-school children in Split-Dalmatia County in Croatia, and especially implied the importance of physical activity in order to have a positive effect on nutritional status (Androja et al., 2023).

A crucial factor in addressing this issue is the role of extracurricular and sports activities. Extracurricular and sports activities have shown to play a crucial role in promoting lifestyle quality and maintaining a healthy weight among children. A study in Croatia found that children who participated in extracurricular and sports activities had lower BMI values compared to those who did not (Nujić et al., 2019). Similarly, research has demonstrated that increased participation in sports activities was related to lower BMI and a decreased chance of overweight and obesity among schoolchildren (Kenđel Jovanović et al., 2021). An increased percentage of fat tissue, especially in the first four grades of primary school, is characteristic of this population (Brničević et al., 2015). It is increasingly implied that interventions in schools should focus on physical education, nutrition education and the availability of healthy eating options aiming at reducing childhood obesity. Playing sports, which is mainly performed in schools during physical education classes, is considered one of the main forms of increasing daily energy consumption in school-age children, and is associated with weight control (Popkin et al., 2012). Determining the current state of a student as an individual, as well as of the group as a whole, enables the teacher to directly control their work and to programme and implement the planned contents in a quality manner in order to achieve the set goals (Androja et al., 2019). Due to the previously mentioned it is considered necessary to determine the current state of children at the beginning and end of each school year through physical education classes for the purpose of work programming (Findak et al., 1992).

In regards to what is said above, the impact of extracurricular activities and sports on the BMI of primary-school students has been a subject of developing interest among researchers. Therefore, the aim of this study was to examine whether there were differences in BMI between students (primary-school four-graders from the city of Split) who participated in extracurricular and sports activities and those who do not. This alarming trend highlights the need for effective strategies to promote healthy lifestyles among children. The findings of this study can provide valuable insights that can serve as a basis for the development of targeted policies and programs to address this urgent public health problem.

METHODS

Study design

This was a cross-sectional study. The participants were children who attended the fourth grade of primary schools in the city of Split, Croatia. The data were collected by physical education teachers during the final measurement phase in the physical education class in the 2023/2024 school year. All teachers were physical education professors and they were trained to measure the students. All of them used the same measuring instruments and methods of measurement, in accordance with the plan and program of physical education of the Republic of Croatia. After weight and height measurements were taken, BMI was determined according to the BMI calculator for children. The listed morphological data and other information, necessary for this research, were taken from the official school records. This was followed by statistical processing and interpretation of the obtained results.

Participants

Non-probability convenience sampling method was used in this study. A total sample consisted of 224 fourth grade primary school students divided into 4 groups: engagement in sports activities (SA), engagement in extracurricular activities different from sports (EA), engagement in both extracurricular and sports activities (SA+EA) and lack of participation in any activity (NOA). No subject was excluded from the study, because only students who were completely healthy were subjected to measurement.

Variables

The variables used in this study were body weight (kg), body height (cm), body mass index (kg/m^2). The dependent variable was BMI.

Statistical analysis

Descriptive statistics was used to summarize the BMI. Measures of central tendency and data dispersion were used. Subsequently, the distribution's normality was assessed using the Kolmogorov-Smirnov test. A two-factor ANOVA was applied to determine the differences between participants who participated in extracurricular and sports and those who did not. A residual value was calculated in order to diagnose the quality and validity of the statistical model. In addition, a post hoc analysis was performed to examine the group differences.

RESULTS AND DISCUSSION

The results of descriptive statistics are shown in Table 1.

Table 1. Descriptive Statistics

Variable	*Group*	*N*	*Mean*	*SD*	*Skewness*	*Kurtosis*	*Min*	*Max*
BMI	*EA*	*18*	*19.531*	*3.823*	*0.257*	*-1.380*	*14.568*	*25.980*
	NOA	*20*	*20.177*	*4.234*	*0.212*	*-0.777*	*13.319*	*27.888*
	SA	*136*	*18.320*	*2.964*	*0.736*	*0.451*	*12.226*	*27.120*
	SA + EA	*50*	*17.957*	*2.294*	*-0.127*	*-1.122*	*13.590*	*21.621*

Legend: EA – extracurricular activities, NOA – no activities, SA – sports activities, SA + EA – sports and extracurricular activities

The Kolmogorov-Smirnov test was conducted to assess the normality of the data distribution for the presented sample, resulting in a p-value of 0.298, and max D=0.065. Given the normal distribution of the data, a two-way ANOVA was used to test the differences.

After conducting a two-factor ANOVA, the results obtained separately for SA and EA indicated no statistically significant differences between the groups. However, the interaction effect of SA and EA represent a statistically significant differentiating factor ($p=0.018$), as shown in Table 2.

Table 2. Two-factor ANOVA

Subjects	*Sum of Sq.*	*df*	*Mean Sq.*	*F*	*p*
Groups	*94.529*	*3*	*31.510*	*3.410*	*0.018*
Residuals	*2033.042*	*220*	*9.241*		

Note. Type III Sum of Squares

To analyse significance of differences separately between each group, a post hoc test was used. It determined which groups were statistically different from each other in terms of SA and EA attendance (Table 3). Post hoc analysis used the powerful Tukey's test, considered a "gold standard". For all groups significance levels of Tukey's test were p>0.05, except NOA and SA + EA (p=0.032). There was a difference between students who participated in both activities compared to students who did not participate in any activity.

Table 3. Post hoc comparation

Groups	*Mean Difference*	*SE*	*t*	p_{Tukey}
EA vs NOA	*-0.646*	*0.988*	*-0.654*	*0.914*
EA vs SA	*1.211*	*0.762*	*1.588*	*0.387*
EA vs SA + EA	*1.574*	*0.836*	*1.883*	*0.238*
NOA vs SA	*1.857*	*0.728*	*2.551*	*0.055*
NOA vs SA + EA	*2.220*	*0.804*	*2.760*	*0.032*
SA vs SA + EA	*0.363*	*0.503*	*0.722*	*0.888*

Note. p-value adjusted for comparing a family of 4

Obtained findings confirmed the difference in BMI among the respondents regarding their involvement in different types of activities. Partial analysis did not establish successive local differences between students who did not engage in any activity, students who participated on extracurricular activities, those who participated in sports activities and students who participated in both activities. It is possible to conclude that activities have a positive cumulative effect on the reduction of body mass index regardless of their nature. It is to be assumed that extracurricular activities regularly include a component of movement that contributes to the total amount of kinesiological activity of students. The above mentioned is shown in Figure 1.

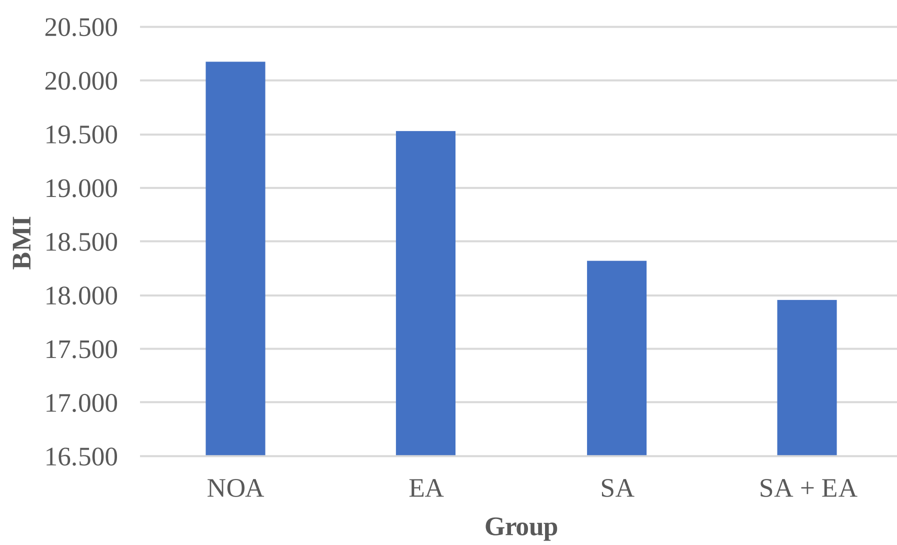

Figure 1. BMI values by groups

The reasons for this can be different. Numerous studies have shown that children who engage in SA and EA usually had a lower BMI compared to less active peers.

One study examined the effectiveness of physical activity interventions in overweight or obese children. The analysis concluded that interventions with objectively measured physical activity outcomes were effective in improving BMI in this population. This highlights the role of increased physical activity in managing childhood obesity (Kawalec et al., 2024). Also, a longitudinal study found that overweight or obese children became less physically active over time compared to their healthy weight peers (Jago et al., 2020). This research also indicated that children who participated in extracurricular activities, even those not specifically focused on sports, also tend to have lower BMI compared to their peers who do not engage in such activities. Several studies have demonstrated that relationship. This study examined the association between extracurricular activity patterns and children's body composition. The researchers found that an active commute to school was inversely related to BMI, but also that frequent sports activity did not reduce children's likelihood of being overweight or obese, which indicates that even extracurricular activities that are not sports can have obesity prevention benefits (Bosch et al., 2019). It may be assumed that children who attend extracurricular activities in Croatia go on foot more than by motorized vehicle, especially those who are living in urban areas, which had an additional effect of an unplanned physical activity. Therefore, the arrival and departure to a certain activity must be counted, whether it is sports or not. To positively influence the mentioned problem, it is necessary to properly plan, program, implement and control the process of physical activity, and this presupposes knowledge of the current anthropological status of students (Bavčević, T. et al., 2020; Bavčević, T., 2018.; Bavčević et al., 2006). PE as the only controlled way of exercise for many students in this critical period, is of exceptional importance for preventing unhealthy life patterns. Regarding that, children who attend more activities are better disciplined and create healthy lifestyle habits, and it is also possible that their parents pay more attention to their health and nutritional status. Such contents are extremely important in the ontogenetic development of students. In this regard, the goal is to prevent adiposity as a cause of chronic non-communicable diseases, metabolic syndromes and comorbidities in students.

No studies examining BMI in the pooled model of SA and EA were found, which may be considered as a strength of this study. The limitation of this research is a relatively small sample and the use of non-probability convenience sampling method.

In summary, the study indicated that higher levels of extracurricular and physical activities were associated with lower BMI in children. Interventions that increase extracurricular and physical activities appear to be effective in improving BMI outcomes in overweight and obese children. The relationship between BMI and extracurricular and physical activities appears to be bidirectional, with higher BMI leading to decreased activities levels as children age. Therefore, it is important to guide and make students, teachers and school professional staff aware of these findings, to plan and programme PE teaching subjects, in accordance with the results of regular kinesiological tests conducted by teachers every school year.

CONCLUSION

Findings of the present study are of exceptional importance for the field of kinesiology and particularly for kinesiological education. Results of the study point exactly to the importance of knowing the student's health status represented by BMI. Also, the findings of this manuscript indicate that BMI cannot be observed only through physical activities, but also through other extracurricular activities. In addition to the above, the obtained findings provide guidelines for the implementation of additional kinesiological, as well as other content in the formation of classes in all-day schools. A professional and scientifically based approach to the problem of overweight and obesity can provide answers to modern social demands such as an increased sedentary lifestyle, shorter sleep time, unbalanced diet and lack of physical activity, which are very pronounced among students of the observed age. Authors planning research on the same or similar topic are suggested to combine activities to achieve more precise results. This research can serve PE teachers, the public health sector and other stakeholders in the education system for the purpose of planning new policies to prevent the biggest pandemic of the 21st century.

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Perception of Volleyball Middle Blockers About Their Playing Role

Lara Dezulović[1], *Mirjana Milić[2], Zoran Grgantov[3]

[1]University of Split, Faculty of Kinesiology, Split, Croatia; [2]University of Split, Faculty of Kinesiology, Split, Croatia; [3]University of Split, Faculty of Kinesiology, Split, Croatia.

*Corresponding author

ABSTRACT

Middle blockers have a crucial role on the court. This specific group of volleyball players, known as "middles," stands out due to their exceptional mobility, ability to perform various attacks, and high-set blocks. The aim of this paper was to determine the personal perception of middle blockers about their playing role in volleyball. The sample consisted of 37 Croatian female volleyball players, i.e., middle blockers, who had been engaged in their playing role for a mean of 3.46±0.65 years. The mean chronological age of the participants was 19.97±2.98 years, their mean height was 184.05±5.40 cm, and their mean body mass was 73.39±8.03 kg. The sample of variables included a set of 23 questions, which were composed for the purposes of this research, and represent an anonymous questionnaire titled *Perception of Middle Blockers About Their Playing Role in Volleyball*. The data showing that Croatian clubs still do not train according to specializations, i.e., according to their playing roles, is concerning because barely the majority of the respondents confirmed that they are divided according to their playing roles during training. The presence of competition for the same playing role further motivates them, as does the coach generally before important matches. The level of confidence among the respondents is also moderate, and they express their opinion that they do not have an adequate and sufficient training process that would enable their progress. This study suggests that psychological characteristics of players, such as motivation, role perception, and support needs, are crucial for their athletic performance. Further research in this field could expand our understanding of these aspects and contribute to better development and support for players in the middle blocker position in volleyball.

Keywords: motivation, personal assessment, playing roles.

INTRODUCTION

Volleyball has evolved into a sport that combines high athletic challenges with dynamic play, offering unpredictable moments and constant changes during gameplay. It has developed over the years, acquiring its distinctive allure and excitement through this evolution. Described as a game full of hope and expectation, where the outcome is difficult to predict, volleyball involves three essential elements: the court, players, and the ball. It offers opportunities for teamwork, strategy, and individual excellence. Players must react quickly to opponents' hits, execute fast and precise plays, and devise tactics to score points. Volleyball is a sport that continuously evolves and adapts to new innovations and techniques, offering not only challenges and excitement but also camaraderie and a passion for the game, making it one of the most beloved sports worldwide. It encompasses various playing roles that volleyball players specialize in throughout their careers, each with specific tasks and responsibilities within the team. These diverse playing roles form the foundational structure of the team, providing players with opportunities to contribute their unique skills and abilities toward achieving a common goal – winning. These roles include *setter*, *opposite hitter*, *libero*, *outside hitter*, and *middle blocker*.

Middle blockers, although often in the shadow of outside hitters or setters, play a crucial role in the dynamics of volleyball. Their ability to react quickly and make decisions often contributes to successful team blocks but can also lead to errors when opposing hitters spike. Their impressive height allows them to literally rise above the net and disrupt opponents' attacks, making it difficult for them to execute precise and powerful hits. Despite their significant physical attributes, middle blockers must also be highly tactically aware. Their ability to read opponents' attacks quickly, time their jumps effectively, and set up blocks can mean the difference between winning and losing a rally. Before setting up a block, middle blockers need to assess the type of attack they need to defend against. There are different types of blocks, such as passive, active, aggressive, zoning, or delayed blocks. Furthermore, their ability to collaborate with setters and other teammates is crucial for synchronized offensive and defensive play. Middle blockers must also be extremely adaptable. They often execute quick attacks primarily in zone 3. This attack, known as "1st tempo," requires exceptional coordination between the middle blocker and the setter. Middle blockers must react swiftly to the setter's setup and leap to execute their hit before the opposing block has a chance to react. Each opponent brings different challenges and attacking styles, so it's important for middle blockers to quickly recognize and respond to these changes. Their role also includes defense, where they often face rapid and unpredictable reactions to opponents' attacks. In situations requiring transition to the back row, middle blockers typically leave the court to be replaced by the libero. In addition to the physical and tactical demands, the mental aspect of the game is also crucial for middle blockers. They must maintain a high level of concentration, determination, and a positive attitude. Ultimately, middle blockers are the foundation of their team's success. Their role adds dynamics and excitement to the game, making them an indispensable part of every volleyball team.

Psychological characteristics have a significant impact on volleyball players' performances during competitions. The importance of psychology in sports has increasingly come to the forefront in recent years and is now defined as a specialized field within psychology that studies athletes' behavior across various aspects of their sporting performances (Knežević, 2018). Sports psychology is defined as a scientific field where psychological principles are applied during sports activities and exercises to enhance athletic performance (Cox, Peranović, & Škverin, 2005). Despite frequent disagreements among researchers in the field of sports psychology, they all shared a common goal: to improve the field of sports psychology, the insights of which today enable better and more stable athlete performances in stressful situations. Regarding self-esteem and physical exercise, research confirms a significant connection between engaging in physical activities and increased levels of self-esteem, as individuals participating in specific types of physical exercise have the opportunity, through their activity, to enhance or even build their self-esteem (Bungić & Barić, 2009). Confidence signifies an individual's belief in their own ability to achieve success. In other words, athletes with high confidence are more likely to achieve positive results, whereas those with low confidence have lower prospects for success. A confident athlete believes in their capability to accomplish their goals and does not perceive obstacles that could hinder their sports performance (Barić, 2012). Group cohesion is considered a "dynamic process reflected in the tendency for a group to stick together and remain united in the pursuit of goals" (Carron & Brawley, 2000). Among team members, there should be support and connection, which are essential elements of team spirit (Festinger, Schachter, & Back, 1950).

Motivation is unquestionably a crucial psychological factor for achieving athletic success. Motivated individuals demonstrate higher efficiency in all aspects of life, including sports. They clearly define their goals and are aware of the reasons why they persistently prepare and train. Athletes can find additional inspiration and encouragement in their environment. However, lacking such support does not necessarily preclude a positive outcome in competition if the athlete possesses other essential characteristics for sports success, such as physical readiness or tactical knowledge. Sports success depends on various elements, including the people within the athlete's environment, as well as personal motivation and mental resilience (Bosnar & Balent, 2009).

Middle blockers have often been the subject of research. Harabagiu and Parvu (2022) analyzed the playing actions of middle blockers, one of the playing roles in volleyball, particularly crucial in predicting opponent attacks. Mirzaei, Gharraee, and Birashk (2014) compared the effects of middle blockers in volleyball competitions at the 2016 Olympic Games in attacking and blocking techniques. Afonso, Mesquita, and Palao (2009) conducted research aiming to analyze how the use of "anticipated block" affects the number of blockers and blocking efficiency during attack and counter-attack phases, providing reference values for implementing anticipatory and read blocks. Palao, Manzanares, and Valades (2014) also analyzed the success of middle blockers. In this study, middle blockers were explored as volleyball players themselves to understand their perception of their playing role.

The aim of this study was to determine the personal perception of middle blockers regarding their playing role in volleyball.

METHODS

The sample consisted of 37 female volleyball players, middle blockers from across Croatia, actively participating in the most prestigious competition, the Super League, in the 2022/2023 season. On average, they had been engaged in their playing role for 3.46±0.65 years. The mean age of the participants was 19.97±2.98 years, their mean height was 184.05±5.40 cm, and their mean body mass was 73.39±8.03 kg. It is a representative sample because it included almost all middle blockers who were active at the highest level of competition, the Super League, considering that each team typically lists three to four middle blockers in their competition roster.

A total of 20 middle blockers, or 54.02% of them, were regular starters in their club's first lineup, while 6 middle blockers, or 16.22%, served as substitutes. Additionally, 17 players, or 29.76%, occasionally started in the first lineup, depending on the match. All participants held valid volleyball licenses from the Croatian Volleyball Federation (HOS) and medical clearance to compete during the 2022/2023 season.

The variable set consisted of 23 questions designed specifically for this study, comprising an anonymous questionnaire titled "*Perception of Middle Blockers About*

Their Playing Role in Volleyball," by Dežulović, Milić, and Grgantov (2023). The questionnaire is closed-ended and includes five questions related to sample description inquiries. The remaining 18 questions are focused on assessing various aspects, including motivation, confidence in play, sense of responsibility, sense of achievement, satisfaction with their status, perception of coach impact and behavior, and the importance of psychological preparation for their playing role in volleyball, rated on a dichotomous scale.

The questionnaire was administered on an online platform. After personally familiarizing themselves with the aim of this research, the female volleyball players, middle blockers, were invited to express their views and opinions. It is important to note that the first author of this study also played as a middle blocker on her team, which represents an additional factor of closeness between the researchers and the participants. All participants provided written consent to voluntarily participate in this research.

To determine the descriptive indicators of the variables, the following measures were calculated: arithmetic means (AM), minimum values (Min), maximum values (Max), standard deviations (SD), skewness (SKEW) and kurtosis (KURT) coefficients to assess distribution shape, frequencies, i.e., absolute (F) and relative values (%) of individual responses. Additionally, MaxD values were determined to identify significant deviations from normal distribution using the Kolmogorov-Smirnov test (KS test). Data analysis was conducted using the statistical software *Statistica Ver 13.00*.

RESULTS AND DISCUSION

Descriptive indicators of the frequency and percentage values for nine statements from the questionnaire "*Perception of Middle Blockers About Their Playing Role in Volleyball*" among all participants who play in the middle blocker position are presented in Table 1.

Table 1. Frequencies and percentages of the nine variables used on the total sample of middle blockers (N=37)

Variables		*F*	*%*
Importance of the playing role - middle blocker	*Yes*	*19.00*	*51.45*
	No	*18.00*	*48.65*
Satisfaction with status in the club	*Yes*	*29.00*	*78.38*
	No	*8.00*	*21.62*
Sense of responsibility towards the club	*Yes*	*23.00*	*62.16*
	No	*14.00*	*37.84*
Presence of training based on playing roles	*Yes*	*19.00*	*51.45*
	No	*18.00*	*48.65*
Success in the playing role of middle blocker	*Yes*	*34.00*	*91.89*
	No	*3.00*	*8.11*
Presence of greater potential for another playing role	*Yes*	*17.00*	*45.95*
	No	*20.00*	*54.05*
Impact of competition on motivation	*Yes*	*32.00*	*86.49*
	No	*5.00*	*13.51*
Impact of the coach on motivation in general	*Yes*	*23.00*	*62.16*
	No	*14.00*	*37.84*
Impact of the coach on motivation during important matches	*Yes*	*26.00*	*70.27*
	No	*11.00*	*29.73*

Legend: F – frequencies; % – percentage value, relative.

By analyzing Table 1, it is evident that middle blockers are divided in their views on the importance of their playing role. Specifically, 51.45% consider their contribution to the game significant, whereas 18 of them lean towards the opinion that it is not entirely accurate. Although 23 respondents, i.e., 62.16%, believe their playing role carries responsibility, 14 volleyball players answered negatively to this statement. Results indicating how satisfied they are with their status in the club show that 78.38%, i.e., 29 middle blockers, responded positively. Concerningly, it appears that Croatian clubs still do not train according to specializations or playing roles, as again 18 players responded negatively, meaning 51.45% of respondents confirmed they are divided according to their playing roles during training. When asked how successful they feel in their positions, a significant 91.86% answered positively, with only three volleyball players considering themselves unsuccessful middle blockers. Possible reasons are evident from the results of the following statement, showing that 17 respondents, i.e, 45.95% of middle blockers, personally believe they have greater potential for another playing role. The presence of competition in the same playing role further motivates them to work, whereas 13.52% do not attach greater importance to it. It is clear that coaches generally provide additional positive motivation, with 23 respondents, i.e., 62.16%, responding affirmatively, and 70.27% of middle blockers additionally being motivated by coaches before important matches.

In Table 2, descriptive indicators of frequency and percentage values are presented for eight statements from the questionnaire "*Perception of Middle Blockers About Their Playing Role in Volleyball*," among all participants playing in the middle blocker position.

Table 2. Frequency and percentage values of eight variables used on the total sample of middle blockers (N=37)

Variables		*F*	*%*
Knowledge of basics of psychological preparation	*Yes*	*22.00*	*59.46*
	No	*15.00*	*40.54*
Experience working with a sports psychologist	*Yes*	*3.00*	*8.11*
	No	*34.00*	*91.89*
Coach involvement in team psychological preparation	*Yes*	*18.00*	*48.55*
	No	*19.00*	*51.45*
Coach's involvement in psychological preparation of middle blockers	*Yes*	*14.00*	*37.84*
	No	*23.00*	*62.16*
Level of confidence	*Yes*	*18.00*	*48.55*
	No	*19.00*	*51.45*
Opportunities for improvement	*Yes*	*36.00*	*67.86*
	No	*1.00*	*32.14*
Adequacy of training process for improvement	*Yes*	*19.00*	*51.45*
	No	*18.00*	*48.55*
Rewards for winning	*Yes*	*22.00*	*59.46*
	No	*15.00*	*40.54*

Legend: F – frequency; % – percentage value, relative.

Analysis of Table 2 shows that middle blockers lack sufficient knowledge about psychological preparation (40.54%), and only 8.11%, i.e., three participants have had experience working with a sports psychologist in their sports careers. Additionally, volleyball players are divided in their opinion regarding the extent to which coaches are engaged in psychological preparation, as 18 middle blockers provided a negative response (51.45%), indicating that the coach's support for psychological preparation of middle blockers in their club is insufficient (62.16%). The confidence level of the participants is also moderate, with 51.45%, i.e., 19 volleyball players providing a negative response. Only one volleyball player expressed doubt about her personal progress potential, but they also believe that they do not have an adequate and sufficient training process to facilitate such progress. Most of the middle blockers state that they personally receive rewards for winning (59.46%).

Similar studies were conducted by Gutović (2017) and Subašić (2022), who used similar adapted anonymous online questionnaires to investigate the perception of setters and libero players about their playing roles.

CONCLUSION

Middle blockers perceive their role as crucial to the team's success. This perception can contribute to their dedication to training and matches, motivating them to continuously improve their skills. Additionally, most of them are satisfied with their level of motivation, highlighting the need for improvement and development of support systems to facilitate their further progress. Furthermore, most middle blockers are satisfied with their level of self-confidence and self-assessment of success, suggesting potential for developing their confidence and perception of their own success in competitions.

This study suggests that psychological characteristics of players, such as motivation, role perception, and the need for support, are crucial for their athletic performance. Further research in this field could expand our understanding of these aspects and contribute to better development and support for players in the middle blocker position in volleyball.

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Gender Differences in Self-Rating Academic Listening Skills Awareness in L2 Kinesiology Students

*Ana Penjak[1]

[1]Faculty of Kinesiology, University of Split, Croatia

*Corresponding author

ABSTRACT

Proficient academic listening skills are one of the most important students' abilities that enable L2 students (non-native English speakers who listen to English texts as a second language) to cope successfully with their academic demands. Gender as a listening variable can be a distinctive factor in obtaining the listening proficiency skills. This study explores gender differences in the self-rating academic listening skills awareness in L2 kinesiology students. All the participants (N=91) completed the *Academic Listening Self-rating questionnaire* (ALSA). The data were analyzed using a between-subjects t-test, revealing no significant differences ($p>0.05$) in 46/47 ALSA items. The findings suggest that gender was not a predictor of the academic listening skills awareness in L2 kinesiology students. Although the results of the study clearly indicate that there are gender differences, i.e. that males utilize a bit more of their academic listening micro-skills than females, those differences are not to be taken as pedagogical implications. The findings of the study have implications for multidimensional educational assessment in kinesiology students, and future research in this area is highly recommended.

Keywords: Listening comprehension, Non-native speakers, Academic ability, Gender, Academic success.

INTRODUCTION

Listening skills are one of the most complex mental processes that combine listener's attention, cognitive skills, perception, and memory, along with the listener's prior linguistic knowledge (Hamouda, 2013; Vandergrift & Baker, 2015).

Academic listening, on the other hand, differs from the general listening (Benson, 1989) in requiring from the listener to have micro-skills (for instance, the ability to identify a lecture's purpose and scope or the ability to identify relationships among units within discourse) and to be able to draw on greater extent of the background knowledge (Flowerdew, 1994) of the topic within the academic setting (university lectures, tutorials, seminars). In a word, having proficient academic listening skills enables L2 student (non-native English speakers who listen to English texts as a second language) to manage their academic demands successfully (Huang, 2005; Deb, 2020). But in order to determine the proficiency level of their academic listening skills, the self-rating method has to be applied.

Namely, self-rating is an educational assessment within the process of language learning in which students systematically appraise their own skills and abilities. (Brantmeier, 2005, 2006; Little, 2005; Rivers, 2001). Ekbatani (2000) reports that a self-rating method is a rigorous method that reinforces students' awareness of their own language listening skills strengths and weaknesses, and Nunan (1988) suggests that a self-rating method can be a useful pedagogical tool and effective indicator in teaching process. Even more, self-rating provides independence to language learning (Little, 2005); it improves students' learning and self-confidence in English classes (Butler & Lee, 2006) and in those virtual educational contexts (Dragemark, 2006).

Additionally, in this process of determining language skills proficiency, studies pointed out that gender impacts language learning (Yazdani & Ghafar Samar, 2010), that it represents a listening variable and that, as such, can be one of its distinctive features (Nguyen, 2022; Deliany & Cahyono, 2020; Ackerman, 2006; Gibb, Fergusson & Horwood, 2008). Even more, it has taken as proven that females are superior to male in language ability (Boyle, 1987), i.e. Akin (2016) and Ciascai and Lavinia (2011) suggest that women, in general, have better metacognitive skills compared to men. Therefore, establishing gender differences can have an impact on the students' overall academic listening comprehension outcome.

The aim of this study is to determine and explain whether there are gender differences in academic listening skills awareness in L2 kinesiology students. And since no previous research has addressed the issue on the same sample, the study aims to offer new insight into the topic.

METHODS

Sample

The sample consisted of a total of 91 undergraduate students of kinesiology (M=38, F=53; age 21.1 ± 1.9) from a public university in Croatia. Inclusion criteria required that they had learned English since primary school and completed one mandatory English language course as part of their program.

Design and Procedure

Data were collected using the *Academic Listening Self-Rating Questionnaire* (ALSA) (Aryadoust, Goh, & Lee, 2012). The questionnaire consisted of 47 standardized items based on six dimensions each integrating different listening micro-skills: linguistic components and prosody (LCP), cognitive processing skills (CPSs), relating input to other materials (RIOM), note-taking (NT), memory and concentration (MC), and lecture structure (LS). Questions were answered using a four-response Likert scale (1=Poor, 2=Satisfactory, 3=Good, and 4=Excellent). Due to the necessity of identifying the psychometric characteristics of the observed questionnaire, the Rating Scale Rasch model, structural equation modeling, and correlation analyses were used (Aryadoust, Goh, & Lee, 2012). The questionnaire, administered in English, was distributed through the Google One Drive platform. Participants were assured of anonymity and voluntary participation, with no time restrictions. The study adhered to the Declaration of Helsinki guidelines. The study was conducted from December 2022 to February 2023.

Statistical analysis

Data were presented as mean and standard deviation for each gender. The Kolmogorov-Smirnov test was used to assess normality. Levine's test checked for homogeneity of variances, and a t-test for independent samples determined gender differences in questionnaire items. For those items that were deviated significantly from the normal distribution, Mann-Whitney U test together with continuity correction was used. Type I error was set at $p < 0.05$. Statistical analysis was performed using Statistica 14.0 software (Cloud Software Group, Inc. (2023). Data Science Workbench, ver. 14.).

RESULTS AND DISCUSSION

Prior to the statistical analysis, the Kolmogorov-Smirnov test revealed that most of the items had a distribution that did not deviate significantly from a normal distribution ($p>0.20$), so parametric analysis was used for those variables. Table 1 consists of t-test for independent samples results. In doing so, Levene's test for homogeneity of variances was applied.

Table 1: using t-test for independent samples (95% confidence interval for mean values-95% CI, test statistics- t value, level of statistical significance-p, test statistics for homogeneity of variance-F ratio, level of statistical significance for Levene's test-p Levene).

Items	Female M±SD	Male M±SD	95% CI	t-value	p	F-ratio	p Levene
1	3.38±0.63	3.35±0.80	-0.25±0.31	0.23	0.82	1.63	0.08
2	2.94±0.67	2.85±0.66	-0.16±0.35	0.70	0.48	1.04	0.89
4	3.21±0.54	3.30±0.69	-0.32±0.15	-0.70	0.48	1.66	0.07
5	2.87±0.69	2.98±0.63	-0.37±0.14	-0.91	0.37	1.19	0.53
6	3.02±0.67	3.20±0.71	-0.45±0.08	-1.37	0.17	1.12	0.68
7	3.06±0.73	3.07±0.70	-0.29±0.26	-0.12	0.91	1.08	0.77
8	2.75±0.65	2.91±0.78	-0.44±0.12	-1.12	0.26	1.44	0.19
9	3.23±0.67	3.26±0.78	-0.31±0.25	-0.20	0.84	1.34	0.29
10	3.10±0.66	3.17±0.84	-0.36±0.22	-0.48	0.63	1.60	0.09
11	2.69±0.76	2.96±0.78	-0.57±0.02	-1.82	0.07	1.06	0.84
12	2.85±0.67	3.04±0.75	-0.47±0.08	-1.38	0.17	1.26	0.40
13	3.00±0.79	3.07±0.72	-0.37±0.22	-0.50	0.62	1.20	0.51
14	3.23±0.65	3.33±0.70	-0.36±0.16	-0.78	0.44	1.18	0.56
15	2.96±0.84	2.93±0.82	-0.28±0.36	0.22	0.83	1.05	0.87
17	3.12±0.65	3.15±0.66	-0.28±0.22	-0.26	0.80	1.03	0.92
18	2.77±0.70	3.02±0.76	-0.53±0.03	-1.75	0.08	1.18	0.55
19	2.65±0.76	2.91±0.76	-0.55±0.04	-1.71	0.09	1.01	0.96
20	2.83±0.71	3.20±0.71	-0.65±0.10	-2.74	0.01	1.01	0.97
22	2.79±0.75	2.87±0.73	-0.37±0.20	-0.57	0.57	1.06	0.83
23	2.88±0.70	3.02±0.71	-0.41±0.14	-0.97	0.33	1.03	0.93
24	2.92±0.65	3.02±0.63	-0.34±0.15	-0.77	0.44	1.07	0.80
25	2.85±0.70	2.89±0.69	-0.31±0.22	-0.32	0.75	1.02	0.95
26	2.63±0.74	2.89±0.77	-0.55±0.04	-1.73	0.09	1.07	0.80
27	2.83±0.68	2.83±0.80	-0.29±0.28	-0.04	0.96	1.38	0.26
28	2.81±0.69	3.06±0.81	-0.54±0.04	-1.70	0.09	1.39	0.24
29	2.79±0.67	2.94±0.76	-0.43±0.12	-1.12	0.27	1.31	0.34
30	2.67±0.71	2.81±0.75	-0.42±0.14	-1.00	0.32	1.14	0.64
31	2.67±0.79	2.83±0.69	-0.45±0.12	-1.11	0.27	1.28	0.37
32	2.60±0.75	2.76±0.78	-0.46±0.13	-1.10	0.27	1.08	0.80
33	2.67±0.81	2.81±0.75	-0.44±0.16	-0.93	0.35	1.15	0.61
34	2.83±0.81	2.80±0.81	-0.28±0.34	0.19	0.85	1.00	1.00
35	2.81±0.74	3.06±0.71	-0.53±0.03	-1.76	0.08	1.09	0.76
36	2.88±0.65	2.94±0.71	-0.32±0.20	-0.45	0.65	1.21	0.49
38	2.92±0.76	3.07±0.77	-0.45±0.15	-1.01	0.31	1.03	0.92
39	2.75±0.71	2.94±0.76	-0.48±0.09	-1.36	0.18	1.15	0.61
40	2.83±0.68	2.80±0.76	-0.25±0.31	0.22	0.83	1.26	0.40

42	*2.71±0.70*	*2.85±0.76*	*-0.42±0.14*	*-0.99*	*0.33*	*1.20*	*0.51*
43	*2.85±0.75*	*3.00±0.75*	*-0.44±0.14*	*-1.05*	*0.29*	*1.00*	*0.99*
44	*2.71±0.75*	*2.76±0.75*	*-0.34±0.24*	*-0.33*	*0.74*	*1.00*	*0.99*
45	*3.08±0.68*	*3.04±0.67*	*-0.22±0.30*	*0.30*	*0.76*	*1.03*	*0.92*
46	*2.83±0.76*	*2.80±0.79*	*-0.27±0.33*	*0.20*	*0.84*	*1.07*	*0.81*
47	*2.88±0.81*	*2.89±0.74*	*-0.30±0.29*	*-0.03*	*0.98*	*1.18*	*0.55*

Legend: M±SD-Mean ± Standard Deviation

Items, When I am listening in English, I can: 1. understand numbers, commonplace names, and short phrases in Standard English easily; 2. 2. often remember much of the content of the lecture a day later; 3. concentrate on the lecture without being distracted by my own thoughts; 4. understand simple descriptions given by my professors about familiar persons, places, and objects; 5. understand the language of short oral reports of events and biographical info; 6. understand short and simple technical descriptions; 7. understand the language expressing personal likes and dislikes without reference to a dictionary; 8. understand oral reports about current and past events; 9. generally understand simple descriptions of feelings and wishes; 10. understand radio and TV news programs without major problems; 11. understand meanings that are not directly stated in lectures/seminars/tutorials; 12. easily get clues from the slides to understand lectures/seminars/tutorials better; 13. understand the main ideas and facts of lectures; 14. understand important names, dates, and numbers in lectures/seminars/tutorials; 15. easily take notes of important details of lectures/seminars/tutorials; 16. understand the language relevant to professional needs without reference to a dictionary; 17. understand details of short descriptions of places, people, and events that I know; 18. understand lectures/tutorials /seminars better whenever the lecturers signal when they are going to go on to another topic; 19. understand the meaning and the purpose of most idioms, cultural references, word play, and irony; 20. tell apart the language of humorous anecdotes and jokes from facts; 21. understand simple descriptions about familiar persons, places, and objects given by other students with a different first language than mine; 22. understand the lecturers who are non-native English speakers better than the native speakers; 23. relate the description of an object to a map; 24. understand the language expressing spatial relationships and directions; 25. understand the relationships among the ideas in a lecture; 26. distinguish main points of lectures/tutorials/seminars from details; 27. connect the information of the lecture with my textbook and handouts; 28. understand the lecture/ tutorial/seminar format—how it starts, continues, and ends; 29. rephrase the content of the lecture and then take notes on it; 30. understand facts without being concerned about distinguishing main points from details in a lecture/ tutorial/seminar; 31. follow the hypothesis, persuasion, or argument in lectures/ tutorials/seminars; 32. keep up with and understand lecturers/tutors who speak fast; 33. summarize the info. from lectures/ tutorials/seminars; 34. recognize incorrect grammar and vocabulary when listening to my peers speaking English; 35. understand key vocabulary items when listening to a lecture/ tutorial/seminar; 36. understand how different ideas in a lecture relate to each other; 37. distinguish between supporting examples and major points easily; 38. identify the main topic of the lecture; 39. understand lectures/tutorials/seminars better if they are delivered in formal language with fewer jokes and anecdotes; 40. correct my understanding of lectures/tutorials/ seminars immediately if my understanding is incorrect; 41. identify the purpose and scope of lectures/tutorials/seminars; 42. distinguish between information that is relevant or irrelevant to the main points in lectures/tutorials/ seminars; 43. tell when the lecturer/tutor is about to start a new topic; 44. concentrate on lectures/tutorials/seminars without being distracted by people, things, and sounds around me in the room; 45. understand simple descriptions given in English about familiar persons, places, and objects by students with the same first language as me; 46. paraphrase the lecture/tutorial/seminar content to take notes of it; 47. understand the main ideas and important facts of conversations about academic subjects in lectures/ tutorials/seminars.

Table 2: Gender differences in ALSA items using nonparametric statistics (test statistics-U, Z, level of statistical significance-p).

Items	*U*	*Z*	*p*
3	*1262.50*	*-0.89*	*0.33*
16	*1139.00*	*-1.67*	*0.07*
21	*1298.00*	*-0.67*	*0.45*
37	*1243.00*	*-1.01*	*0.26*

41	*1309.50*	*-0.59*	*0.51*

From the obtained results, we read that the only statistically significant difference has been determined in the item 20 ('*When I am listening in English, I can tell apart the language of humorous anecdotes and jokes from facts*') which belongs to the cognitive component factor. Even more, we notice that items 11 and 19 are also very close to being statistically significant, and, like item 20, belong to the cognitive component factor. From the aforementioned item results, we read male students use more of cognitive skills than females. This comes as a surprise since some studies emphasize that women are better in cognitive abilities, are more successful in listening performance, and relate prior language knowledge easier with the understanding of new contents than men (Tatarinceva; 2009; Baleghizadeh & Rahimi, 2011; Deb, 2020). Men, on the other hand, are better in using language in describing objects or giving directions (Kheder & Rouabhia, 2023). Namely, we believe that different factors might have attributed to these results: different socio-cultural factors, motivation factors, learning environment factors or the lack of the right opportunity to learn languages. And although we cannot say that the obtained results indicate that gender can be a predictor of the students' overall academic listening skills proficiency, i.e. of the level of their listening comprehension outcome, they provide an understanding of students' academic listening skills needs and abilities. Knowing the differences (both between genders and between particular micro-skills), may help teachers create adequate teaching material that would guide students to take better control of their comprehension and learning process as well as help them overcome general listening skills challenges they are faced with in the process of achieving proficient L2 academic listening skills.

CONCLUSION

After employing a standardized measure to assess the students' awareness of their academic listening skills, we conclude that there are gender differences in students' usage of the academic listening micro-skills but those differences do not play any essential role in predicting their future listening comprehension achievements. To address this concern more precisely, future research should correlate students' self-rating results with their individual performance on the standardized listening tests (for instance, IELTS).

Nevertheless, due to its underlying structure and the potential to raise university students' awareness of their general listening skills, we believe the self-rating method and the ALSA questionnaire should be adopted into the learning curricula in all university contexts. Namely, applying ALSA to such environments can also help students improve their independent learning and foster their autonomy.

Finally, we believe that the results of the study might serve as guidelines to universities authorities to become more aware of student challenges and the need for the adequate language learning support system.

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The Impact of Different Distance Measure on Cluster Structure In Quantitative Research In Kinesiology

*Igor Jelaska[1]

[1]Faculty of Kinesiology, University of Split, Split, Croatia

*Corresponing author

ABSTRACT

It is well known that various clustering techniques are standard tools in sport science and kinesiology, there is no empirical data on impact of different distance measures on final outcome in quantitative research, especially in kinesiology. On the sample of 39 examinees Cluster analysis was applied under Wards amalgamation rule and different six different metric functions: *Euclidean distance*, *Manhattan distance*, *Chebychev distance*, *power distance*, *percent disagreement distance* and *1-pearson r* distance. Although similar cluster structures have been obtained using different metric functions, if using generated clusters further in research different results can be associated to different metric function. Results are pointing to the fact that *percent disagreement distance* and *1-pearson r* distance provide most different cluster structures. It has also been concluded that structure of the clusters have to be observed independently of calculated distance scales. It is recommended that researchers while using cluster analysis techniques provide additional info on reasons why particular metric function and amalgamation rule is used. That information can reduce possible ambiguities and misleading conclusions and also can give additional insight into methodological appropriateness and limitations of observed as well as future researches.

Keywords: tree joining, dendogram, metric function, similar clusters, quantitative research

INTRODUCTION

Cluster analysis is multivariate exploratory technique which goal is to join set of objects (variables or examinees) into relatively homogenous groups called clusters due to their similarity or precisely speaking, distance function (Prelic et al., 2006). As methodological tool, cluster analysis is unavoidably used in various scientific disciplines: sport sciences (Finch et al., 2015; Gucciardi, Mahoney, Jalleh, Donovan, & Parkes, 2012; Kingsland et al., 2015; Noordhof, Mulder, de Koning, & Hopkins, 2015), biology , environmental studies (Hernandez-Ceballos, Cinelli, Tollefsen, & Marin-Ferrer, 2016), pharmacy (Leonard & Droege, 2008), bioinformatics (Cordero et al., 2011; Pavlopoulos, Moschopoulos, Hooper, Schneider, & Kossida, 2009; Schonherr et al., 2012; Shamir et al., 2005), data mining, machine learning, pattern recognition, image analysis and many other. There are several approaches to data clustering: tree clustering, k-means clustering, and two-way clustering. Also, lots of scientific approaches is trying to optimize existing clustering algorithms. For example, the existing methods are not readily applicable for the problems that demand high stringency (Kim, Chitturi, & Grishin, 2012)

Cluster analysis algorithm begins with calculation of distances between all objects that are being clustered. Concept of distance, although intuitively “clear“ term (when thinking in terms of Euclidean distance), can be considered as relatively abstract. Mathematically, a distance on a arbitrary set E is a function defined

$$d: E \times E \rightarrow R$$

where R is the set of real numbers, and for all $x, y, z \in E$ the following conditions (axioms) are satisfied:

1. *Axiom of positivity:* $d(x, y) \geq 0$
2. *Coincidence axiom*: $d(x, y) = 0 \quad \textit{if and only if} \;\; x = y$
3. *Symmetry axiom:* $d(x, y) = d(y, x)$
4. *Triangle inequality axiom:* $d(x, z) = d(x, y) + d(y, z)$

Distance between objects are elements of distance matrix **D**. If dealing with n objects to be clustered, distance matrix has n rows and n columns and have 0's on the diagonal. If we use notation for i[th] and j[th] object e_i and e_j respectively, then following statement holds:

$$a_{i,j} \in \mathbf{D} \Rightarrow a_{i,j} = d(e_i, e_j)$$

where d is distance between e_i and e_j.

There are different possibilities of defining distance function d that satisfies axioms (1)-(4). Some possibilities are Euclidean distance, Manhattan distance, Chebychev distance, power distance, percent disagreement distance and 1-pearson r distance. More precisely,

Euclidean distance is defined as

$$d(e_i, e_j) = \sqrt{(x_1 - y_1)^2 + (x_2 - y_2)^2 + \cdots + (x_m - y_m)^2} = \sqrt{\sum_{k=1}^{m} (x_k - y_k)^2}$$, Manhattan (taxi cab) distance is defined as $d(e_i, e_j) = |x_1 - y_1| + |x_2 - y_2| + \cdots |x_m - y_m| = \sum_{k=1}^{m} |x_k - y_k|$, Chebychev distance is defined as $d(e_i, e_j) = \max(|x_1 - y_1|, |x_2 - y_2|, \ldots, |x_m - y_m|) = \max_{k=1,\ldots,m} (|x_k - y_k|)$, power distance with parameters r and p is defined as

$$d(e_i, e_j) = \sqrt[r]{|x_1 - y_1|^p + |x_2 - y_2|^p + \cdots |x_m - y_m|^p} = \sqrt[r]{\sum_{k=1}^{n} |x_k - y_k|^p}$$, percent disagreement is defined as

$$d(e_i, e_j) = \frac{\operatorname{sgn}|x_1 - y_1| + \operatorname{sgn}|x_2 - y_2| + \cdots + \operatorname{sgn}|x_m - y_m|}{m} = \frac{\sum_{k=1}^{m} \operatorname{sgn}|x_k - y_k|}{m}$$

and 1-pearson r distance is defined as $d(e_i, e_j) = \frac{\operatorname{cov}(e_i, e_j)}{\sigma_i \sigma_j} = 1 - r(e_i, e_j)$.

It can be seen that Euclidean and Manhattan Distance are special cases of *Power distance*. Due to that fact, it can be assumed that cluster structure obtained with them will be similar.

Although there is scientific debate on issues of different metric functions in various applied sciences (Finch, 2005; Wierzchoń & Kłopotek, 2015) none of such exist in kinesiology and/or sport sciences.

Taking into account all abovementioned, goal of this research is to provide and compare generated clusters id dependance of metric function.

METHODS

The research was realized by using the sample of 39 examinees aged 10-11 years. Parents of all participants were introduced to the goals of the study and were informed that participant can quit anytime without any penalties, All measurement were done in complete accordance with Helsinki declaration. The sample of variables used were 7 variables standardly used in kinesiology identification of basic fitness status: situps (MDTR), held part in the hang (MVIS), side steps (MKUS), polygon backwards (MPOL), straddle forward bend (MPRR), hand-tapping (MTAP), long jump from a standstill (MSDM). All the measurements were done by experienced kinesiologists who had experience in collecting aforementioned data. Tree joining cluster analysis was applied under Wards amalgamation (linkage) rule and six different metric functions: *Euclidean distance*, *Manhattan distance*, *Chebychev distance*, *power distance*, *percent disagreement distance* and *1-pearson r* distance. Dendogram was provided for each of the metric function. All calculations have been done used software package for statistical calculations Statistica 14.0.1.8. (Cloud Software Group, Inc. (2023). Data Science Workbench)

RESULTS AND DISCUSION

Figures 1-6 present dendogram of Cluster analysis for different distance measures: *Euclidean distance*, *Manhattan distance*, *Chebychev distance*, *power distance*, *percent disagreement distance* and *1-pearson r* distance.

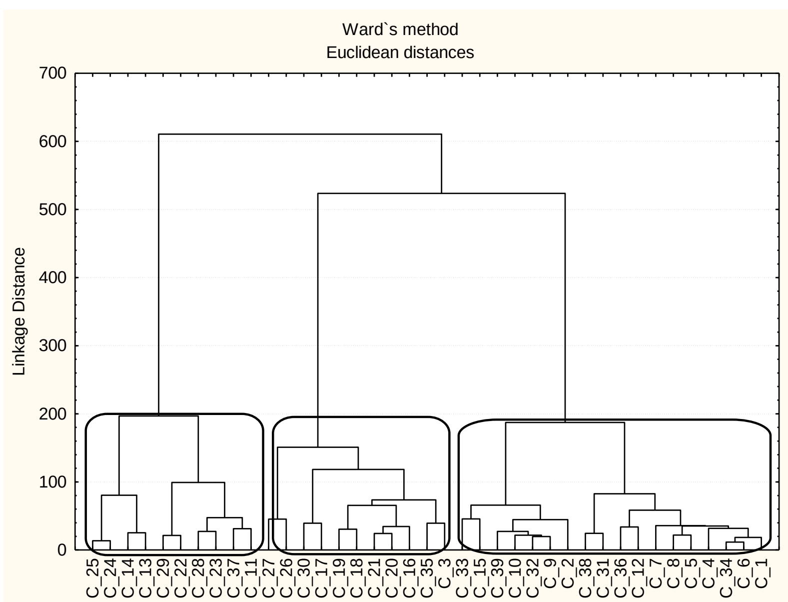

Figure 1: Cluster analysis dendogram for *Euclidean* distance

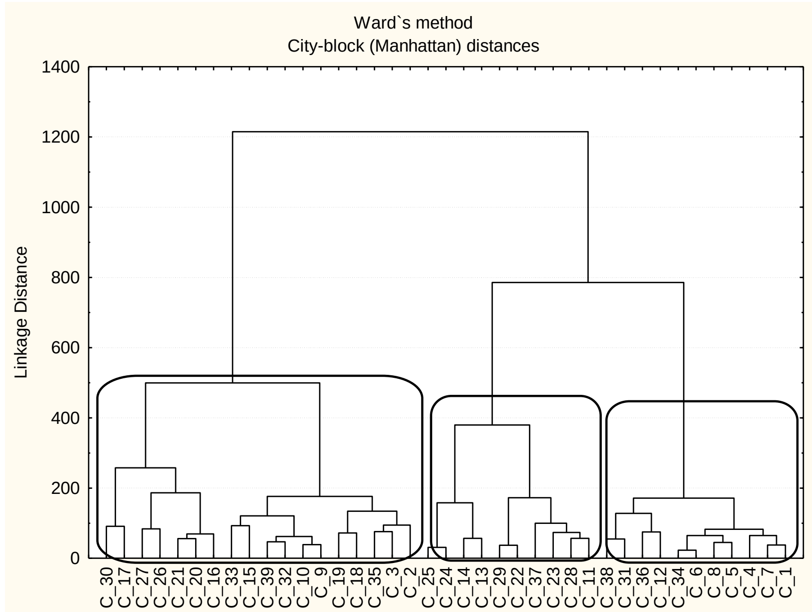

Figure 2: Cluster analysis dendogram for *Manhattan* distance

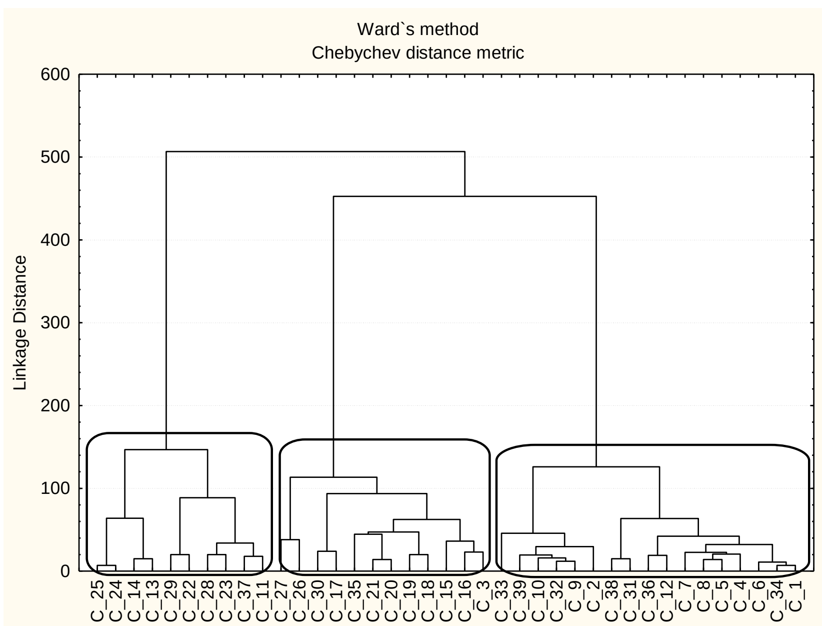

Figure 3: Cluster analysis dendogram for *Chebychev* distance

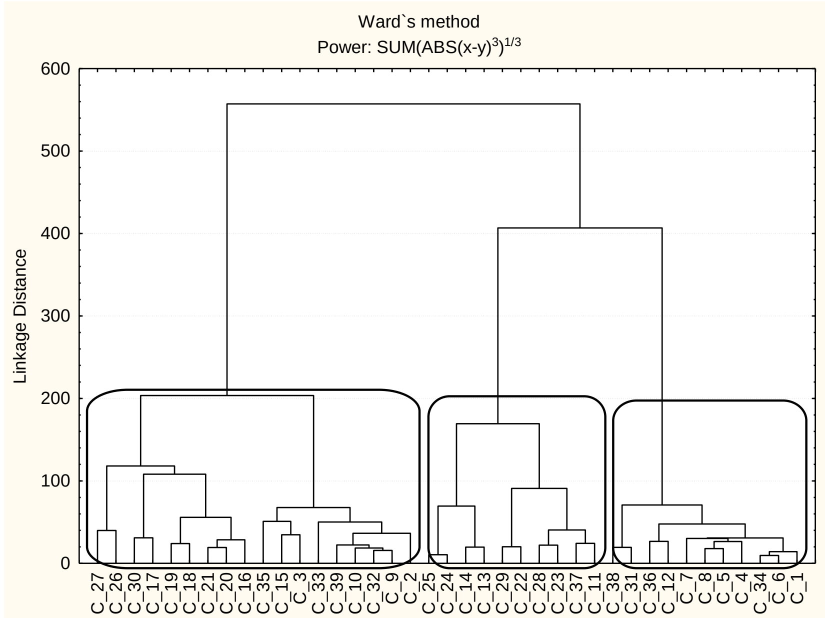

Figure 4: Cluster analysis dendogram for *Power distance* (r=p=3)

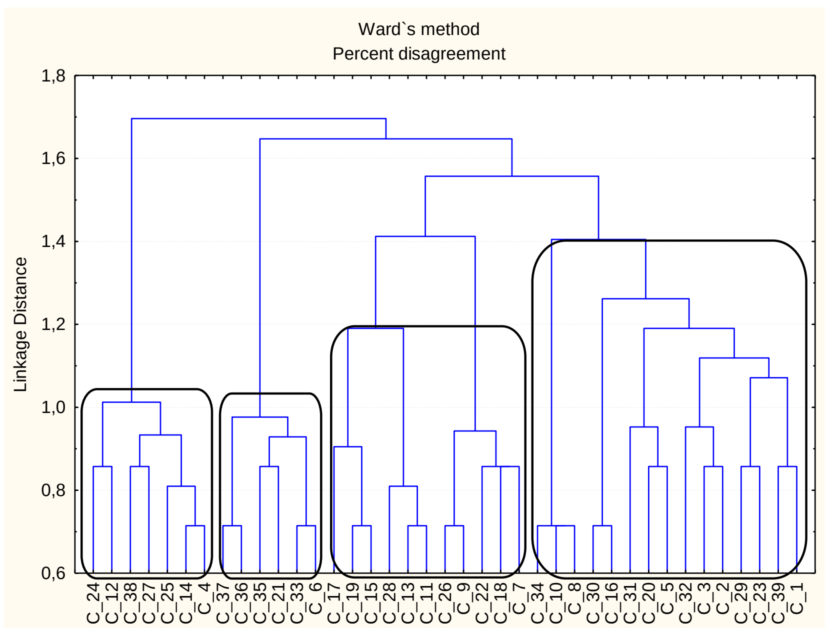

Figure 5: Cluster analysis dendogram for *Percent disagreement* distance

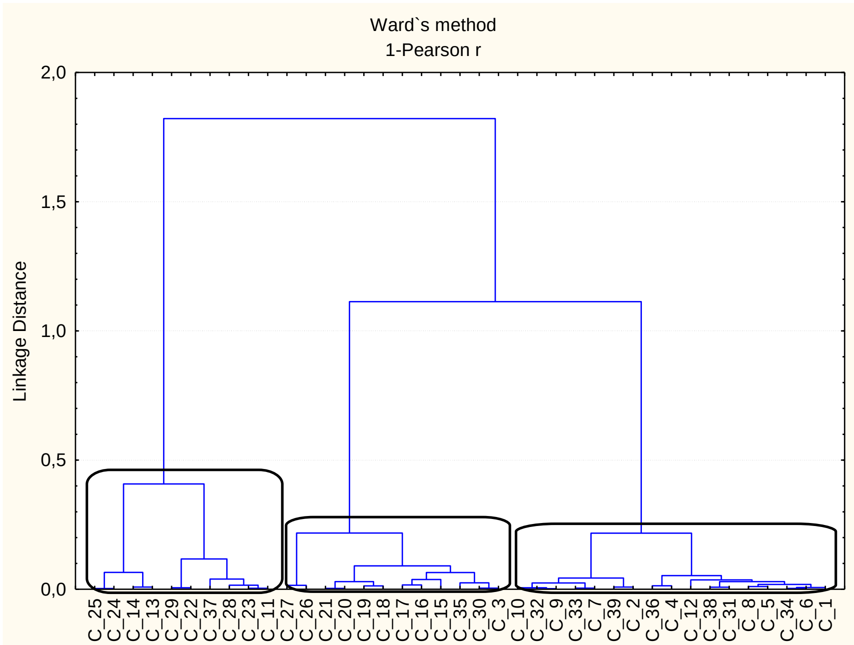

Figure 6: Cluster analysis dendogram for *1-Pearson r* distance

Obtaining insight from Fig.1 – Fig.6. it can be seen that although relatively similar cluster structures have been generated using *Tree joining* techniques, differences are visible. More precisely, scales of distances are essentially different: 700, 1400, 600, 600, 18, and 2 for *Euclidean distance*, *Manhattan distance*, *Chebychev distance*, *power distance*, *percent disagreement distance* and *1-pearson r* distance, respectively. That fact is pointing to the fact that analysis has to be independent of obtained distances of sub-clusters. Also, it can be noted that if researcher is using clusters further as for example, grouping variable in univariate or multivariate difference analysis, different results can be obtained using different metric function. It has been visible that *percent disagreement distance* and *1-pearson r* distance provide most different cluster structures.

CONCLUSION

Results are pointing to the fact that researchers especially in kinesiology and/or sport sciences while using different cluster analysis techniques and approaches, to avoid possible ambiguousness, should provide additional info on reasons why particular metric function and amalgamation rule is used. Those data can give additional insight into methodological appropriateness and limitations of observed as well as future researches in kinesiology but also in general. Finally, it have to be underlined that interpretations and further applications of obtained clusters, especially in applied kinesiology have to be independent of distance scale.

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The Effect of Match Location on Running Performance of Elite Soccer Teams Competing in The UEFA Champions League

*Toni Modrić[1]

[1]Faculty of Kinesiology, University of Split, Split, Croatia

*Corresponding author

ABSTRACT

This study aimed to examine the effect of match location on the match running performance (MRP) of UEFA Champions League (UCL) players. The MRP data for outfield players was collected from all teams (n = 32) participating in all matches (n = 125) of the UCL 2022/23 season using an optical tracking system. The MRP variables included total distance covered (TD), low-intensity running (LIR), moderate-intensity running (MIR), and high-intensity running (HIR). A linear mixed model was adjusted to examine the effect of match location on MRP. Cohen's d (d) was used to identify effect sizes. The results showed no difference in TD (d = 0.09), LIR (d = 0.03), and MIR (d = 0.05) irrespective playing at home or away. On the other hand, UCL teams achieved significantly greater HIR at home compared to away matches (d = 0.38). These findings indicated that UCL teams exhibit similar TD, LIR, and MIR irrespective of whether they are playing at home or away but greater HIR at home compared to away matches. This study demonstrated that the overall running workload of most elite soccer teams remained similar irrespective of the match location, while the intensity of exertion increased when playing at home.

INTRODUCTION

Soccer, a complex team sport, is known for its high physical demands (Barnes, Archer, Bush, Hogg, & Bradley, 2014). To comprehend these demands, match running performance (MRP) is often analyzed by measuring the total distance covered, the distances covered at various speeds, and the rates of acceleration (Mallo, Mena, Nevado, & Paredes, 2015). Previous research on MRP in soccer has shown that elite players can cover distances ranging from 9 to 14 km per match, including 0.7 to 3.9 km of high-speed running and 0.2 to 0.6 km of sprinting (Modric et al., 2023). Sports scientists and performance analysts primarily utilize MRP data to assist coaches and practitioners in making informed decisions regarding the structuring of training elements and match preparation (Aquino et al., 2020). However, interpretation and application in practice can be hampered due to the high match-to-match variability in MRP (Carling, Bradley, McCall, & Dupont, 2016). For this reason, it is essential to understand the factors affecting MRP.

Empirical evidence demonstrated that myriad factors may affect MRP, including match location (Trewin, Meylan, Varley, & Cronin, 2017). Theoretically, familiar surroundings, support from local fans, reduced travel fatigue, and psychological comfort can boost players' motivation and adrenaline, potentially leading to enhanced MRP. However, research investigating MRP according to the match location has reported inconsistent findings. For example, García-Unanue et al. analyzed professional first-division soccer players from Spanish La Liga and reported their increased total distance during away matches (García-Unanue et al., 2018). Despite investigating also professional first-division soccer players, Barrera et al. revealed increased total distance at home matches in Portuguese Primeira Liga (Barrera, Sarmento, Clemente, Field, & Figueiredo, 2021).

The possible explanation for such inconsistent findings may be a different sample used. Specifically, most of the studies investigating MRP according to match location analyzed teams belonging to only one country (Barrera et al., 2021; García-Unanue et al., 2018). Therefore, the results were undoubtedly influenced by the geographical, cultural, historical, and social aspects of the observed countries (Sapp, Spangenburg, & Hagberg, 2018). For this reason, analysis of the MRP of teams from different countries according to match location is warranted. One of the most elite competitions that includes teams from different countries is the UEFA Champions League (Toni Modric et al., 2023). Therefore, this study aimed to examine the effect of match location on the MRP of UCL players.

METHODS

Sample

The MRP data for outfield players was collected from all teams (n = 32) participating in all matches (n = 125) of the UCL 2022/23 season. Due to poor-quality data, three matches were initially excluded, leaving 122 matches for the final analysis. From each match, two observations were considered (one for the home and one for the away team), resulting in a total retrieval of 244 teams' observations which were used as cases. All data were anonymized following the principles of the Declaration of Helsinki to ensure confidentiality. The study was approved by the local university ethics board. As the data used in this research were gathered as part of the players' routine monitoring, informed consent was not required.

Procedures

The MRP data were collected using the Player & Ball Tracking System by Hawk-Eye Innovations Limited (Basingstoke, England). The system's reliability was evaluated using the official Electronic and Performance Tracking Systems (EPTS) test protocol established by the Fédération Internationale de Football Association (FIFA). The MRP variables included total distance covered (TD) (km), low-intensity running (LIR) (km) (< 15 km/h), moderate-intensity running (MIR) (km) (15–20 km/h), and high-intensity running (HIR) (km) (> 20 km/h).

Statistical analysis

A linear mixed model was adjusted to examine the effect of match location on MRP. For this purpose, the two-level categorical variable "match location" (coded as "1" or "2" for home or away observations, respectively) was created and introduced into the model as a fixed effect. Players' identities were modeled as random effects to account for the repeated measures. The assumptions of homogeneity and normal distributions of residuals were verified through the use of residuals vs fitted plots and Q-Q plots, without revealing specific problems. The main effect comparison of match location was summarized using the least significant difference (LSD). Cohen's d was used to identify effect sizes (ES) and interpreted as follows: <0.2, trivial; 0.2–0.6, small; 0.6–1.2, medium; 1.2–2.0, large; and >2.0, very large (Cohen, 2013). All the analyses were performed using the SPSS software (IBM, SPSS, version 25.0), and the significance level was set to $p < 0.05$.

RESULTS AND DISCUSSION

The results showed no difference in TD (110,765.21 vs 110,579.14 m; trivial ES), LIR (84780.13 vs 84817.9 m; trivial ES), and MIR (16,790.71 vs 16,752.69 m; trivial ES) irrespective playing at home or away. On the other hand, UCL teams achieved significantly greater HIR at home compared to away matches (9,195.42 vs 9,007.5 m; small ES) (Tables 1 and 2).

Table 1. Descriptive statistics for MRP according to the match location (data are given as mean±SE)

	Home	*Away*
TD (m)	*110,765.21±493.03*	*110,579.14±493.03*
LIR (m)	*84,780.13±342.3*	*84,817.9±342.3*
MIR (m)	*16,790.71±170.15*	*16,752.69±170.15*
HIR (m)	*9,195.42±105.98*	*9,007.5±105.98*

TD – total distance; LIR - low-intensity running; MIR – moderate-intensity running; HIR – high-intensity running

Table 2. Differences in MRP according to the match location

	Estimate	*SE*	*df*	*t-value*	*p-value*	*ES*
TD						
Intercept	*110579.14*	*493.03*	*163.84*	*224.28*	*0.00*	
Match location: Home	*186.07*	*388.38*	*121.73*	*0.48*	*0.63*	*0.09*
LIR						
Intercept	*84817.90*	*342.30*	*164.65*	*247.79*	*0.00*	
Match location: Home	*-37.77*	*271.93*	*121.75*	*-0.14*	*0.89*	*0.03*
MIR						
Intercept	*16752.68*	*170.15*	*168.09*	*98.46*	*0.00*	
Match location: Home	*38.02*	*139.92*	*121.80*	*0.27*	*0.79*	*0.05*
HIR						
Intercept	*9007.50*	*105.98*	*171.18*	*84.99*	*0.00*	
Match location: Home	*187.92*	*89.70*	*121.87*	*2.10*	*0.04*	*0.38*

SE – standard error; df – degrees of freedom, ES – effect size; TD – total distance; LIR - low-intensity running; MIR – moderate-intensity running; HIR – high-intensity running

These findings indicated that UCL teams exhibit similar TD, LIR, and MIR irrespective of whether they are playing at home or away. Specifically, the TD was almost identical (110,765.21 meters at home vs. 110,579.14 meters away), with a trivial ES, suggesting that the overall physical demands do not significantly change based on the venue. Similarly, LIR and MIR distances also showed negligible differences with trivial ES, further reinforcing the notion that the primary running patterns of UCL teams remain consistent regardless of the home or away setting. This consistency could be attributed to the high level of professionalism and fitness standards in UCL teams (Modric et al., 2023), which likely ensure that players maintain similar levels of performance regardless of the venue. Such findings are in line with some previous research in elite soccer which demonstrated that players maintain a consistent level of physical output in terms of overall distance covered, irrespective of match location (Lago, Casais, Dominguez, & Sampaio, 2010).

However, a notable exception to this pattern is observed in the HIR metrics. The study found that UCL teams achieved significantly greater HIR at home compared to away matches (9,195.42 meters at home vs. 9,007.5 meters away), with a small ES. This finding suggests that while the overall running workload remains similar, the intensity of exertion increases when playing at home. This could be attributed psychological advantages of playing at home, such as familiar surroundings, supportive fans, and the absence of travel fatigue (Staufenbiel, Lobinger, & Strauss, 2015), which might boost players' motivation and energy levels, leading to more frequent and intense high-speed and sprint runs. Home teams may also adopt more aggressive tactics, pressing opponents higher up the pitch and engaging in more high-intensity sprints, leveraging the support of the home crowd. Conversely, away teams might adopt a more conservative approach, focusing on defense and counter-attacking, which might reduce the opportunities for high-intensity running.

These findings have important implications for training and match preparation. Coaches and trainers might consider these dynamics when planning training sessions, emphasizing high-intensity running drills more for home matches to capitalize on the natural advantage and preparing strategies to counteract the potential decline in HIR during away matches. Additionally, understanding that overall distance and lower-intensity running remain stable can help in maintaining a consistent fitness regimen without overemphasizing these aspects based on the venue.

CONCLUSION

In summary, while UCL teams demonstrate similar physical demands in terms of total distance, low-intensity, and moderate-intensity running regardless of match location, there is a significant increase in high-intensity running during home games. This distinction underscores the influence of psychological and tactical factors associated with playing at home, highlighting the need for tailored training and strategic approaches to maximize performance in different venues. Future research could delve deeper into the psychological aspects influencing these physical performance metrics and explore interventions that could mitigate the differences observed in high-intensity running between home and away matches.

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Parental Attitudes on Preschool Children's Participation in Organized Sports

Hrvoje Sivrić[1]*, Lea Tomić[1]

[1]University of Slavonski Brod, Slavonski Brod, Croatia

ABSTRACT

The main scope of the research is to determine the differences in parents' attitudes towards their preschool children's active participation in organized sports activities outside kindergarten. It hypothesizes that parents of children who participate in organized sports hold distinct attitudes compared to parents of non-active children. The sample consisted of 246 parents with an average age of 35.09±5.67. Parents were categorized into two groups: those with children who actively participate in organized sports and those with children who do not. Respondents completed an online questionnaire using a 5-point Likert scale to indicate their degree of agreement with various statements. Canonical discrimination analysis revealed a statistically significant difference between the two groups (CanR=0.50, p=0.00). The results indicate that parents of active children place a higher importance on their child's participation in organized sports, are more likely to encourage physical activities outside kindergarten and have a greater awareness of the need for physical activity. These findings underscore the crucial role of parental attitudes and behaviours in fostering children's involvement in organized sports. Encouragement and the perceived importance of sports activities are central to whether children engage in these activities. Efforts to increase children's participation in sports should focus not only on the children but also on educating and motivating parents about the benefits of sports. By enhancing parental awareness and support, a more conducive environment for children's active participation in sports can be created, promoting healthier and more active lifestyles.

Keywords: physical, assessment, awareness, difference, active

INTRODUCTION

The increasing prevalence of disorders such as obesity and stress among young people underscores the urgent need for improved kinesiology programs to promote physical activity and well-being from an early age (Prskalo et al., 2010). Encouraging physical activity in preschool children is essential for establishing lifelong healthy habits, as emphasized by Heimer and Sporiš (2022). Engaging children in organized sports outside kindergarten can play a significant role in fostering these habits. Research has shown that educating parents about the importance of spending quality free time can address the problem of insufficient engagement in educational and creative activities (Ginsburg, 2007; Hofferth & Sandberg, 2001). Quality planned and organized activities are crucial for the optimal growth and development of children (Trajkovski et al., 2004). Given that play is a fundamental right of the child and not merely a reward or punishment (Findak & Delija, 2001), it is vital to integrate physical activities into their daily routines. Physically active children tend to be more resourceful, communicative and better equipped to handle various tasks (Starc et al., 2004). Findak and Delija (2001) have highlighted the importance of a well-structured physical exercise program for pre-schoolers, which should be tailored to their developmental needs and include diverse activities and games. Moreover, Ginsburg et al. (2019) emphasize that play strengthens parent-child bonds, with sports being a significant part of this interaction. The role of parents in fostering their children's physical activity is critical. Blažević et al. (2012) have shown that joint participation in games and sports significantly contributes to children's development. Preschools and families play key roles in promoting physical activity, crucial for preventing physical inactivity-related risks, which are among the leading causes of death worldwide (Tomac et al., 2015). The family, as the closest social environment, has a driving and stimulating role in most activities, including physical activity (Andrijašević, 2010). Filipović (2012) reinforces this by asserting that parents are the cornerstone of safe and quality child development in all aspects, including sports. Recent studies by Filipović (2012) further highlight that parental attitudes towards sports are a crucial factor in encouraging children's active participation in sports activities. Participation in sports activities is vital for health protection and disease prevention in children (Heimer & Sporiš, 2022). The aim of this paper is to determine the differences in parents' attitudes towards their preschool children's active participation in organized sports activities outside kindergarten. It is hypothesized that parents whose children actively participate in organized sports activities outside kindergarten will differ in certain factors of influence and attitude. Understanding these differences is crucial for children's participation in physical activities, thereby promoting healthier and more active lifestyles from an early age.

METHODS

Participants – The examinee sample consisted of 203 participants, with an average chronological age of 35,09±5,67 and an age range of 24 to 52 years. The participants were parents of preschool children, with the majority being female 91.63% (186) and a smaller proportion being male 8.37% (17). Regarding the observed children, 52.70% (107) were female and 47.30% (96) were male. According to the criterion of active participation of the child in organized sports activities outside kindergarten, the total sample was divided into two groups: SOD1 (1st group) included 57.14% (116) - parents of children who actively participate in organized sports activities outside kindergarten and SOD2 (2nd group) included 42.86% (87) - parents of children who do not actively participate in organized sports activities outside kindergarten. Variable sample – For the purposes of analyzing the differences in parents' attitudes towards their preschool children's active participation in organized sports activities outside kindergarten, a questionnaire containing a total of 40 items was used in this research. For this work, 12 items were analyzed. Apart from the categorical variable SOD - which represents the active participation of the child in organized sports activities outside kindergarten and the chronological age of the participants and children, the other variables were measured on a 5-point Likert scale (1=none to 5=exceptional). The variables used in this study are described as follows: DOB - age of the participants; POS - assessment of the level of awareness about the need to engage in physical activities in general in life; UZO - assessment of the importance of parental role models in encouraging the child's physical activity; PSU - encouraging children to participate in sports or physical activities outside kindergarten; SOS - assessment of the importance of child participation in organized sports activities; ZDR - assessment of information about the health benefits of regular physical activity for children; TAD - evaluation of supporting physical activity of the child as a means of preventing health problems; SPR - the importance of child participation in sports programs in kindergarten; INT - assessment of the importance of integrating sports activities into the regular kindergarten program for the overall development of the child; EDU - assessment of how often parents use games as a form of education and support in child development; OBI - assessment of participation in family activities that include physical activity. Methods of data processing – The results processing methods included the calculation of descriptive statistical parameters for all variables, such as the arithmetic mean (AS), standard deviation (SD), minimum (Min) and maximum (Max) scores, as well as the median (Med) and mode (Mod). To determine whether there are significant differences between the two groups, a canonical discrimination analysis was performed. Within the framework of the canonical discrimination analysis, the coefficient of canonical discrimination was determined, along with the position of the groups on the discriminant function and the correlation between the variables and the discriminant function. The significance of the coefficients of the canonical discriminant function was tested using Bartlett's test. The data were processed using the statistical package STATISTICA 13.0. Procedure – All participants voluntarily and anonymously filled out the online survey questionnaire. The questionnaire was administered from April 9 to April 23, 2024, during a period free from exam deadlines, holidays and vacation distractions. This timing allowed parents to more freely and realistically express their views and practices in raising preschool children.

RESULTS AND DISCUSSION

Table 1 presents descriptive indicators for the total sample and two parent groups based on children's participation in organized sports activities.

Table 1: Descriptive indicators of measuring variables

Var	*Total sample (N=246)*			*SOD1 (N=116)*			*SOD2 (N=87)*		
	AS±SD	*Min*	*Max*	*AS±SD*	*Min*	*Max*	*AS±SD*	*Min*	*Max*
DOB	*35.09±5.67*	*24*	*52*	*35.73±5.86*	*24*	*52*	*34.23±5.31*	*24*	*49*
POS	*3.61±0.97*	*1*	*5*	*3.77±1.00*	*1*	*5*	*3.40±0.88*	*1*	*5*
UZO	*4.41±0.69*	*2*	*5*	*4.45±0.66*	*2*	*5*	*4.36±0.71*	*2*	*5*
PSU	*4.02±0.90*	*1*	*5*	*4.34±0.68*	*2*	*5*	*3.60±0.97*	*1*	*5*
SOS	*3.82±0.90*	*1*	*5*	*4.08±0.78*	*1*	*5*	*3.47±0.93*	*1*	*5*
ZDR	*4.02±0.92*	*1*	*5*	*4.16±0.81*	*2*	*5*	*3.85±1.03*	*1*	*5*
TAD	*4.40±0.68*	*2*	*5*	*4.45±0.66*	*2*	*5*	*4.33±0.69*	*2*	*5*
SPR	*4.18±0.83*	*1*	*5*	*4.27±0.80*	*2*	*5*	*4.06±0.85*	*1*	*5*
INT	*4.24±0.76*	*2*	*5*	*4.27±0.74*	*2*	*5*	*4.21±0.78*	*2*	*5*
EDU	*3.86±0.72*	*2*	*5*	*3.84±0.75*	*2*	*5*	*3.87±0.68*	*2*	*5*
OBI	*3.95±0.90*	*1*	*5*	*3.97±0.88*	*2*	*5*	*3.92±0.93*	*1*	*5*

Apart from EDU - which measures how often parents use games for education, all average values are higher for SOD1 (parents of active children). The average value of all the average values of the observed variables for the groups is SOD1=4.16 and SOD2=3.91, indicating significant differences in attitudes. Parents of active children generally have more favourable attitudes towards physical and sports activities. In addition to EDU, the variation in results is higher for SOD2 (parents of non-active children) across most variables, except for POS - which assesses the level of awareness about the need to engage in physical activities. This suggests greater heterogeneity in the attitudes of these parents. The higher average value of all standard deviations in SOD2 (0.85) compared to SOD1 (0.78) reflects more varied responses and less consensus about the importance of physical activities. This contrasts with the more uniform attitudes of SOD1 parents, likely due to their children's active participation in sports, reinforcing positive attitudes and consistent practices regarding physical activity. POS - assessment of the level of awareness about the need to engage in physical activities had the lowest average value (POS=3.61), with SOD1=3.77 and SOD2=3.40, indicating a need for increased awareness about physical activities, especially among parents of non-active children. TAD - assessing physical activity as a means of preventing health problems, had the highest values (TAD=4.40 overall, SOD1=4.45, SOD2=4.33), showing strong recognition of health benefits. The average values for EDU - assessment of how often parents use play as a form of education and OBI - participation in family physical activities were below 4.00, with EDU=3.95 and OBI=3.85. This suggests that parents could improve in using play for education and participating in family physical activities, emphasizing the role of play and family involvement in fostering a child's development and active lifestyle. By creating a supportive environment for physical activity, parents can significantly enhance their children's health and well-being. Table 2 presents the differences in arithmetic means and results of canonical discriminant analysis between the two groups, demonstrating statistically significant distinctions (CanR=0.50, p=0.00). The coefficient of 0.50 indicates a moderate level of differentiation between the groups based on the observed variables, with the discriminant function effectively distinguishing between parents of children who actively participate in organized sports activities (SOD1) and those who do not (SOD2). This suggests that factors such as parental attitudes towards physical activity, awareness of its benefits and engagement in supporting their children's participation in sports play pivotal roles in differentiating between parents of active and non-active children.

Table 2: Differences of arithmetic means and canonical discriminant analysis between groups

CANR	*λ*	*h²*	*df*	*p*
0.50	*0.75*	*56.21*	*10*	*0.00*

It is evident from Table 3 that there are statistically significant differences between groups of parents in two variables: PSU - which assesses the encouragement of children to participate in sports or physical activities outside kindergarten and SOS - which evaluates the importance of the child's participation in organized sports activities. The statistical significance in these two variables highlights crucial aspects of parental attitudes and behaviours that distinguish the groups of parents based on their children's participation in organized sports activities. The significant difference in PSU between the groups suggests that parents whose children actively participate in organized sports (SOD1) are more likely to encourage their children to engage in sports or physical activities outside of kindergarten compared to parents of non-active children (SOD2). These results imply that encouragement from parents plays a vital role in whether children participate in organized sports. Parents who recognize the benefits of physical activities and actively motivate their children to participate are more likely to have children who engage in these activities. This can be attributed to a supportive home environment where physical activity is valued and promoted. Longitudinal research conducted by Sääkslahti et al. (2019) showed that the level of physical activity in preschool age predicts cardiovascular health and motor skills in adolescence. These findings highlight the importance of establishing healthy movement habits from an early age. Similarly, research by Nystoriak and Bhatnagar (2018) shows that regular aerobic activity reduces the risk of cardiovascular disease by strengthening the heart muscle, lowering blood pressure and improving circulation. Similarly, the significant difference in SOS indicates that parents of active children place a higher importance on their child's participation in organized sports activities than parents of non-active children. This highlights a key attitude difference; parents who see organized sports as crucial for their child's development are more likely to ensure their child participates in these activities. This attitude reflects an understanding of the broader benefits of organized sports, such as physical fitness, social skills, teamwork and discipline.

Table 3: Differences between groups in individual variables

Var	*λ*	*p*
POS	*0.76*	*0.19*
UZO	*0.76*	*0.28*
PSU	*0.85*	*0.00*
SOS	*0.78*	*0.00*
ZDR	*0.75*	*0.71*
TAD	*0.75*	*0.36*
SPR	*0.75*	*0.32*
INT	*0.76*	*0.10*
EDU	*0.75*	*0.69*
OBI	*0.76*	*0.08*

These findings from Table 3 emphasize the pivotal role of parental attitudes and behaviours in fostering children's active participation in organized sports. The significant differences in PSU and SOS between the two groups of parents underline how encouragement and perceived importance are central to whether children engage in sports activities. Parental encouragement is a key factor. Children are more likely to participate in sports when they receive active support and motivation from their parents. This support might include enrolling children in sports programs, attending their games, or simply fostering a positive attitude towards physical activity at home. Parents who believe that participation in organized sports is essential for their child's development are more likely to prioritize and facilitate their involvement in such activities. This belief is often rooted in an understanding of the multifaceted benefits of sports, including physical health, psychological well-being and social development. These findings suggest that efforts to increase children's involvement in sports should not only focus on the children themselves but also on educating and motivating parents about the benefits of sports. By enhancing parental awareness and support, it is possible to create a more conducive environment for children's active participation in sports, thereby promoting healthier and more active lifestyles.

CONCLUSION

The aim of this paper was to determine differences in parents' attitudes towards their preschool children's participation in organized sports activities outside kindergarten. Based on their child's participation, parents were categorized into two groups: those with children who actively participate in organized sports and those with children who do not. The results indicate that parents of active children hold significantly different attitudes compared to parents of non-active children. Specifically, parents of active children place higher importance on participation in organized sports and are more likely to encourage their children to engage in sports activities outside kindergarten. These parents also have a greater awareness of the need for physical and sports activities in their children's lives. The findings highlight the crucial role of parental attitudes and behaviours in fostering children's involvement in organized sports. Encouragement and the perceived importance of sports activities are central to children's engagement in these activities. The research suggests that efforts to increase children's participation in sports should focus on educating and motivating parents about the benefits of sports. Enhancing parental awareness and support can create a more conducive environment for children's active participation in sports, promoting healthier and more active lifestyles. The significant differences observed between the two groups underscore the impact of parental attitudes on children's involvement in organized sports. This research contributes to a better understanding of the factors influencing children's physical activity and supports the promotion of active lifestyles among preschool children.

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Prevalence and Localization of Knee Injuries in Women's Futsal Players

Ana Marija Pedišić[1], Ivan Zeljko[2], *Mirjana Milić[3]

[1]University of Split, Faculty of Kinesiology, Split, Croatia; [2]University of Mostar, Faculty of Natural Sciences and Mathematics and Education, Department of Kinesiology, Mostar, Bosnia and Herzegovina; [3]University of Split, Faculty of Kinesiology, Split, Croatia

ABSTRACT

Injuries are, unfortunately, an integral part of every sport, with the most common cause considered to be the disparity between physical exertion and the body's preparedness for said exertion. The aim of this study was to determine the incidence and localization of knee pain in senior female futsal players. The sample of participants included 53 female futsal players competing at the highest level of the Croatian league. The players' mean chronological age was 24.69±4.43 years, with a mean height of 168.47±5.52 cm and a mean body mass of 64.19±7.15 kg. The *Questionnaire on the incidence of knee pain and injuries*, developed by Penga, Milić, and Milavić (2020), was applied. The questionnaire was adapted for futsal and demonstrated good metric characteristics. Descriptive parameters of arithmetic mean and standard deviation, frequencies, and their relative values were used. Considering the mean values in the distribution of results, it was found that one variable significantly deviates from the others. Most futsal players reported that pain most commonly occurs after sports activity. The second most common occurrence of pain is during sports activity. According to the results, injuries most frequently occur on the front side of the knee, below the patella. The second most frequent injuries are located on the front side, above the patella. The obtained results confirm previous findings that futsal is among the sports with the highest incidence of knee injuries.

Keywords: frequency of injuries, futsal, patella, occurrence of pain.

INTRODUCTION

Using information that explains the structure of technical-tactical elements of the game, a structural analysis of the sport is conducted. This analysis includes information on different types of movements with and without the ball during a match. Due to its structural complexity, futsal belongs to the group of sports characterized by polystructural complex movements, where complex structures of both cyclic and acyclic movements dominate. These consist of complexes of simple and complex movements under conditions of team cooperation during the match (Dogramaci, Watsford & Murphy, 2011). In futsal, predominant actions include changes in rhythm and direction during running, explosive starts from various positions (static and dynamic), feints, deceptive movements, shots on goal (each team around 30 per match), and goalkeeper defenses.

To gain more playing space, players must move at submaximal and maximal intensities. In such situations, the speed and explosiveness of individual players play a significant role. The anatomical analysis provides information on which muscle groups, muscles, and topological regions of the body are activated during movement structure and in what manner in different forms of movement (Milanović, Salaj & Gregov, 2012).

The muscles of the lower extremities and trunk play a crucial role in futsal performance. Also significant are the arm muscles, which assist in movements such as changes in direction and acceleration. The most stressed joints include the hip, ankle, and knee joints.

Injuries are, unfortunately, an integral part of every sport. They are defined as the loss or abnormality of bodily structure or function resulting from isolated exposure to physical energy during sports training or competition, diagnosed as a medically recognized injury after examination by a clinical professional (Soligard et al., 2016). They are undesirable because they keep athletes off the field, causing periods of reduced training intensity or training cessation, which can lead to stagnation or regression. The onset of injury is influenced by a multitude of risk factors such as sport type, gender, movement technique/efficiency, older age, injury history, neglect of training load management, increased psychological stress, and fatigue. (Gabbett et al., 2016; Soligard et al., 2016; Green et al., 2020; Montalvo et al., 2019).

Futsal is a contact sport, and 64% of injuries occur due to contact with opposing players (Junge & Dvorak, 2010). With the increase in the sport's population, the issue of safety becomes increasingly important. A study conducted in the Netherlands showed that futsal, with an injury incidence rate of 55.2 per 10,000 hours of sport participation, ranked among the top ten sports with the highest injury frequency. A high frequency was recorded, with a rate of 195.6 injuries per 1,000 hours of play across three consecutive Futsal World Cups (Junge & Dvorak, 2010). Similarly, the most common types of injuries among Brazilian players were contusions and sprains, with percentages of 31.25% and 28.12%, respectively (Ribeiro & Costa, 2006). Regarding body region, the lower extremities (69.7%) were the most susceptible to injuries, followed by the head and neck (12.7%). Furthermore, the knee, thigh, and ankle were identified as the body parts with the highest injury rates in the study reviews (Ribeiro & Costa, 2006; Junge i Dvorak, 2010).

Futsal is among the sports with the highest incidence of injuries, specifically knee and ankle injuries. Regarding the type of injury and the mechanism causing it, bone injuries usually result from the contact with the opponents, whereas muscle, tendon, and ligament injuries result from non-contact mechanisms. In this regard, the non-contact injuries are often more severe than those caused by direct contact. In terms of gender, male players appear to have a higher frequency of ankle injuries, whereas female players have a higher frequency of knee injuries. The anterior cruciate ligament rupture is the most commonly reported knee injury, accounting for 20.3% of all knee injuries, followed by medial meniscus rupture (10.8%), medial collateral ligament injury (7.9%), lateral meniscus injury (3.7%), lateral collateral ligament injury (1.1%), and posterior cruciate ligament injury as the least frequent (0.65%), according to Majewski, Susanne & Klaus (2006). A sports injury can be defined as trauma to the body or its parts that can temporarily or permanently disable and inhibit motor function (Weinberg & Gould, 2019). The musculoskeletal system is most commonly affected. Brzić (2012) highlights that up to 80% of sports injuries result from traumatic events. According to Van Mechelen et al. (1992), sports injuries can be described through several criteria: the injury itself, treatment duration, time away from play, absence from competitive activity, and potential for lasting damage. Injuries are categorized as acute or chronic. Acute injuries typically occur in contact sports, whether individual or team-based, and are characterized by sudden tissue overload due to a clear cause within a short timeframe (Sandelin, Santavirta, Lattila, Vuolle & Sarna, 1988). The incidence of knee pain and injury is the subject of ongoing research in futsal. Sports injuries are inherent to any sport. It is crucial to understand the mechanical origins of these injuries and identify risk factors that may increase their occurrence.

The highest percentage in the table of major injuries in soccer refers to the knee. Localization and severity of injuries in the UEFA Champions League season 2001-2002 (modified from Waldén, Hägglund & Ekstrand, 2005) indicate a total of 131 knee injuries, accounting for 20% of all injuries, with 22% classified as mild, 14% as minor, 16.5% as moderate, and a significant 34% categorized as severe knee injuries. Knee injuries require extensive rehabilitation, with 25% of soccer players not achieving full recovery within one year.

Several authors have analyzed the incidence and characteristics of injuries among futsal players, risk factors for injuries, identification of potential injury causes in futsal, injury epidemiology, differences in spinal anteroposterior curvature between soccer and futsal players, injury prevention, and more (Hong & Bartlett, 2008; Junge & Dvorak, 2010; Varkiani, Alizadeh, Pourkazemi, 2013; Minoonejad et al., 2016).

Following the above, the primary aim of this study was to determine the prevalence and localization of knee pain in senior female futsal players.

METHODS

The sample consisted of 53 futsal players competing in the 1st Croatian Women's Futsal League. All players were adults, with a mean chronological age of 24.69±4.43 years, mean height of 168.47±5.52 cm, and mean body mass of 64.19±7.15 kg. The mean starting training age was 17.76 years, and the mean age of specialization was 18.26 years. On average, the futsal players had played 3.91 competitive seasons in their playing positions. Among the participants, 16 played as wing-backs and defensive players, 14 as attacking pivots, and six as goalkeepers. A total of 30 participants, i.e., 58%, reported no previous injuries. The remaining 42% of participants had experienced knee injuries during their careers.

Most participants have completed university graduate studies (53.85%), whereas the lowest proportion (11.54%) have only completed primary school.

For this study, the online *Questionnaire on the incidence of knee pain and injuries* (Penga, Milić, & Milavić, 2020) was adapted for use in futsal.

After obtaining approval for the research topic and obtaining verbal consent from club coaches, personal consent was sought from adult players. Upon approval, they completed the anonymous *Questionnaire on the incidence of knee pain and injuries* (Penga et al., 2020), adapted for futsal. The questionnaire was accessed via a previously provided online link. After completing the questionnaire, all collected qualitative responses were encrypted and entered into a Microsoft Excel spreadsheet. Statistical analysis was performed using Statistica *Ver. 13.2*. The research results were presented as graphs and tables, utilizing descriptive statistics, including the mean, standard deviation, frequencies, and relative values.

RESULTS and DISCUSION

Descriptive parameters of the prevalence of knee pain and injuries in female futsal players are presented in Table 1.

Table 1. Descriptive characteristics of the prevalence of knee pain and injuries in female futsal players.

KNEE PAIN	*AM*	*SD*
Pain before sports activity	*2.02*	*1.02*

Pain during sports activity	*2.48*	*1.16*
Pain during sudden stops	*2.02*	*1.21*
Pain during change of direction	*2.25*	*1.31*
Pain during landing	*2.12*	*1.13*
Pain when sliding on the court	*1.79*	*1.16*
Pain at the beginning of sports activity	*1.92*	*1.03*
Pain after sports activity	*2.81*	*1.31*
Pain is caused by exercise cessation	*1.73*	*1.07*
Pain during normal daily activities	*1.77*	*0.98*

Legend: AM-arithmetic mean; SD-standard deviation

Descriptive characteristics of knee pain and injuries in futsal players are presented in Table 1. Upon examining the mean values in the distribution of results, it is evident that one variable devites from the others. Most futsal players cited the same reason. It concerns pain that occurs *after sports activity* (2.81 ± 1.31). The second most prevalent type of pain is *pain during sports activity* (2.48 ± 1.16), followed by *pain during change of direction* (2.25 ± 1.31), *pain during landing* (2.12 ± 1.13), pain during sudden stops (2.02 ± 1.21), *pain before sports activity* (2.02 ± 1.02), *at the beginning of sports activity* and (1.92 ± 1.03), and *pain when sliding on the court* (1.79 ± 1.16). The variables with the lowest mean values relate to the prevalence of *pain during normal daily activities* (1.77 ± 0.98) and *pain caused by exercise cessation* (1.73 ± 1.07).

The reason for this is the high exertion during activities combined with significant forces on the knee during movement. Similar research was conducted by Ikić et al. (2021) and Lučin (2021), who investigated the prevalence and localization of knee pain in basketball players, as well as by Goreta et al. (2021) in soccer players. In these studies, pain after sports activities also had the highest value. Ninčević (2023) and Matas (2023), who applied the same adapted questionnaire for volleyball players, obtained similar results, with pain after sports activities showing the highest values in their studies as well.

After assessing the prevalence of knee pain and injuries, futsal players reported on the localization of knee pain across a total of 17 variables. The assessment results for the total sample (N=53) are presented in Table 2 using frequencies and relative values.

Table 2. Relative values by area of most frequent knee pain sensation in female futsal players

LOCATION OF KNEE PAIN	*N*	*%*
Front/Anterior - below the patella	*7*	*13.46*
Front/Anterior - on the patella	*6*	*11.54*
No knee pain	*6*	*11.53*
Inside/Medial side of the knee	*5*	*9.62*
Outside/Lateral side of the knee	*5*	*9.62*
Posterior (back of the knee)	*4*	*7.69*
Front/Anterior - below the patella, Inside/Medial side of the knee	*4*	*7.69*
Front/Anterior - below the patella, Outside/Lateral side of the knee	*2*	*3.85*
Front/Anterior - on the patella, Outside/Lateral side of the knee, Inside/Medial side of the knee	*2*	*3.85*
Front/Anterior - on the patella, Outside/Lateral side of the knee	*1*	*1.92*
Front/Anterior - on the patella, Front/Anterior - above the patella, Inside/Medial side of the knee	*1*	*1.92*

Front/Anterior - below the patella, Outside/Lateral side of the knee, Inside/Medial side of the knee	*1*	*1.92*
Outside/Lateral side of the knee, Inside/Medial side of the knee	*1*	*1.92*
Front/Anterior - above the patella	*1*	*1.92*
Outside/Lateral side of the knee, Posterior (back of the knee)	*1*	*1.92*
Front/Anterior - on the patella, Inside/Medial side of the knee	*1*	*1.92*
Front/Anterior - below the patella, Front/Anterior - on the patella, Posterior (back of the knee)	*1*	*1.92*
Front/Anterior - below the patella, Front/Anterior - above the patella, Inside/Medial side of the knee,	*1*	*1.92*
Front/Anterior - below the patella, Outside/Lateral side of the knee, Inside/Medial side of the knee, Posterior (back of the knee)	*1*	*1.92*
Front/Anterior - above the patella, Outside/Lateral side of the knee	*1*	*1.92*

Legend: N-number of participants, %-relative percentage values

According to the results, injuries most commonly occur on the front side of the knee, below the patella (N=7; 13.46%). In second place in terms of frequency are injuries on the front side, above the patella (N=6; 11.54%). Knee injuries localized on the inner and outer sides occur in 9.62% of cases (N=5), whereas each of the remaining injuries listed in Table 2 occurs in 7.69% or fewer cases.

According to the results, it is likely a case of patellar tendinopathy, a condition known as the "jumper's knee," which is a common soft tissue injury of the knee. It can occur when the tendon of the patella is unable to cope with the level of stress placed upon it. Over time, microscopic changes occur within the tendon fibers. As the tendon attempts to heal, the fibers become disorganized, leading to severe pain. Pain can occur at three locations: at the insertion point of the quadriceps tendon on the upper part of the patella, at the lower part of the patella, or at the tibial tuberosity where the patellar ligament attaches. In Lučin (2021), basketball players also reported pain below the patella as the most common area of pain, as did soccer players in the study by Goreta et al. (2021).

CONCLUSION

The aim of this study was to determine the prevalence and localization of knee pain and injuries among 53 female futsal players competing in the 1st Croatian Women's Futsal League, using the adapted *Questionnaire on the incidence of knee pain and injuries* developed by Penga, Milić, and Milavić (2020). The questionnaire effectively measured the incidence and localization of knee pain and injuries among futsal players.

The measured incidence among futsal players shows that the most common occurrence is pain after sporting activities. Pain during sports activity and pain during change of direction follow in second and third place by incidence. Variables related to pain during normal daily activities and pain caused by exercise cessation have the lowest mean values. According to the results, injuries most commonly occur on the front side of the knee, below the patella. In second place by frequency are injuries on the front side of the knee, above the patella. The obtained results have almost identical values as previous findings, indicating that futsal ranks among sports with the highest frequency of knee injuries.

The limitations of this study certainly include a small number of participants; thus, future research should focus on increasing the number of female participants, including questions about injuries other than knee injuries and attempting to determine the differences between the sexes within futsal and other ball sports.

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Relation Among Peak Height Velocity, Anthropometric Indices, and Motoric Abilities in Youth Swimmers

Toni Propadalo[1]*, Vladimir Pavlinović[1], Dario Vrdoljak[1]

[1]Faculty of Kinesiology, University of Split, Croatia

*Corresponding author

ABSTRACT

The study's goal was to see if there is any significant correlation between PHV, anthropometric indices, and motoric ability tests and 25m freestyle swimming. The sample of participants included 15 young male swimmers. Their chronological age was 9.71±0.99 years. Used variables were age, PHV, maturity offset, body height, seating height, body mass, leg length, 25m freestyle swimming, medicine ball throw, sit-ups, and 20m sprint run. Results showed significant differences in medicine ball throw compared to body height; taller kids threw the ball further. Sit-ups compared with body mass; kids with lower body mass did more sit-ups. 20m sprint compared by age, older kids run faster. PHV compared with age and body height, and Maturity offset compared by age and body height; if the kid is older or taller it has reached a bigger maturity offset and PHV. Body height, body mass, and age are very important at a young age and can make a big difference in a young swimmer's performance. Coordination, strength, and speed at ages 8 to 11 have in progressed linear growth. Also, in swimming, there is something called "the feeling for the water" - the more time you spend consistently in the water your coordination adapts efficiently. Bigger differences in the results can be explained by sensible phases of child motor development. We didn't see a significant change in any variables connected with the 25m swim, kids start to develop motor skills on the ground and at an early age. New media such as water takes a different set of motor skills to be used/developed. This means that younger kids can have better results if they have more training experience than their older colleagues because their specific coordination, strength, and speed are used more efficiently in water.

Keywords: Children, Development, Motor skills, Water sports, PHV

INTRODUCTION

Puberty is a critical period of biological maturation, characterized by a growth spurt and the development of secondary sexual characteristics. The onset and progression of puberty vary among individuals, with differences in timing (the age at which certain pubertal milestones are reached), velocity (the rate of progression through puberty), and duration (the period between the onset and completion of puberty or between specific stages). These parameters exhibit significant individual variability (Gluckman & Hanson, 2006). During adolescence, the peak height velocity (PHV) represents a phase of rapid growth in height. This period is particularly crucial for young athletes as monitoring PHV can help optimize training programs and minimize injury risks. Ignoring the effects of PHV and critical developmental phases can jeopardize an athlete's health. Moreover, understanding PHV can provide valuable insights for sports selection, as physical characteristics significantly influence performance levels. Research indicates that height can play a crucial role in an athlete's success, offering natural advantages in certain sports. The increasing focus on the relationship between anthropometric and motor characteristics has led to new demands in sports anthropometric research (Szabo et al., 2020). Motor abilities (MA), which encompass everyday skills and sports performance movements, are vital for athletic performance. Well-developed motor abilities enable athletes to expend less energy and move more quickly. Knowledge of motor skills in young schoolchildren is directly related to the effects of physical education and the development of specific motor skills. During the early school years, the dynamics of development are slow compared to the preschool years. The general mobility factor present in preschoolers begins to vary in the first few years of elementary school, a period marked by rapid motor skill development (Nikolic et al., 2015). In swimming, motor skills differ from those used on land, requiring specific coordination and skill sets to achieve optimal results. Children's life experiences and stimulation form the foundation for acquiring critical motor skills for various sports activities (Clark & Metcalfe, 2002). Strength development during adolescence follows a linear growth pattern, which is also of great importance. Although strength has traditionally been measured through isometric and isokinetic tests, recent studies have focused on exercises commonly found in dryland strength training programs as predictors of swimming performance (Pérez-Olea et al., 2018). This research aims to explore how these factors affect swimming performance in adolescent athletes. There is a notable lack of studies addressing this subject in competitive adolescent swimming.

METHODS

Participant

The sample of participants included 15 male swimmers. Their chronological age was 9.71±0.99 years. Participants did not have any illness or medical condition that may have prevented them from performing tests. Their parents were informed about the procedures and purpose of the study and signed informed consent before the investigation began. The study was conducted following the declaration of Helsinki, and the Ethical Board of the Faculty of Kinesiology, University of Split, Croatia (Ethical board number 2181-205-02-05-22-035).

Variables and procedure

Used variables were age, PHV, maturity offset (MO), body height (BH), seating body height (SBH), body mass (BM), leg length (LL), 25m freestyle, medicine ball throw (MBT), sit-ups (SU), training age (TA) and 20m sprint run.MO was calculated by the formula: Maturity offset (years) = - 8.128741 + (0.0070346 × (age × sitting height)); (Moore et al.,2015). All anthropometric indices were measured by strict protocol (Ross WD et al.,1991). BH, SBH, and LL were measured using measuring tape.BM was calculated on a digital scale. MBT was measured lying down on the back, participants had three attempts and the best throw was recorded as a result. SU were measured by max repetition in one minute. The 25m freestyle was the best-recorded result in the competition that our athletes had until that moment. TA was estimated by the time passed from entering the sport and the time until we did measurements. The 20m sprint run was measured with a stopwatch, athletes had three attempts, and the best attempt was recorded as a result. A formula calculates PHV and the following variables are required: gender, date of birth, date of measurement, height, sitting height, and weight. (Mirwald et al.,2002).

Statistics

Descriptive statistics parameters were calculated: arithmetic mean and standard deviation, minimal and maximal results. Kolmogorov-Smirnov test was calculated to estimate the normality of distribution in each variable. Pearson's correlation was calculated for analysing relations among variables. All statistical analysis was done in Statistica v13.00 software.

RESULTS

The results of descriptive statistics are presented in Table 1. According to the Kolmogorov-Smirnov test calculation, it can be seen that all variables have a normal distribution and are therefore suitable for parametric statistical methods ($p>0.20$).

Table 1. Descriptive parameters of measured variables, on the total sample of participants (N=15)

Variable	Mean	Minimum	Maximum	SD	max D	K-S (p)
Age (years)	9.71	8.00	11.00	0.99	0.26	p > .20
PHV	-0.77	-2.06	0.35	0.83	0.18	p > .20
Maturity offset	-3.00	-3.80	-2.17	0.58	0.15	p > .20
Body height (cm)	145.38	135.00	159.80	7.05	0.11	p > .20
Seating height (cm)	75.11	64.00	82.00	4.51	0.16	p > .20
Body mass (kg)	40.19	29.60	51.10	7.19	0.16	p > .20
Leg length (cm)	70.27	58.00	78.00	5.72	0.18	p > .20
25m sprint (s)	26.59	19.69	36.43	5.00	0.15	p > .20
Medicine ball throw (cm)	283.21	108.00	415.00	88.98	0.14	p > .20
Sit-ups	19.21	11.00	30.00	6.33	0.15	p > .20
20-meter sprint (s)	4.50	3.97	6.09	0.61	0.25	p > .20
Training age	15.08	6.00	41.00	12.34	0.35	p > .20

Legend: PHV- peak high velocity.

Table 2 demonstrates a correlation between anthropometric indices with speed (25 and 20m sprint) and strength tests (Medicine ball throw and Sit-ups). It can be noted that a significant correlation occurs between medicine ball throw and body height ($r=0.58$). On the other hand, Sit-ups correlate negatively with body mass (-0.65). Other variables do not correlate significantly ($r= -0.46 – 0.54$). Additionally, correlations between chronological parameters and tests showed significant results only between age and 20m sprint ($r=-0.77$) (see Table 3).

Table 2. Pearson correlation test between anthropometric indices and speed and strength tests

Variable	25m sprint (s)	Medicine ball throw (cm)	Sit-ups	20m sprint (s)
Body height (cm)	-0.15	0.58*	-0.25	-0.20
Seating height (cm)	0.02	0.21	-0.44	0.25
Body mass (kg)	0.12	0.15	-0.65*	0.49
Leg length (cm)	-0.21	0.54	0.07	-0.46

*Legend: *-significant correlations*

Table 3. Pearson correlation test between chronological parameters and speed and strength tests

Variable	25m sprint (s)	Medicine ball throw (cm)	Sit-ups	20m sprint (s)
Age (years)	-0.46	0.28	0.34	-0.77*
PHV	-0.39	0.48	-0.04	-0.52
Maturity offset	-0.43	0.39	0.05	-0.57
Training age	0.09			

*Legend: PHV- peak high velocity; *-significant correlations*

The correlation between PHV, Maturity offset, age, and anthropometric indices is shown in Table 4. The results show a significance between age with PHV (r=0.81) and maturity offset (r=0.83). Also, a significant correlation can be seen between body height with PHV (r=0.72) and maturity offset (r=0.58). Seating height and body mass do not reach a significant correlation with PHV and maturity offset.

Table 4. Pearson correlation test between PHV, Maturity offset, and age and anthropometric indices

Variable	*Age (years)*	*Body height (cm)*	*Seating height (cm)*	*Body mass (kg)*
PHV	*0.81**	*0.72**	*0.43*	*0.28*
Maturity offset	*0.83**	*0.58**	*0.44*	*0.16*

*Legend: PHV- peak high velocity; *-significant correlation*

DISCUSSION

The results indicated several significant differences. One finding was that taller children performed better in the medicine ball throw, which was conducted while lying down. This advantage is likely due to longer arm length, resulting in greater swing force production. These results are consistent with a 2008 study showing positive correlations between medicine ball throw scores and both height (r = 0.34) and weight (r = 0.34) (Davis et al., 2008). For sit-ups, children with lower body mass performed more repetitions. These results may be explained by a rapid gain in weight in adolescence period of life. This explanation is consistent with the study by Park et al. 1994 based on 6580 students from grade 4 to senior high from Seoul, district town, and countryside were evaluated for sexual maturity using Tanner staging, weight, height and body mass index and compared for growth. There was an increase of 5.5 kg in weight for boys at the same age as for growth in height, that is between 11 and 14 years of age. In girls, an average weight gain of 5.1 kg occurred between 11 and 13 years of age, slightly later than that of growth in height. Rapid gain in weight occurred during Tanner stages 2~3 for girls. A total gain of 20.70 kg for boys occurred during the whole sexual maturation period while girls gained a total of 19.73 kg (Park et al., 1994). This result can be attributed to the fact that lighter children often have less body fat, giving them an endurance advantage in this test. While body mass alone does not provide a complete picture of body composition, the similarity in age and grouping of the participants allowed for meaningful comparisons. In another study from 2008 higher waist circumference and subcutaneous skinfolds at the thigh, abdomen, and subscapular sites were associated with poorer performance in these exercises. Therefore, targeted conditioning to reduce body fat at these sites could improve performance (Esco et al., 2008). In the 20m sprint, older children ran faster than their younger counterparts, highlighting that motor development progresses with age. This finding aligns with a study on Spanish preschoolers, which showed that sprint times decreased as children aged, providing reference values for running speed in this age group (Latorre-Román et al., 2017). However, similar correlations were not observed in water-based activities. Comparisons of peak height velocity (PHV) and maturity offset with age and height revealed that older and taller children had reached higher maturity levels and PHV. This is expected, as taller and older children generally mature faster, both physically and in terms of bone structure. An interesting but non-significant observation was the relationship between training age and 25m swim performance. Due to the small sample size, the study was limited in its ability to detect significant correlations. Nonetheless, it is generally understood that longer training in any sport improves proficiency. Swimming, emphasizes the importance of developing a buoyancy and sense of fluid movement. Unlike land-based activities where older children typically outperform younger ones, swimming performance can be superior in younger children if they have more experience and better technique. Technique and experience are not the only factors that are important. Height, body fat, motor abilities, and many factors play a role in swimming performance. In other words, it is hard to point out a few things that are the most influential. Height can give an advantage in swimming but doesn't necessarily mean that you will be a better swimmer if you are taller. For example in the study from 1964 swimming results had no significant correlation with height and weight although results didn't have significant correlations there were still connections to the results which could change to significant if the author took a different sample (Stroup, F. 1964). This suggests that swimming requires a unique set of motor skills and emphasizes the importance of specialized training in water.

CONCLUSIONS

This study revealed several intriguing findings about the unique nature of swimming compared to land-based sports. Unlike on land, swimming requires time for individuals to feel relaxed and understand their body movements in the water. As a result, proficient swimmers may not necessarily be the best athletes on land due to the distinct demands of swimming. Immersing oneself in swimming is a remarkable experience for both children and adults. With increased time spent in the pool or sea, one's body becomes more adept at gliding through the water efficiently. Swimmers begin to control their movements better and achieve fluidity. The study demonstrated that younger or smaller children could outperform their taller, stronger, or older peers if they spent more time swimming. This finding underscores why swimming is considered a sport that benefits from early specialization. However, a limitation of this study is the small sample size. Despite this, the study likely emphasizes the importance of monitoring peak height velocity (PHV), motor abilities, and anthropometric indices when working with adolescent athletes. Tracking these variables is likely crucial for helping adolescent athletes reach their potential. These tests serve the purpose of monitoring athletes' physical condition and give us a better understanding of athletes' anatomical structure and performance abilities and therefore are beneficial and should be performed.

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Assessment of Situations Stressfulness in Volleyball

*Boris Milavić[1], Luka Pezelj[2], Vesna Trut[3]

[1]Faculty of Kinesiology, University of Split, Split, Croatia; [2]Faculty of Maritime Affairs, University of Split, Split, Croatia; [3]National Security and Defense University "Dr. Franjo Tuđman", Zagreb, Croatia

*Corresponding author

ABSTRACT

On a sample of 145 young volleyball players, a newly constructed questionnaire of assessment of stressful situations in volleyball with 47 items was applied to determine the primary appraisal of situations. Seven scales for assessing the stressfulness of volleyball situations 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. All scales are at least satisfactorily homogeneous, reliable and sensitive. The expressiveness of the stressfulness of the items varies between a *very high* assessment of the *situation of losing the first two sets* (5.95) to an *extremely low* assessment of the situation of *playing against the team we beat* (1.82). Scores on the scales range from a *very high* score on the *high stressful situations* scale (5.01) to a *very low* score on the *low stressful situations* scale (2.18). All scales are significantly and highly intercorrelated with each other. It was determined that the scales form one latent component, whereby 61.4% of the common variance is explained, and the overall reliability of the overall score is *very good* (alpha=0.89). The aim of this study was achieved by constructing of 7 quality scales for primary appraisal of situations in volleyball. The constructed scales and determined findings of this study point to the need to carry out further research in order to determine the relationships between these assessments of situations and other possibly important variables for sports (e.g., *age, gender, playing position*), as well as the need to determine the types of stressfulness of volleyball situations assessments.

Keywords: *cognitive appraisal, primary appraisal, questionnaire, sport, stress*

INTRODUCTION

Success in sport requires continual management of constantly changing challenges. The pursuit of achievement involves not only physical skills, but also strong psychological and emotional skills over a long period of time (Hanin, 2010). Athletes may face many difficulties in their pursuit of excellence such as competitive anxiety, performance plateaus, performance dips, injuries, tough opponents, complex relationships with the coach, and excessive personal and societal expectations (Jowett at al., 2017; Neil et al., 2011). Such threats and challenges can lead to the appearance of stress. Numerous studies confirm that stress is ubiquitous in sports, especially in sports competitions (Litwic-Kaminska, 2020; Salvador, 2005), and therefore can impair the performance and motivation of athletes, and negatively affect their overall physical and psychological well-being (Crocker, Tamminen and Gaudreau, 2015, Kovács et al., 2022).

The term stress is commonly used to describe a series of negative feelings and reactions in response to adverse situations. However, the transactional perspective of stress indicates that stress is a process, more precisely a transaction between person and environment in which perception of an event plays a key role. Thus, stress can help or inhibit individual performance depending on this perception. Lazarus and Folkman (1984) distinguish between primary and secondary cognitive appraisal. Primary appraisal deals with whether something relevant to the individual's well-being will happen, and secondary appraisal deals with the individual's coping options in a given situation. The authors assumed that stress occurs when a specific event threatens the achievement of some goals, and that an increase in stress levels affects mental performance. In the sports context, stress is a process that involves a dynamic transactional relationship between the athlete and the environment. During sports activities, the athlete assesses the specific demands of the situation in relation to personal goals, obligations and values (primary appraisal). In addition, the athlete also assesses coping options, future expectations and actions (secondary appraisal). How an athlete copes with specific demands is likely to affect personal and social outcomes (Lazarus, 2000). Stress can also be seen as part of an adaptation process in which people must constantly adapt to changing conditions. The process of adaptation in sports includes not only the athlete's assessment of stressors but also their emotional, cognitive, behavioral and physiological reactions, and adaptation to the assessed conditions through self-regulation processes and planned behavior (Tamminen, Crocker and McEwen, 2014).

Team sports are particularly stressful because they involve the coordinated work of team members in competition with another team for a common goal (McEwan & Beauchamp, 2014). Although teamwork is crucial for performance and results in team sports, the extremely important individual contribution of each team member should not be ignored. This especially applies to young athletes (Basiaga-Pasternak, 2018; Bisagno et al., 2022; Hess, 2018). Successful coaching of young athletes in team sports implies a clear understanding of how they evaluate important events related to their individual and team performance already at the beginning of their sports career. Cognitive appraisal describes how young athletes interpret and evaluate specific demands in team sports performance and shows that some of them may perceive these demands as more threatening or challenging than others (Gomes, Faria, & Vilela, 2017). A clearer understanding of the stress process in young volleyball players, including cognitive appraisal, can enable their coaches and sports psychologists to work more effectively on stress management, and therefore on their performance.

METHODS

As part of a research project, a newly constructed questionnaire for assessing the stressfulness of volleyball situations in of 47 items was applied to 145 young volleyball players (118 females and 27 males) between 13 and 18 years old, with an average age of 14.99 ± 1.46 years. The questionnaire items were constructed in collaboration with two top volleyball experts with many years of experience working with young volleyball players. Respondents assessed each situation as to how stressful it was for them if it had already happened to them or how stressful it could be when they are only thinking about the possibility of its happening. Respondents anonymously evaluated the items of the questionnaire on a Likert scale with 9 measurement units (0 – *not stressful at all*; 3 – *somewhat stressful*; 6 – *quite stressful*; 9 – *completely stressful).* In data processing, procedures were used to determine the latent structure (exploratory *Principal Component Analysis*, using both *Oblimin* and *Varimax* rotations with the Guttman-Kaiser criterion to determine the number of significant components), and to determine the basic metric characteristics of *homogeneity* (*Principal Component Analysis*), *reliability* (*Cronbach alpha* coefficient), and *sensitivity* (Kolmogorov-Smirnov *max D* test, range of results; indices of distribution *skewness* and *kurtosis*). Missing values in the questionnaire were replaced with the mean of items during the initial data processing. In order to be able to easily and qualitatively compare the scores of scales with different numbers of particles, the scores on the scales of the questionnaire were calculated in such a way that all the data on the items of a particular scale were added up, and then that sum was divided by the number of items in that scale. The overall score on the questionnaire was calculated in the same way. To determine the descriptive characteristics of particles and scales, basic metric parameters were calculated: *mean, standard deviation, minimal,* and *maximal score*.

RESULTS

Principal Component Analysis with Oblimin rotation was applied to the data of all items, and the items were projected onto 11 significant components explaining 71.7% of the common variance. 36 particles were projected onto more than one component. That information was used to construct 7 scales for assessing the stressfulness of volleyball situations. Scales contain 40 items out of a total of 47 items in the questionnaire, and are shown in Table 1.

Table 1. Primary Appraisal of Situations Stressfulness in Volleyball (PASS-Vb) Questionnaire scales

High stressful situations scale								
Items	*Eigen*	*% Var*	*Alpha*	*FS*	*Mean*	*SD*	*Min*	*Max*
	3.37	*48.1*	*0.82*					
Lost the first two sets				*0.73*	*5.95*	*2.24*	*0*	*9*
Playing a decisive game in the league				*0.74*	*5.93*	*2.47*	*0*	*9*
Fourth set lost				*0.66*	*5.60*	*2.20*	*0*	*9*
My smash on the deciding ball				*0.73*	*4.99*	*2.83*	*0*	*9*
My smash in the deciding set				*0.74*	*4.52*	*2.68*	*0*	*9*
Playing against a team of similar quality				*0.60*	*4.26*	*2.62*	*0*	*9*
Playing against the team we were losing to				*0.66*	*4.24*	*2.53*	*0*	*9*
Decisive points scale								
Items	*Eigen*	*% Var*	*Alpha*	*FS*	*Mean*	*SD*	*Min*	*Max*
	3.64	*60.6*	*0.87*					
My serve on the deciding point in the match				*0.74*	*5.56*	*2.89*	*0*	*9*
Their set ball on our serve				*0.79*	*5.54*	*2.62*	*0*	*9*
Their match ball on their serve				*0.80*	*5.40*	*2.61*	*0*	*9*
Their match ball on our serve				*0.83*	*4.96*	*2.72*	*0*	*9*
Our match ball on their serve				*0.79*	*4.49*	*2.58*	*0*	*9*
Our match ball on our serve				*0.71*	*4.19*	*2.79*	*0*	*9*
Serve reception scale								
Items	*Eigen*	*% Var*	*Alpha*	*FS*	*Mean*	*SD*	*Min*	*Max*
	3.64	*60.6*	*0.87*					
My serve reception on the decisive point				*0.87*	*5.31*	*2.77*	*0*	*9*
My serve reception in the deciding set				*0.84*	*4.85*	*2.85*	*0*	*9*
My bad serve reception				*0.84*	*4.65*	*2.60*	*0*	*9*
My fault receiving serve				*0.79*	*4.39*	*2.41*	*0*	*9*
My serve reception in the first set				*0.64*	*3.12*	*2.52*	*0*	*9*
My playing scale								
	Eigen	*% Var*	*Alpha*	*FS*	*Mean*	*SD*	*Min*	*Max*
	2.90	*48.4*	*0.78*					
Entering as a substitute in the deciding set				*0.73*	*5.38*	*2.51*	*0*	*9*
My bad defense of the field				*0.72*	*5.10*	*2.23*	*0*	*9*
Playing in another playing position				*0.67*	*4.49*	*2.74*	*0*	*9*
My poorly executed of ball lifting				*0.67*	*4.16*	*2.47*	*0*	*9*
Entry into the game as a substitute				*0.76*	*3.86*	*2.47*	*0*	*9*

Playing in front of a large number of spectators				*0.61*	*3.57*	*2.65*	*0*	*9*
Block - spike scale								
Items	*Eigen*	*% Var*	*Alpha*	*FS*	*Mean*	*SD*	*Min*	*Max*
	4.32	*61.7*	*0.90*					
My touch of the net at the block				*0.83*	*4.79*	*2.62*	*0*	*9*
My failed spike (the ball went out)				*0.81*	*4.76*	*2.71*	*0*	*9*
My blocking on the decisive ball				*0.87*	*4.66*	*2.76*	*0*	*9*
My unsuccessfully line spike				*0.76*	*4.63*	*2.54*	*0*	*9*
My spike is blocked, point for the opponent				*0.78*	*4.48*	*2.57*	*0*	*9*
My block jump in the deciding set				*0.72*	*4.09*	*2.62*	*0*	*9*
My failed block				*0.70*	*3.83*	*2.50*	*0*	*9*
My team is losing scale								
Items	*Eigen*	*% Var*	*Alpha*	*FS*	*Mean*	*SD*	*Min*	*Max*
	2.37	*59.2*	*0.76*					
While the opposing team is in a large lead				*0.67*	*5.62*	*2.22*	*0*	*9*
My failed serve				*0.83*	*5.04*	*2.34*	*0*	*9*
First set lost				*0.79*	*3.54*	*2.20*	*0*	*9*
While the opposing team is in a small advantage				*0.78*	*3.43*	*1.93*	*0*	*7*
Low stressful situations scale								
Items	*Eigen*	*% Var*	*Alpha*	*FS*	*Mean*	*SD*	*Min*	*Max*
	2.87	*57.4*	*0.82*					
Start of the first set				*0.59*	*2.68*	*2.26*	*0*	*9*
Playing in a guest hall				*0.83*	*2.51*	*2.23*	*0*	*9*
While my team arrives their advantage				*0.74*	*2.19*	*2.28*	*0*	*9*
Playing at home				*0.78*	*1.85*	*2.18*	*0*	*9*
Playing against the team we were beating				*0.82*	*1.82*	*2.23*	*0*	*9*

Notes: Eigen — eigen value of component variance; % Var — percentage of explained variance; Alpha — Cronbach's alpha reliability coefficient; FS — factor saturation; SD – standard deviation; Min – minimal result; Max – maximal result.

All scales are *homogeneous* because all items in each scale were projected into a single component, and these components explained between 48.1% and 67.1% of the common variance of the scale. All scales are at least satisfactorily *reliable*, as the internal consistency coefficients of the Cronbach alpha type vary from a *satisfactory* 0.76 to a *high* 0.90.

The *high stressful situations* scale items are related to the highest, *very highly* rated stressful situations expressed, varying from 5.95 (*losing the first two sets*) to 4.24 (*playing against the team we were losing to*). The *decisive points* scale has six items that relate to *highly* rated stressful situations associated with playing "decisive balls - plays" in the game, which vary from 5.56 (*my serve to the decisive point in the match*) to 4.19 (*our match ball to our serve*). The *serve reception* scale refers to the average evaluated situations related to the service reception in the game, which varies from 5.31 (*my serve reception on the deciding point*) to 3.12 (*my serve reception in the first set*). The *my playing* scale refers to the average assessed situations related to the playing circumstances of the young player, which vary from 5.38 (*entering as a substitute in the deciding set*) to 3.57 (*playing in front of a large number of spectators).* The *block - spike* scale refers to the average rated situations associated with playing a block or smash in the game of volleyball, which varies from 4.79 (*my touch of the net on a block*) to 3.83 (*my unsuccessful block*). The *my team is losing* rating refers to the average estimated situations associated with the situation in which the playing team is in a subordinate position during the match, which varies from 5.62 (*while the opposing team is in a large lead*) to 3.43 (*while the opposing team is in a* *small advantage*). The *low stressful situations* scale refers to very low rated situations, frequent and common in volleyball, whose ratings vary from 2.68 (*beginning of the first set*) to 1.85 (*playing at home*).

All constructed scales were significantly, but most often *moderate* to *strong* intercorrelated. The highest correlations (above 0.70) are found in the "triangle" between the three scales: the *high stressful situations* scale, the *block - spike* scale, and the *my team is losing* scale. These established findings, about high intercorrelations between all scales, led to the need to determine the latent structure of the questionnaire, i.e. to determine if there is general dimension or measure underlying primary appraisal of the stressfulness of situations.

Table 2. Latent structure, descriptives, and sensitivity of the PASS-Vb Questionnaire

Primary Appraisal of Situation Stressfulness in Volleyball (PASS-Vb) Questionnaire											
Scales	*Eigen*	*% Var*	*Alpha*	*FS*	*Mean*	*SD*	*Min*	*Max*	*Max D*	*Skew*	*Kurt*
	4.30	*61.4*	*0.89*								
High stressful situations				*0.85*	*5.01*	*1.75*	*0.71*	*8.86*	*0.08*	*-0.30*	*-0.39*
Decisive points				*0.82*	*4.95*	*2.09*	*0.00*	*9.00*	*0.09*	*-0.23*	*-0.78*
Serve reception				*0.67*	*4.44*	*2.09*	*0.00*	*9.00*	*0.07*	*-0.38*	*-0.33*
My playing				*0.81*	*4.43*	*1.74*	*0.33*	*8.00*	*0.06*	*-0.08*	*-0.57*
Block - spike				*0.85*	*4.39*	*2.07*	*0.00*	*8.86*	*0.05*	*-0.11*	*-0.65*
My team is losing				*0.82*	*4.38*	*1.66*	*0.50*	*8.00*	*0.08*	*-0.22*	*-0.50*
Low stressful situations				*0.65*	*2.18*	*1.66*	*0.00*	*7.40*	*0.11**	*0.66*	*-0.21*
Overall PASS-Vb score				*-*	*4.25*	*1.46*	*1.08*	*7.49*	*0.06*	*-0.23*	*-0.52*

Notes: Eigen — eigen value of component variance; % Var — percentage of explained variance; Alpha — Cronbach's alpha reliability coefficient; FS — factor saturation; SD – standard deviation; Min – minimal result; Max – maximal result; Max D – Kolmogorov-Smirnov goodness-of-fit test; Skew – distribution skewness; Kurt – distribution kurtosis.

All the constructed scales were projected onto a single component, and with that component the scales of *high stressful situations* and *block – spike* (0.85 each), scales of *decisive points*, and *my team is losing* (0.82 each), and *my playing* (0.81) were the most saturated. The scales of the questionnaire explained 61.4% of the common variance, and the overall measure is *very* reliable (Alpha=0.89). Almost all indicators of sensitivity of the scales were *satisfactorily* expressed. Average scores on the scales range from 5.01 (*high stressful situations* scale) to 2.18 (*low stressful situations* scale), but most scale averages are above the 4.00 estimate. The ranges of scores on the scales vary from a minimum of 0.00 to a maximum of 9.00.

DISCUSSION

Even 11 situations of 40 items were *highly* evaluated (above 5.00), and 18 situations were evaluated as *moderate* (from 4.00 to 4.99). Those situations that are mostly decisive situations (either in one match or in a competitive season) or extremely unfavourable for the young player/team (e.g., *losing the first two sets, playing a decisive match in the league, my serve on a decisive point in the match, entering as a substitute in the decisive set*, ...). The situations that were assessed as *moderate* happen often or very often in the game (e.g., *my spike in the deciding set, playing against a team of similar quality, my bad serve reception, my poorly executed spike, my failed smash - the ball went out, my spike blocked - point for the opponent*, ...). These situations most often represent mistakes made in the game by individual players. With the exception of just one item of the questionnaire, for all other items full range of possible assessments was determined (from *not stressful at all* to *extremely stressful*), even within *low stressful situations* scale items. This shows that all situations in volleyball were assessed as *extremely* stressful for at least small part of sample of the young players.

Three scales that were highly intercorrelated and that were most saturated with the component of *general stressfulness* represent the "basic" scales of this questionnaire (scales: *high stressful situations*, *block-spike* and *my team is losing*). In these scales items, it could be recognized the somehow “responsibility” of an individual young player for (possible) mistake (or mistakes) that may result as impairing or as "damage" for the team achievement. A common cause of the *cognitive state anxiety* of individual athletes is the sense of responsibility that the individual feels for the sporting achievement and success of his entire team. The individual is burdened by his/her possible mistakes in the game. As well, such mistakes made can lead to a negative social evaluation of the individual within the team, which can consequently affect the loss of the individual's self-esteem. Almost all PASS-Vb scales were assessed at least as *moderate* (except *low stressful situations* scale) but the ranges of these scales were very wide (ranging from *not at all stressful* up to *extremely stressful*). Those maximum possible scores on the scales indicate that at least some of the young players find playing volleyball *extremely stressful* in many different situations. As well, this study proved that it is possible to use the overall PASS-Vb questionnaire in further research as a general measure of the primary appraisal of stressful situations in volleyball.

The results of this study on young volleyball players indicate several possible and broad reasons related to the primary appraisal of stressful situations. First, it is possible that some youth volleyball coaches are not sufficiently aware of the experience different stressful situations of their young players. Second, it is possible that coaches pay the most attention primarily to those who show excellence in playing, while they care less about those who are poor in playing and who experience a higher level of stressful situations. Young players with such manner of primary appraisal of situations will probably more often experience an elevated cognitive or somatic state anxiety, which may negatively affect their playing performance. In order to improve the way of experiencing and the primary appraisal of situations, coaches could (or perhaps, they should) undertake different and extensive activities: to prepare players to *think rationally* about efficiency and about possible mistakes related to different volleyball playing situations (e.g., *no one has 100% success; it is not to expect a player to have perfect efficiency in all situations; successful players are those who make fewer mistakes than others; mistakes are an integral part of the game and should be expected to happen*); try to recognize and to take care of those young players who feel high stress in playing volleyball (e.g., they should openly talk about it with the players; *feeling stressed is not necessarily a mistake, nor is it a weakness of the player*); to teach young players to evaluate different situations in volleyball more as *challenging,* and less as *threatening* situations; try *to reduce the pressure* that they themselves (or the club management) put on young players in order to achieve immediate sporting success; to train and to develop *situational competencies* (and *situational self-confidence*) of young players for situations that are considered highly stressful; they should stop *expecting or demanding perfection* (*or perfectionism*) in the playing of volleyball from young players; try to develop general volleyball *self-confidence* in players; to enable young athletes *to achieve a lot of* *successful situations* in training, as well as give them a lot of *positive feedback*, as well as, *positive reinforcements*; in clubs, to develop primarily a *motivational climate* focused on mastery (*task orientation*), and less focused on achievements (*ego orientation*); in volleyball teams, to develop a high level of *social cohesion*, and *task cohesion* focused on playing volleyball.

This study contains some limitations. The first and most important limitation, the *validity* of this questionnaire and its scales has not been established at all, nor has it been confirmed, because no other variables (e.g., *age*, *playing performance*, *experience of playing volleyball*, ...) were used, nor any other questionnaires for validation (e.g., measures of *state anxiety*, *self-confidence*, *cohesion* or *concentration*) were used. Second, based only on assessments of the stressful situations of young players, it is not possible to draw any conclusions about the possible causes of these assessments. Therefore, the recommendations listed in the previous paragraph can only be considered as general recommendations based on the scientific knowledge of sports psychology. In order to solve the mentioned limitations, it is recommended to continue with further research on primary appraisal of situations in order to try to determine the relationships of assessments of the stressfulness with the variables of *gender*, *age* and *playing position* of young volleyball players. Furthermore, it is recommended to determine the possible existence of different *types of assessment of stressful situations* and then to determine types' basic characteristics and frequencies in the population of young players.

CONCLUSIONS

The aim of this study was successfully achieved by constructing 7 scales, with generally satisfactory metric characteristics, for assessing the stressfulness of situations. It was established that young volleyball players most often assess situations in volleyball as *moderately* stressful, and often as *highly* stressful. Those situations that are *decisive* and those that are *more significant* for the young player as well as for the team as a whole were assessed as more stressful. It is recommended to continue using this questionnaire in further research in order to precisely determine the *validity* of constructed scales, as well as, the entire PASS-Vb questionnaire. It is recommended to include more variables of young athletes in further research, which may be significantly related to the way of assessing situations in volleyball (e.g., *gender*, *age*, *playing position*, *playing experience*, and *general* and/or *situational success* of playing volleyball).

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Self-Reported Physical Activity Level of Former Croatian Dinghy Sailors

*Sandra Lulić[1], Goran Gabrilo[1], Ognjen Uljević[1]

[1]Faculty of Kinesiology, University of Split, Split, Croatia

*Corresponding author

ABSTRACT

The aim of this study was to investigate the level of physical activity among former dinghy sailors after their sports careers and to determine if there are differences between men and women. The study involved 26 former dinghy sailors (males-16, and females-10), with an average age of 33.04 years and an average career length of 14.65 years. Participants completed the International Physical Activity Questionnaire (IPAQ) for self-assessment of physical activity during the last 7 days, which includes questions from 4 categories: vigorous activities, moderate physical activities, walking, and sitting. Gender differences were analyzed using an independent sample t-test. Comparing the years of active dinghy sailing, the average age of men is 13.50 years, and women 16.50 years. In this sample, participants were moderate to highly active individuals, and both males and females were above the average of recommended weekly physical activity (WHO). The results showed there are no significant differences between the groups in this study, but males are more into vigorous physical activity, walking, and spending more time sitting than females while females spend more time in moderate physical activity than males. A possible limitation of the study is the small number of participants, but considering the specific nature of the sample, which is inherently limited, it can be concluded that engaging in sailing produces better lifestyle habits, and individuals who have sailed are likely to be more physically active in later stages of life.

Keywords: Sport sailing; Exercise; Inactivity; IPAQ, Public Health;

INTRODUCTION

Sailing is a complex sport influenced by numerous external elements affecting movement, speed, and performance (Anderson, 2008). Meteorological factors such as wind strength and wind direction, waves, clouds, and sea currents are very important components of sailing (Callewaert, Boone et al. 2015). Therefore, equipment in sailing is of crucial importance, but also very significant influencing factors are the experience of the person or the crew, their cognitive abilities, and their physical fitness (Bojsen-Møller, Larsson et al. 2015).

Dingy sailing is Olympic-class sailing in which one or two crew boats compete. Primary actions for dinghy sailing are steering, sheeting (controlling the sails by pulling on the ropes), and hiking (leaning over the side of the boat), which makes dinghy sailing a versatile sport where technical and tactical skills, morphology, and physical fitness are determining factors in performance (Bojsen-Møller et al., 2015). Due to all of the above, training loads in sailing are very high, demanding, and complex. Even though the physical demands of dinghy sailing are high, the duration of a dinghy sailor career is quite long. The lower injury rate and longer sports career duration in sailing than in other Olympic sports have already been recorded (Neville and Folland, 2009; Tomas R. E. and Tomas B. C., 2019).

But, what happens after competitive dinghy sailing is finished?

It is of exceptional importance to continue an active lifestyle, and the impact of physical exercise after a sports career positively affects the health status and mental health of former athletes (Schinke, Stambulova, and Moore, 2018). Also, involvement in sports during the teenage and adolescent periods of life creates healthy habits and encourages an active lifestyle. Physical activity is one of the basic factors for maintaining health in later life. Inactivity affects health and can cause numerous diseases, such as heart and cardiovascular diseases, mental illnesses, diabetes, obesity, hypertension, atherosclerosis, osteoporosis, etc. (González, Fuentes, and Márquez, 2017). Active lifestyle positively influences the aging process since the decrease in physical fitness in the active population is much slower (Warburton et al. 2006).

According to the literature, Croatian citizens are one of the most obese nations in Europe, with an inactive style of living, with more than 60% of the adult population being inactive (Jelaković, Baretić et al. 2023). Also, involvement in sports or organized physical activity in Croatia is decreasing (Ministarstvo turizma i sporta Republike Hrvatske., 2023; Grad Split, 2023). Worldwide, former athletes are more physically active after their careers than non-athletes, with only around 13% of former athletes being inactive (de Subijana, Galatti et al. 2020). There is a lack of studies on the physical activity level of Croatian former athletes, but in one of the research on former rhythmic gymnasts, results are encouraging, with only 5% of the subjects being inactive (Gabrilo, 2022).

The aim of this study is to investigate the level of physical activity among former dinghy sailors and to see if there are any differences in activity levels between men and women.

METHODS

In this research 26 former dinghy sailors participated (mean age, 33.04 years of age), separated in two groups: 10 females (mean age, 32.20 years of age) and 16 males (mean age, 33.56 years of age). A self-administered International Physical Activity Questionnaire (IPAQ) that had been previously used in similar studies was used as a measurement tool (Craig, Marshall et al. 2003). Participants filled out an online questionnaire that was conducted via an internet platform. Based on previous studies the content validity of the questionnaire is therefore presumed (Lee, Macfarlane et al. 2011). The questionnaires were designed to be used by adults aged 18–65 years. The short version (7 questions) provided information on the time spent walking, in vigorous- and moderate intensity activity and in sedentary activity. Participants were instructed to refer to all domains of physical activity. Two questions about sailing careers were added to the IPAQ questionnaire.

1. How long was your active sailing career (in years)?

2. How long since you stop active sailing (in years)?

The data collected from the short IPAQ questionnaires was summed, and descriptive data was calculated for both groups. To establish the differences between male and female sailors, a t-test for independent samples was conducted. A value of $P < 0.05$ was considered statistically significant. The statistical analyses were performed using Statsoft's Statistica version 13.

RESULTS AND DISCUSSION

Table 1: Descriptive data and t-test for independent samples: differences between male and female sailors

Questions	MALES (N-16)				FEMALES (N-10)				t-test	
	Mean	Min	Max	SD	Mean	Min	Max	SD	t	p
Age	33.56	21	56	9.74	32.20	21	48	8.19		
How long was your active sailing career (in years)?	13.50	4	23	5.68	16.50	11	24	4.62	-1.40	0.17
How long since you stop active sailing (in years)?	11.25	1	30	7.41	6.50	1	12	4.17	1.84	0.08
During the last 7 days, on how many days did you do vigorous physical activities like heavy lifting, digging, aerobics, or fast bicycling?	4.00	2	6	1.48	3.75	1	7	2.55	0.27	0.79
How much time did you usually spend doing vigorous physical activities on one of those days? (in minutes)	162.27	15	540	139.88	155.00	60	480	129.90	0.12	0.91
During the last 7 days, on how many days did you do moderate physical activities like carrying light loads, bicycling at a regular pace, or doubles tennis? Do not include walking.	3.33	1	7	2.06	4.17	1	7	2.79	-0.76	0.46
How much time did you usually spend doing moderate physical activities on one of those days? (in minutes)	132.14	20	330	103.19	162.00	60	360	119.25	-0.53	0.60
During the last 7 days, on how many days did you walk for at least 10 minutes at a time?	6.07	1	7	2.02	4.44	1	10	2.79	1.63	0.12
How much time did you usually spend walking on one of those days? (in minutes)	80.42	15	180	58.25	58.57	5	120	41.50	0.87	0.40
During the last 7 days, how much time did you	264.00	60	600	177.19	206.67	0	480	175.21	0.77	0.45

spend sitting on a week day? (in minutes)	

Legend: (mean, Min – lowest result, Max – highest result, SD – standard deviation, t-value; p-value - significant statistical difference between groups if p<0,05)

Table 1 represents descriptive statistical data for men and women. There are no significant differences between the groups in this study. The length of the sports career, which is impressive for both groups, makes it evident that women have been involved in active sailing for a bit longer than men. Males mean age 13.50 years, and females mean age 16.50 years of active dinghy sailing, respectively. The length of sports career in dinghy sailing has already been reported as long-lasting (Neville and Folland, 2009; Tomas R. E. and Tomas B. C., 2019), and this study confirms the long career duration in Croatian dinghy sailors. An interesting fact in this study is the male-female ratio (61.5 % male vs 38.5 % female). This proportion is in accordance with gender involvement in sailing in Croatia, and in sports in Croatia in general (Grad Split, 2023), but also in accordance with a social phenomenon that "sports are for men" (Theberge, 2000., Eime et al. 2016).

Even though there are no statistically significant differences between the groups, the research results indicate that males are more into vigorous physical activity, walking, and spending more time sitting than females (vigorous activity: males – 58,57 minutes / females - 155,00 minutes; walking: males – 80,42 minutes / females - 155,00 minutes; sitting: males – 264,00 minutes / females – 206,67 minutes). Females spend more time in moderate physical activity than males (moderate activity: males – 132,14 minutes / females - 162,00 minutes). The mentioned differences are probably explained by the fact that men more often choose activities of higher intensity, while women prefer to choose activities of moderate intensity (Hands, Larkin et al. 2016). According to the World Health Organization (WHO, 2022), the recommended weekly amount of physical activity for adults is 150–300 minutes of moderate physical activity, 75–150 minutes of vigorous physical activity, or their equivalent combination. In the observed sample of participants, it can be noted that they performed an average of 159 minutes / 3.89 days of vigorous physical activity, 140 minutes / 3.57 days of moderate physical activity, and walked an average of 72.37 minutes / 5.43 days during one week. From Table 1, it is evident that the participants spend longer periods of time engaging in vigorous physical activities and walking and a little less engaging in moderate physical activity. Therefore, due to the equivalent combination of intense and moderate activity and walking, it can be concluded that the participants fulfill the recommended weekly physical activity by the World Health Organization (WHO, 2022) and that their level is moderately active according to the criteria of the IPAQ questionnaire. Both men and women, during a dinghy sailing career, are involved in the same amount of training load and even train together most of the time, so a similar activity level was expected. Comparing this sample of subjects with those of other former athletes, we can conclude that the activity level of former dinghy sailors is similar to that of former rhythmic gymnasts (Gabrilo, 2022). Comparing this research with that of former sailors and the research conducted with former rhythmic gymnasts, it is evident that they are significantly more active than the average population of the

Republic of Croatia (Ministarstvo turizma i sporta Republike Hrvatske., 2023). This research emphasizes the importance of involvement in sports at a young age to create healthy lifestyle habits.

CONCLUSION

This paper was made to evaluate the weekly physical activity of former sailors and what impact sailing leaves after a sports career. In the observed sample, there are significantly fewer women than men, which confirms the fact that, in general, the number of women in Croatian sailing is significantly lower compared to men, all due to the insufficient promotion of women's equality in sports. Furthermore, one of the more interesting data points in this research is the duration of a sailing career, which is considerably longer than in other sports. Gender differences indicate that men are more often involved in vigorous physical activities in their weekly routine, while women spend most of the time doing moderate physical activity. However, both groups are above average for the recommended amount of weekly physical activity. In other words, there is no statistically significant difference between men and women in physical activity level, but both groups transfer the same benefits of doing sports and transfer them into healthy lifestyle habits; only the choice of intensity is different. Which leads to the conclusion that people who are engaged in dinghy sailing will very likely remain physically active long after the end of their career, and will achieve long-term quality health benefits. In future research, it is necessary to increase the sample of respondents as much as the specificity of this population allows, and it would be good to include a check of health status to see if there is a direct transfer of the effects of sailing on health.

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Physical Activity and Quality of Life of Adolescents

Božo Vasilj[1], *Franjo Lovrić[1], Martina Rezić[1]

[1]University of Mostar, Faculty of Science and Education, Mostar, Bosnia and Herzegovina

*Corresponding author

ABSTRACT

The aim of this research is to determine the level of physical activity of high school students and its connection with the perception of quality of life. The sample consists of 158 students (78 men and 80 women) of the High School in Čitluk, Bosnia and Herzegovina, with an average age of 16.8 years. The sample of variables is comprised from World Health Organization – Quality of Life questionnaire, and Physical Activity Questionnaire for Adolescents (PAQ-A). Data are presents in program Statistica. Analyses of differences among men and women in PAL were done by independed T- test, and correlation between PAL and satisfaction with life level (SWLL) were done by Pearson´s correlation coefficient. Results showed very low level of PAL (2.46), and significant differences in PAL between men and women (t- test=3.47; p=0,001). Correlation between PA and SL are statistical significant (r=0.36; p=0.001). Low level of physical activity in modern living conditions is a worrying trend and a global public health problem. This is confirmed by the results of this research. Therefore, through the school activities themselves, it is necessary to arouse the interest of high school students through interesting curricular and extracurricular activities that would increase the participation of young people in physical activity. CONCLUSIONS: The research results indicate a generally low level of physical activity among adolescents, with an emphasis on schoolgirls. A significant connection between the level of physical activity and the perception of the quality of life was also confirmed.

Keywords: high school students, satisfaction of life, level of physical activity, questionnaire.

INTRODUCTION

Physical activity is defined as any bodily movement produced by skeletal muscles that results in energy expenditure (Caspersen et al., 1985). Physical activity in daily life can be categorized into occupational, sports, conditioning, household, or other activities. Physical activity involves people moving, acting and performing within culturally specific spaces and contexts, and influenced by a unique array of interests, emotions, ideas, instructions and relationships (Piggin, 2019). In addition to the above, when we talk about the quality of life, the part about the health importance of physical activity is especially recognized and emphasized (Hallal et al. 2006.; Koster et al., 2012). The guidelines of the World Health Organization (2018) state that regular physical activity is proven to help prevent and treat noncommunicable diseases (NCDs) such as heart disease, stroke, diabetesand breast and colon cancer. It also helps toprevent hypertension, overweight and obesityand can improve mental health, quality of life and well-being. Physical activity in young people has been associated with a reduced risk of obesity, metabolic syndrome, beneficial effects on mental health, school performance, sleep duration and wellbeing. Most evidence suggests that physical activity declines with age throughout adolescence, although evidence on the magnitude of the declineis equivocal (Corder et al., 2019). Although students in high school have physical education classes, and in addition are not employed and burdened with family obligations, the data on the level of physical activity of adolescents is devastating. Most of them stop their organized sports activities in this period and spend most of their free time passively. Worldwide, 3 in 4 adolescents (aged 11–17 years), do not currently meet the global recommendations for physical activity set by WHO (2018). Those recommendations say that children and adolescents should do at least an average of 60 minutes per day of moderate to vigorous-intensity, mostly aerobic, physical activity, across the week. Vigorous-intensity aerobic activities, as well as those that strengthen muscle and bone, should be incorporated at least 3 days a week.

The aim of this paper is to determine the level of physical activity of high school students and its connection with the perception of quality of life.

METHODS

One hundred and fifty-eight adolescents (78 boys and 80 women, 16.8 ± 1.2 years) took part in the study. The sample was taken in the city of Čitluk, Bosnia and Herzegovina in school-age adolescents. The variables in this study included sociodemographic characteristic sex (male or female) and age in years, anthropometrics (body height, body weight and body mass index, BMI=mass(kg)/height^2(m)), physical activity level and quality of life. Assessment of the level of physical activity and quality of life was assessed using a questionnaire. Participants completed the questionnaire on the online platform Survey Monkey (SurveyMonkey Inc., San Mateo, USA).

Physical Activity Questionnaire for Adolescents (PAQ-A) was used to assess the physical activity level (PAL). Participants had to recall the past seven day and report it through nine items. The first eight item included questions about types of physical activity (i.e., activities during free play, sports, physical educations classes and transportions) and ninth item was not considered in the final score (participants who had some injuries). The items were scaled on the 5-point Likert scale, and the overall score ranged 1 to 5 representing minimum and maximum PAL.

The quality of life (QoL) was measured using the questionnaire from World Health Organisation (WHO). Satisfaction with life was measured using the satisfaction with life level (SWLL). This level has 10 item on a 5-point Likert scale ranging from 1 (tottaly disagree) to 5 (totally agree). The mean of the item is used to calculate the total SWLL.

Experiencing negative feelings (bad mood, despair, depression and anxiety) are shown by graphs with answer: 1- never; 2- sometimes; 3- usually; 4- quite often; 5- always.

The data were processed from statistical package Statistica 13.0 (Statsoft, Tulsa, OK, USA) and MS Excel. For the presentation of data basic descriptive statistics was use and as a result, means and standard deviations were calculated for numerical variables. The Kolmogorov-Smirnov test was used to check the normality of the distributions. Analyses of differences among men and women in PA were done by independed T- test, and correlation between PA and satisfaction of life (SL) were done by Pearson´s correlation coefficient. To assess statistical significance of differences we used the level of significance $p<0.05$ and $p>0.20$ for Kolmogorov-Smirnov test (test for normality).

RESULTS

Table 1 shows the descriptive characteristics of participants. They had a mean age 16.85 ±

1.17 years. The mean of the body weight is 67.24 kg and body height 177.21 cm. High school adolescents had a mean of BMI 21.12 (healthy weight).

Table 1. Descriptive characteristics of participants

Participants	*Mean (SD) Total*	*Mean (SD) Boys*	*Mean (SD) Girls*
N	*158*	*78*	*80*
Age	*16.85 (1.17)*	*16.91 (1.19)*	*16.80 (1.16)*
Bodyweight	*67.24 (12.98)*	*75.96 (11.30)*	*58.63 (7.73)*
Bodyheight	*177.21 (10.26)*	*184.64 (7.78)*	*169.97 (6.53)*
BMI	*21.12 (3.23)*	*22.24 (2.64)*	*20.04 (3.40)*

Table 2 shows the descriptive statistics of physical activity level (PAL) and satisfaction with live level (SWLL). The results show low level of PAL (2.46) and optimal to high level of SWLL (3.85).

Table 2. Descriptive statistics of physical activity level (PAL) and satisfaction with live level (SWLL)

	Physicalactivitylevel (PAL)			*Satisfactionwithlifelevel (SWLL)*		
	Total	*Boys*	*Girls*	*Total*	*Boys*	*Girls*
Mean (SD)	*2.46 (0.70)*	*2.65 (0.7)*	*2,28 (0.7)*	*3.85 (0.64)*	*3.96 (0.77)*	*3.75 (0.61)*
Min	*1.25*	*1.25*	*1.25*	*2.30*	*2.30*	*2.30*
Max	*4.75*	*4.75*	*4.75*	*5.00*	*5.00*	*5.00*

High school adolescents assessed their quality of life like a pretty good (46%) and 15% like a very good. It is worrisome that there are adolescents who assess their quality of life with very bad (1%) and bad (4%) (figure 1).

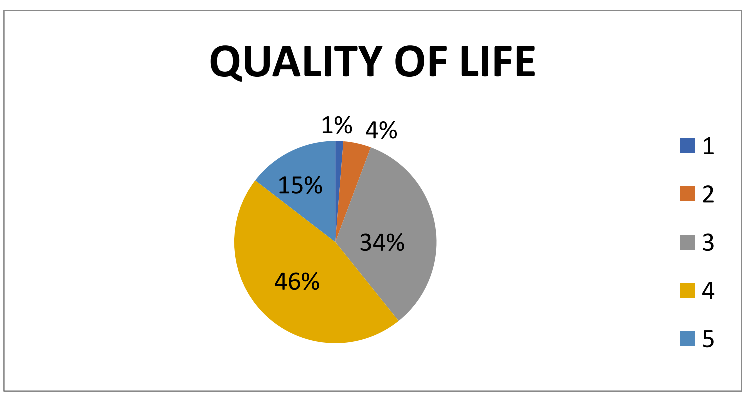

Figure 1. Quality of life

Table 3 shows the differences between girls and boys in level of physical activity and satisfaction with life. Boys showed higher levels of physical activity and satisfaction with life compare to girls. Results showed very low level of PAL (2.46), and significant differences in PAL between boys and girls (t-test=3.47; p=0.001), and significant differences in SWLL between boys and girls (t-test=2.04; p=0.001). P value of Kolmogorov-Smirnov test showed normal distribution (p>0.20).

Table 3. Independent T- test and KS test

Variables	Boys	Girls	t- value	p value	KS p value
Physical activity level (PAL)	2.65 (0.7)	2,28 (0.7)	3,47	0.001	p>0.20
Satisfaction with lifelevel (SWLL)	3.96 (0.77)	3.75 (0.61)	2.04	0.001	p>0.20

Correlation between of physical activity level (PAL) and satisfaction with life level (SWLL) showed positive, small but statistical significance correlation (table 4).

Table 4. Pearson`s coefficient of correlation

Variables	Mean (SD)	r	r²	t value	pvalue
PAL	2.5 (0.7)	0.36	0.13	4.85	0.001
SWLL	3.9 (0.7)				

Total of 21% adolescents often (15%) or always (6%) experience negative feelings. Most of adolescence sometimes experience negative feelings (44%) (figure 2). Results showed the data of two week past.

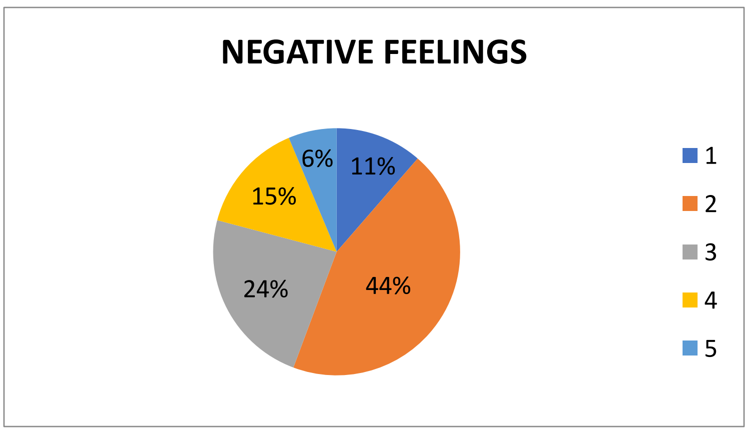

Figure 2. Experiencing negative feelings

Almost 71% of the adolescents declared being satisfied with their health status (pretty satisfied 40% and very satisfied 31%) (figure 3). 3% adolescents declared being very unsatisfied with health status.

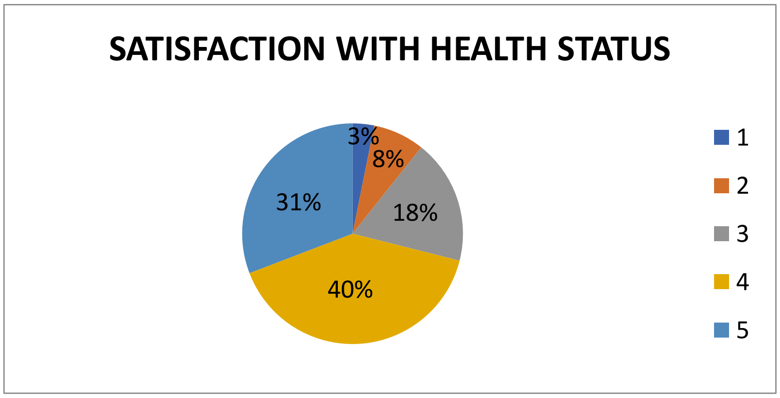

Figure 3. Satisfaction with health status

DISCUSSION AND CONCLUSION

The presented results on the low level of physical activity of adolescents are in accordance with previous research (Dumith et al., 2011.; World Health Organisation2018.; Guthold et al., 2020). Also, the differences in the level of physical activity between female and male students are in favor of previous research in which male students are more active than female students (Bergier et al., 2016.; 2018)

We can say that these results are expected and confirm the sedentary lifestyle of today's youth.What is even more worrying is the lower level of physical activity in adulthood than in adolescence (Corder et al., 2019). Contents that include daily physical activity, as well as that in free time, are reduced to a minimum. The above leads to the development of negative habits in which movement and physical exercise are not on the priority list.

The authors of this article consider the disproportion between the results of a low level of physical activity and a high percentage of young people's life satisfaction to be particularly interesting. The question arises about the education of young people about the importance and benefits of physical activity as a prevention of a large number of chronic non-communicable diseases (Wilmot et al., 2012) that will certainly affect the quality of life in the future.So, low level of physical activity in modern living conditions is a worrying trend and a global public health problem. Therefore, through the school activities themselves, it is necessary to arouse the interest of high school students through interesting curricular and extracurricular activities that would increase the participation of young people in physical activity. Additionally, for a clearer picture and new answers, it would be interesting to investigate the physical literacy of adolescents, which is considered one of the determinants of the level of physical activity (Öztürket al., 2023). Also, we should not run away from our own responsibilityas a physical education teacher, which refers to the quality of physical education classes and its influence in promoting an active lifestyle.

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Rapid Weight Loss among Boxing Athletes: Prevalence, Magnitude, and Methods

*Goran Kuvačić[1], Nikola Marketin[1], Vedran Bajlo[1], Saša Krstulović[1]

Faculty of Kinesiology, University of Split, Split, Croatia

*Corresponding author

ABSTRACT

This study aimed to determine the prevalence, magnitude, and methods of rapid weight loss (RWL) among amateur boxers from Croatia, Slovenia, Bosnia and Herzegovina, and Serbia. A total of 86 active competitors aged over 12 participated, using a modified Rapid Weight Loss Questionnaire (RWLQ). Results indicated that all surveyed boxers (100%) engaged in RWL practices. The average RWL score was 40.6 ± 13.9, with boxers losing an average of 3.1 kg (4% of body weight) over 8.4 ± 5.9 days. Nearly 18% reported losing 8-10% of their body weight at their maximum, while 37.2% typically lost 2-4 kg before competitions. Older and more successful boxers demonstrated higher RWLQ scores. ANOVA showed significant differences in RWLQ scores across competitive levels, with international-level boxers having lower scores than county/city-level boxers ($F = 3.62$, $p = 0.01$). Boxers who changed weight categories had significantly higher RWLQ scores ($t = 2.27$, $p = 0.03$). The findings highlight the widespread use of RWL practices and potential health risks.

Keywords: questionnaire, weight management, amateur boxing

INTRODUCTION

Boxing is considered one of the world's most physically and mentally demanding sports. Despite its popularity, even professional boxing has received very little attention in the global scientific literature. (Ruddock, Wilson, Thompson, Hembrough & Winter, 2016). One of the current topics in almost all combat sports, including boxing, is the rapid weight loss. Given that boxing falls into the category of weight-class sports for fairer competition, boxers are required to reach the set limit before the competition. Weight reduction is an essential part of boxing due to the rules that divide athletes into weight categories to ensure a fairer selection, i.e., pairing boxers of similar size. Due to limited scientific studies on the prevalence of rapid weight loss, its true frequency is unknown, but it is estimated that more than 50% of athletes have engaged in rapid weight loss during the competitive period. Research has shown that rapid weight loss can have significant physical, physiological, and psychological effects on athletes. For this reason, well-planned and safe weight loss under the supervision of a team of coaching staff, sports nutritionists, and sports doctors is recommended. (Khodaee, Olewinski, Shadgan & Kiningham, 2015).

In the practice of combat sports, the difference between the upper and lower limits of two consecutive categories is around 15%, while in boxing and judo, the difference is only 5%-10% (Franchini, Brito, and Artioli, 2012). From this, it can be concluded that if a boxer's body weight is in the middle of the weight categories, there is a greater possibility that they will engage in rapid weight reduction to a lower category. To achieve the weight limit and compete in a lighter weight category, a typical approach is acute and/or chronic energy restriction. There is a tendency to believe that if one eats and drinks in a controlled manner before the weigh-in period, the athlete can regain strength. However, despite this belief, there is not enough scientific research to examine the consequences (Hall and Lane, 2001). In the case of extreme rapid weight loss, we put health and performance in the ring at great risk. It is also necessary to highlight the most at-risk group, which is children and adolescents, who are in even greater danger, and there is an indication that extreme weight loss can negatively affect their development.

Therefore, this research aimed to determine the prevalence, magnitude, and methods of rapid weight loss among amateur boxers. Additionally, the following partial aims have been defined in accordance with the main aim: a) to determine the correlation of RWLQ results with the main characteristics of amateur boxers; b) to identify differences in RWLQ results between boxers of different competitive success; c) to identify differences in RWLQ results between boxers who have changed their weight category and those who have not changed it in the last two years.

METHODS

The sample of participants consisted of eighty-six amateur boxers from four countries (Croatia, Slovenia, Bosnia and Herzegovina, and Serbia). The research was conducted via an electronic questionnaire (SurveyMonkey platform, USA). The inclusion criteria for sending the questionnaire was that the boxers had to be active competitors older than 12 years old.

To collect data on methods of rapid weight loss among boxers, a modified Rapid Weight Loss Questionnaire (RWLQ) was used (Artioli et al., 2010). After making the necessary modifications (original modification of the questionnaire), the content validity of the questionnaire was checked (validated by experts consisting of a nutritionist, a sports doctor, a boxing coach, and a competitive boxer). The questionnaire was then translated into Croatian, Slovenian, Bosnian, and Serbian by professional translators.

The normality of the distribution of results was checked using the Shapiro-Wilks test. Since the distribution was not violated, the results are presented using the arithmetic mean ± standard deviation (SD), range, frequencies, and percentage points (%). Athletes weighing more than 91 kg were excluded from this study because they did not need to lose weight. Pearson's product-moment correlation coefficient (r) was used to determine the correlation between RWLQ results and the main characteristics of the boxers. Analysis of variance (ANOVA) was used to determine the differences in RWLQ score between boxers of different competitive success (international, regional, national, and county/city level). Bonferroni correction was applied for multiple comparisons between observed groups. The Student's t-test for independent samples was used to determine the differences in RWLQ score between boxers who changed weight categories and those who did not change their weight category in the last two years. The significance level was set at $p < 0.05$. All data were analyzed using SPSS 28.0 statistical software (SPSS, Chicago, IL, USA)

RESULTS AND DISCUSSION

Table 1 displays the main characteristics of the participants and their characteristics related to weight loss. According to the RWLQ score, the practice of rapid weight loss is evident among all boxers (100%). It can be concluded that the prevalence of rapid weight loss in this study is higher than all previous studies conducted on samples of combat sports athletes, except those conducted on elite boxers (Peron, 2009) and kick-boxers (Dugonjić, Krstulović, Kuvačić (2019). Analysis of the frequency and range of average and highest weight loss, expressed as a percentage of the boxers' total body weight, indicates that almost 18% of participants reported losing the most weight in their careers, between 8-10%. About 37.2% of them, on average, lose 2-4 kg before competitions, and it takes them approximately 8 ± 5 days to achieve this.

Table 1. Main participants and weight loss characteristics (n = 86)

Variable	*mean*	±	*SD*	*Min*	-	*Max*
Participants characteristics						
Age (years)	*21.3*	±	*6.2*	*13*	-	*42*
Body weight (kg)	*78.1*	±	*14*	*42*	-	*120*
Body height (cm)	*181.4*	±	*9*	*148*	-	*204*
BMI (kg/m²)	*23.7*	±	*3.3*	*16.8*	-	*39.2*
Age started boxing (years)	*14*	±	*3.8*	*5*	-	*27*
Age started competitions (years)	*15.2*	±	*3.4*	*10*	-	*28*
Current body weight (kg)	*74.1*	±	*11.3*	*40*	-	*91*
Body weight out-season (kg)	*77.2*	±	*14.3*	*37*	-	*122*
Competitions last year (n)	*6.2*	±	*6*	*1*	-	*24*
Medals last year (n)	*3*	±	*2.1*	*0*	-	*14*
Weight loss characteristics						
Most weight loss (kg)	*5.4*	±	*3.2*	*1*	-	*15*
Most weight loss (%)	*6.9*	±	*3.6*	*1.2*	-	*18.3*
Weight losses last year (n)	*2.9*	±	*2.2*	*0*	-	*12*
Average weight loss (kg)	*3.1*	±	*1.7*	*0*	-	*8*
Average weight loss (%)	*4*	±	*2*	*0*	-	*9.6*
Days to lose weight (n)	*8.4*	±	*5.9*	*1*	-	*30*
Age started weight loss practice (years)	*16.5*	±	*5.9*	*10*	-	*32*
Weight usually regained (kg)	*3.1*	±	*1.8*	*1*	-	*10*
RWLQ score	*40.6*	±	*13.9*	*13.5*	-	*73*

Table 2 shows reported weight loss methods. The three most commonly used weight loss methods among amateur boxers were increased exercise, restricting fluid intake, and skipping 1 or 2 meals. Further analysis shows that a high percentage of athletes use extreme weight reduction methods (i.e., laxatives 16.3%, diuretics 30.2%, diet pills 3.5%, vomiting 8.1%). This result is concerning because it is known that these methods particularly impair the athletes' psycho-physical condition (Dugonjić et al., 2019). Additionally, boxing (45.3%) and strength and conditioning coaches (24.3%) influenced weight management behaviors most among amateur boxers. On the other hand, the least influence came from doctors and nutritionists.

Table 2. Reported weight loss methods (frequencies) (n = 86)

Method	Always (%)	Sometimes (%)	Almost never (%)	Never (%)	Do not use anymore (%)
Gradual					
Gradual diet	29.1	36	15	17.4	2.3
Increased exercise	58.1	25.6	4.7	9.3	2.3
Rapid					
Skipping 1 or 2 meals	33.7	50	4.7	11.6	0
Fasting (entire day without eating)	8.1	32.6	14	44.2	1.2
Restricting fluid intake	37.2	37.2	5.8	19.8	0
Training in heated rooms	27.9	37.2	11.6	22.1	1.2
Sauna	16.3	41.9	11.6	29.1	1.2
Training in rubber/plastic suits	30.2	40.7	5.8	23.3	0
Using winter or plastic suits	3.5	18.6	8.1	69.8	0
Spitting	8.1	14	15.1	61.6	1.2
Laxatives	16.3	41.9	11.6	29.1	1.2
Diuretics	30.2	40.7	5.8	23.3	0
Diet pills	3.5	18.6	8.1	69.8	0
Vomiting	8.1	14	15.1	61.6	1.2

The relationships between the RWLQ score and the main participant characteristics in the observed sample are shown in Table 3. Statistically significant correlations were found with the age of the boxers, BMI, and the number of medals won in the past year. Older boxers are more likely to practice rapid weight loss methods, which is ultimately logical. The processes of growth and development conclude around the age of 19, leading to the stabilization of body weight (Malina, Bouchard, i Bar-Or, 2004).

Table 3. Relationships between RWLQ results and the main characteristics of the boxers (n = 86)

Variable	r	r^2	t	p
Age (years)	0.28	0.08	2.71	<0.05
Age started boxing (years)	-0.13	0.02	-1.18	0.24
Age started competitions (years)	0.05	0.24	-1.23	0.22
BMI (kg/m^2)	0.3	0.09	2.92	<0.05
Competitions last year (n)	0.02	0.04	1.9	0.06
Medals last year (n)	0.26	0.07	2.5	<0.05

Legend: r - Pearson's product-moment correlation coefficient, r^2 - coefficient of determination, t – t value, p - significance level

Figure 1 shows the RWLQ scores of boxers with different competitive success levels. Anova revealed significant differences between groups were found (F = 3.62, p =

0.01), specifically between boxers at the international level and those at the county/city level (p = 0.02). The graph shows a declining trend in RWLQ score with the competitive level. The least successful boxers have the lowest scores. This can be explained by the fact that top-level boxers tend to remain in their weight categories as long as possible. Changing categories leads to reduced competitive success due to new opponents, decreased strength and power, and other factors (Franchini, Brito & Artioli, 2012).

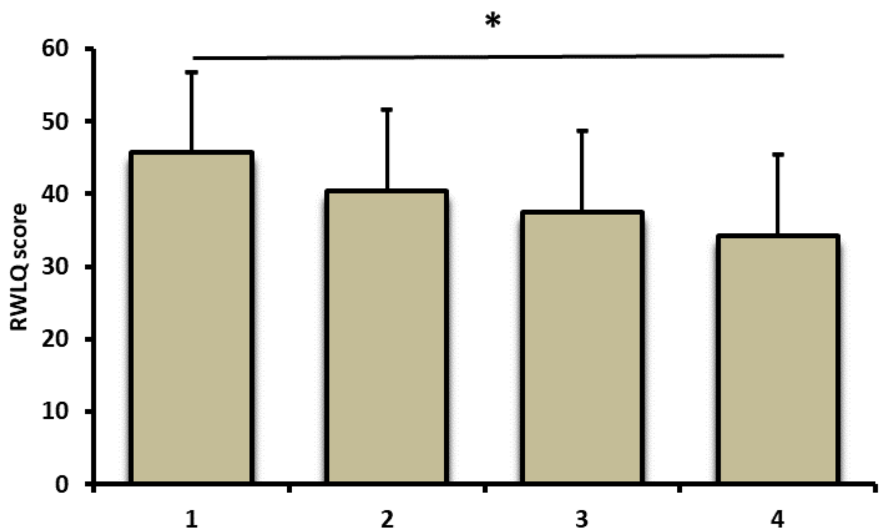

Figure 1. Differences in RWLQ score between boxers of different competitive success.
*1 – international level, 2 – regional level, 3 – national level, 4 – county/city level; * p < 0.05*

Figure 2 shows RWLQ scores of boxers who have changed their weight category and those who have not changed it in the last two years. Results indicate that boxers who changed their weight category have a significantly higher RWLQ score (t = 2.27, p = 0.03) compared to those who remained in their categories (43.7 vs. 37.1). This is an interesting finding considering that moving to a higher category implies less need for weight reduction. Since the questionnaire evaluates current weight management behaviors, as well as the history of weight loss, it is expected that athletes with a previous history of extreme weight loss would score higher on the RWLQ than athletes who have never used extreme weight loss methods (Artioli et al., 2010).

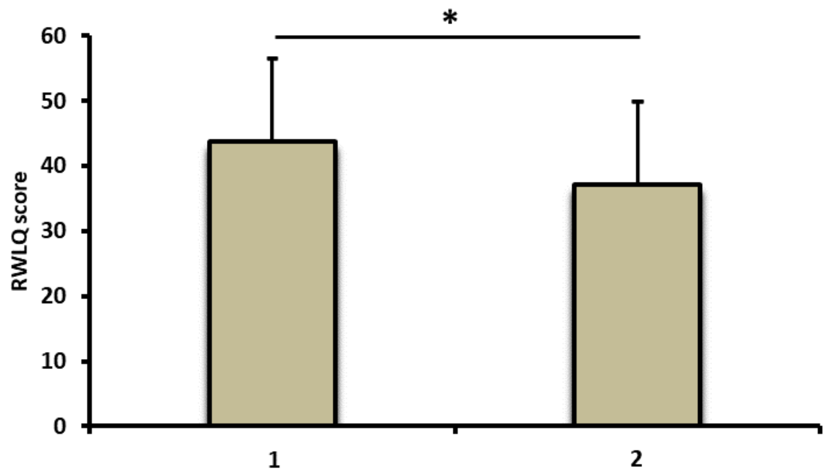

*Figure 2. RWLQ scores of boxers who have changed their weight category and those who have not changed it in the last two years; * p < 0.05*

CONCLUSION

The results of this study indicate that the practice of rapid weight loss is present in all boxers (100%). The research also showed that boxers who changed weight categories had significantly higher scores on the RWLQ score, indicating more aggressive weight loss methods that can have dangerous health consequences. Future research should include more boxers from different countries and various levels of competition. Investigating the long-term physical and psychological consequences of rapid weight loss is also essential.

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Analysis of Situational Efficiency of U-19 Goalkeepers From First Croatian League

Miro Labrović[1], *Ante Rađa[1,2], Jakov Marasović[1], Marko Erceg[1], Antonio Sebežević[2]

[1]Faculty of Kinesiology, University of Split, Split, Croatia; [2]HNK Hajduk Split, Split, Croatia

*Corresponding author

ABSTRACT

The situational efficiency of goalkeepers in football is one of the most important factors that influence the team's success. It primarily depends on their ability to quickly assess the situation, react correctly and make decisions in high-tempo moments of the game. First goal of this research was to analyze situational efficiency parameters of U19 goalkeepers from the first Croatian league. The second goal was to determine if there were differences in the parameters of the situational efficiency of goalkeepers from clubs with different levels of success in actions with and without ball in possession**.** 17 soccer goalkeepers who played 16 matches of the first junior Croatian soccer league (U19) participated in this research. The respondents were divided into two groups: MSG (more successful teams goalkeepers) and LSG (less successful teams goalkeepers). In the paper, 25 variables of the situational efficiency of soccer goalkeepers were observed, 7 of which were variables in actions without the ball in possession and 17 variables were in actions with the ball in possession**.** MSG had a ratio of 3.86 in actions during possession vs actions without ball in possession. Similarly, LSG also had higher number of actions during possession but with a lower ratio (2.45). In actions without ball in possession (with $p<0.05$), the number of saves in 16 m and the number of goals conceded inside 16 m (2.86/2.53 vs. 0.82/0.35) were higher in the goalkeepers of less successful teams than in the goalkeepers of more successful teams. On the other hand, in actions with the ball in possession, it is observed that the MSG are more active in play with the ball possession in the first zone than the LSG (11.35 vs. 4.07). LSG intervened more often in inactive play with leg A1 than those goalkeepers of more successful clubs (5.27 vs. 2.71)**.** The results suggest a lower number of defensive interventions by goalkeepers of more successful teams than less successful ones. Furthermore, as far as attacking actions are concerned, especially in the opening phase of the game, the goalkeepers of more successful teams showed greater activity than the goalkeepers of less successful teams. The distribution of the ball proved to be an important factor both in this research and in general in today's football, where the goalkeeper needs to be technically sound because it is used more and more in the opening phase of the game and as an additional option when coming out of pressing. In modern soccer, passing is one of the greatest goalkeeping qualities that can separates top goalkeepers from the rest.

Keywords: situational efficiency, goalkeepers, more successful teams, less successful teams

INTRODUCTION

In the last few decades, soccer has become one of the most popular sports in the world, with a huge number of players, fans and clubs all over the planet (Johnson, 2019, Lee, 2020). However, success in football is not only a matter of luck or talent - the ability of individual players to effectively perform their roles in the team, especially in the defensive line, also plays a big role (Wilson, 2022). One of the key players in this regard is the goalkeeper, who plays an important role in stopping the opponent's attacks and maintaining the team's stability. The role of the goalkeeper in football has undergone significant changes throughout different historical periods. From passive participants in defense to key distributors of possession play, goalkeepers have become an indispensable part of modern football (Smith, 2018, Wilson, 2021). Their number of touches in matches has increased with the aim of actively participating in building play and short combinations with the rest of the team. Some of the roles of goalkeepers are goal protection, defense organization, reactions to shots, tactical understanding and psychological influence on the team that makes them an irreplaceable part of the team (Brown, 2017). Vlaović et al., 2020 point out that the abilities like quick reaction, dexterity and accurately catching or deflecting the ball are key to preventing the opponent from scoring. According to research by the author Gonzalez et al. 2021, a goalkeeper must have quick reactions and exceptional reflexes to stop shots from close range or distance in types of breaks such as free kicks, corners or penalties. The ability of goalkeepers to react calmly and accurately to these situations can be crucial for preserving the result of the match (Smith, 2018, Wilson, 2021, Sousa et al., 2022). The situational efficiency of goalkeepers in football is one of the most important factors that influence the team's success, as shown by previous research (Liu et al., 2015, Smith, 2017). It primarily depends on their ability to quickly assess the situation, react correctly and make decisions in high-tempo moments of the game (Brown, 2017). Research conducted by Murphy et al., 2024 showed that the average efficiency of goalkeepers to prevent a goal was about 67%, indicating that in most cases they were able to save the shot. In addition to the goalkeeper's performance with his hands, those with the ball in his feet also play a big role (Sousa et al., 2022). A goalkeeper who knows how to play with the ball at his feet is better in the opening phase of the football game and is offered as an additional option in building the attack (Santos et al., 2022). Goalkeepers with better ball distribution in modern football are more often selected as more successful than those with worse footwork (Karaula, 2022, Szwarc et al., 2023). Seaton & Campos 2011 suggest that goalkeepers should possess good accuracy with the ball and technical abilities. Goalkeepers who were selected as better quality differed significantly in the variables of passes and accurate long balls in contrast to those of less quality (Szwarc, 2010, Bašić, 2016). First goal of this research was to analyze situational efficiency parameters of U19 goalkeepers from the first Croatian league. The second goal was to determine if there were differences in the parameters of the situational efficiency of goalkeepers from clubs with different levels of success in actions with and without ball in possession.

METHODS

Participants

17 soccer goalkeepers 18.3±0.3 years of age who played 16 matches of the first junior Croatian soccer league (U19) participated in this research. Respondents were divided into groups in relation to the quality of the team: MSG (more successful teams goalkeepers) and LSG (less successful teams goalkeepers). Quality of the team is based on ranking from competitive season 2021/2022. Goalkeepers from the teams at the top 4 of the league table were classified as MSG while others were classified as LSG.

Variables

In the paper, 25 variables of the situational efficiency of soccer goalkeepers were observed, 7 of which were variables in actions without the ball in possession and 17 variables were in actions with the ball in possession.

Actions without ball in possession**:** saves in 16m, high ball successful catch, high ball not successful catch, hand pass 1st zone, hand pass 2nd zone, goals conceded inside 16m, goals conceded outside 16m

Actions with ball in possession: active play with ball, A1, active play with ball A2, active play with ball A3, active play with ball F1, active play with ball F2, active play with ball F3, inactive play with ball A1, inactive play with ball A2, inactive play with ball A3, inactive play with ball F1, inactive play with ball F2, inactive play with ball F3, exit to the ball A1, exit to the ball A2, exit to the ball A3, exit to the ball F1, exit to the ball F2, exit to the ball F3

Legend – (A1) accurate passes zone 1, (A2) accurate passes in zone 2, (A3) accurate passes in zone 3, (F1) fail passes in zone 1, (F2) fail passes in zone 2, (F3) fail passes in zone 3.

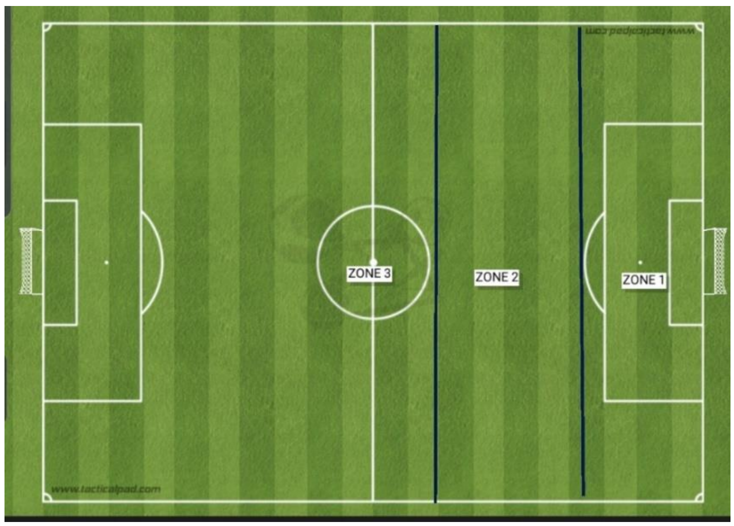

Figure 1. Zone of play by the goalkeepers

Legend – zone 1 (20m from the goal), zone 2 (20-40m from the goal), zone 3 (40m+ from the goal)

Statistical analysis

Previously collected data was manually entered into Microsoft Excel tables and later processed in the "Statistica 13.5" program. Descriptive statistics parameters were calculated for all variables and all groups of respondents. T-test for independent samples was used to determine statistical significance between groups.

RESULTS

Table 1. T-test for independent samples for actions without ball in possession between goalkeepers of more successful and less successful teams.

Variables	*A1*	*A2*	*t*	*p*	*N1*	*N2*	*SD1*	*SD2*
saves in 16m	*0.82*	*2.86*	*-4.37*	*0.000*	*17*	*15*	*0.66*	*1.80*
high ball successful catch	*1.70*	*2.06*	*-0.61*	*0.548*	*17*	*15*	*1.91*	*1.28*
high ball not successful catch	*0.11*	*0.13*	*-0.13*	*0.898*	*17*	*15*	*0.32*	*0.35*
hand pass 1st zone	*3.17*	*3.00*	*0.26*	*0.795*	*17*	*15*	*1.92*	*1.89*
hand pass 2nd zone	*0.47*	*0.87*	*-1.44*	*0.159*	*17*	*15*	*0.64*	*0.91*

goals conceded inside 16m	*0.35*	*2.53*	*-4.44*	*0.000*	*17*	*15*	*0.49*	*1.95*
goals conceded outside 16m	*0.17*	*0.33*	*-0.77*	*0.445*	*17*	*15*	*0.39*	*0.72*

Legend – (A1) arithmetic mean of goalkeepers of more successful teams, (A2) arithmetic mean of goalkeepers of less successful teams, (t) t-test, (p) level of statistical significance, (N1) number of observed matches of goalkeepers of more successful teams, (N2) number of observed matches of goalkeepers of less successful teams, (SD1) standard deviation of goalkeepers of more successful teams, (SD2) standard deviation of goalkeepers of less successful teams

In Table 1, LSG have a higher number of saves inside 16m and the number of goals conceded inside 16m than MSG, and these differences were the only ones that proved to be significant (2.86/2.53 vs. 0.82/0.35). MSG show less success in catching high balls in contrast to LSG (1.70 vs. 2.06). MSG and LSG show the approximate effectiveness in their unsuccessful catch of high balls (0.11 vs. 0.13). MSG showed higher performance than goalkeepers from less successful clubs in the variable of hand passing in the 1st zone (3.17 vs. 3.00). LSG showed higher success in the hand passing variable in the 2nd zone than MSG (0.87 vs. 0.47). LSG conceded more goals outside the penalty area than MSG (0.33 vs. 0.17).

Table 2. T-test for independent samples for actions with the ball in possession between goalkeepers of more successful and less successful teams.

VARIABLES (zones)	*A1*	*A2*	*t*	*p*	*N1*	*N2*	*SD1*	*SD2*
active play with ball A1	*11.35*	*4.07*	*4.56*	*0.000*	*17*	*15*	*5.42*	*3.173*
active play with ball A2	*2.88*	*2.20*	*0.65*	*0.521*	*17*	*15*	*1.96*	*3.802*
active play with ball A3	*1.88*	*1.67*	*0.34*	*0.735*	*17*	*15*	*2.09*	*1.345*
active play with ball F1	*0.00*	*0.00*			*17*	*15*	*0.00*	*0.000*
active play with ball F2	*0.53*	*0.53*	*-0.01*	*0.989*	*17*	*15*	*0.87*	*0.743*
active play with ball F3	*1.88*	*2.40*	*-0.86*	*0.399*	*17*	*15*	*1.90*	*1.454*
inactive play with ball A1	*2.71*	*5.27*	*-3.39*	*0.002*	*17*	*15*	*1.76*	*2.492*
inactive play with ball A2	*0.71*	*1.53*	*-1.58*	*0.124*	*17*	*15*	*1.05*	*1.846*
inactive play with ball A3	*1.35*	*1.27*	*0.11*	*0.909*	*17*	*15*	*2.09*	*2.154*
inactive play with ball F2	*0.00*	*0.13*	*-1.57*	*0.128*	*17*	*15*	*0.00*	*0.352*
inactive play with ball F3	*0.94*	*2.20*	*-1.51*	*0.141*	*17*	*15*	*1.71*	*2.908*
exits to the ball A1	*1.76*	*1.93*	*-0.30*	*0.764*	*17*	*15*	*1.56*	*1.580*
exits to the ball A2	*1.76*	*1.60*	*0.34*	*0.733*	*17*	*15*	*1.35*	*1.352*
exits to the ball A3	*0.41*	*0.33*	*0.29*	*0.774*	*17*	*15*	*0.87*	*0.617*
exits to the ball F1	*0.06*	*0.07*	*-0.09*	*0.930*	*17*	*15*	*0.24*	*0.258*
exits to the ball F2	*0.12*	*0.40*	*-1.29*	*0.205*	*17*	*15*	*0.33*	*0.828*
exits to the ball F3	*0.06*	*0.00*	*0.94*	*0.356*	*17*	*15*	*0.24*	*0.000*

Legend – (A1) arithmetic mean of goalkeepers of more successful teams, (A2) arithmetic mean of goalkeepers of less successful teams, (t) t-test, (p) level of statistical significance, (N1) number of observed matches of goalkeepers of *more successful teams, (N2) number of observed matches of goalkeepers of less successful teams, (SD1) standard deviation of goalkeepers of more successful teams, (SD2) standard deviation of goalkeepers of less successful teams*

According to Table 2, it can be seen that MSG are more accurate in active play with ball in the first zone than LSG, and this difference was significant (11.35 vs. 4.07, p=0.000). LSG intervened more often in inactive play with ball A1 than MSG, and this variable also proved to be significant (5.27 vs. 2.71, p=0.000). In active play with ball F3, LSG made more mistakes than MSG (2.40 vs. 1.88). In inactive play with ball A2, a greater number of interventions were obtained by LSG than by goalkeepers of more successful clubs (1.53 vs. 0.71). On the other hand, in inactive play with ball A3, MSG had more interventions than LSG (1.35 vs. 1.27). MSG show greater efficiency in exits to the ball in zones 2 and 3, in contrast LSG (1.76/0.41 vs. 1.60/0.33). MSG are slightly more ahead of LSG in fail exits to the ball in zone 3 (0.06 vs. 0.00), while LSG make more mistakes in exits to the ball in zones 1 and 2 in contrast to MSG (0.07/0.40 vs. 0.06/0.12).

Table 3. Number and type of goalkeeper actions

Variables	*N*	*Total number of actions*	*Per game*	*Percentage (%)*	*Ratio*
Actions with ball in possession (MSG)	*506*	*637*	*31.62*	*79.44*	*3.86*
Actions without ball in possession (MSG)	*131*	*637*	*8.18*	*20.56*	
Actions with ball in possession (LSG)	*384*	*543*	*24*	*70.72*	*2.45*
Actions without ball in possession (LSG)	*159*	*543*	*9.93*	*29.29*	

MSG- more successful teams goalkeepers, LSG- less successful teams goalkeepers, Ratio - ratio between actions with ball in possession and actions without ball in possession

The table 3 shows that MSG and LSG had more actions with the ball in their possession than without the ball in their possession. MSG had a higher percentage of actions with ball in possession than LSG (79.44 vs. 70.72%). Subsequently, LSG had more actions without the ball in possession than MSG (29.29 vs. 20.56%). MSG had a 3.86 ratio in possession vs. non-possession actions while LSG had a lower ratio (2.45).

DISCUSSION

First goal of this research was to analyze situational efficiency parameters of U19 goalkeepers from the first Croatian league. The second goal was to determine if there were differences in the parameters of the situational efficiency of goalkeepers from clubs with different levels of success in actions with and without ball in possession. The results of this research showed a statistically significant difference in actions without ball in possession in the variables: *saves in 16m*, *goal conceded inside 16m*. Furthermore, the results show that there are statistically significant differences in the actions with the ball in possession in the variables: *active play with ball A1*, *inactive play with ball A1*.

LSG showed a significantly higher number of *saves inside 16m* than goalkeepers from more successful clubs which is in alignment with findings from Baranda et al., 2019. LSG also had a significantly higher number of *goals conceded inside 16m* than goalkeepers of more successful clubs which was somewhat expected due to a higher number of shots they try to defend compared to MSG. It can be concluded that on average MSG have fewer defensive tasks in contrast to goalkeepers of less successful clubs who are more often exposed to threats from opposing players.

In research done by Szwarc, Lipinska & Chamera, 2010, attacking actions accounted for 58% and defensive actions for 42% of all actions undertaken by the studied goalkeepers. It could be hypothesized that evolution of soccer over the last decade caused increasing demands for goalkeepers to play with the ball in possession. More successful teams required from goalkeepers more actions with ball in possession (*active play with ball A1)* compared to less successful teams in A1 zone. Nonetheless, both MSG and LSG had a higher percentage of actions with the ball in possession than actions without the ball in possession. Similarly, other studies that confirmed same hypothesis were Krističević, Vuleta, Jukić, 2018, Čavala, Bašić and Kvesić, 2018, Marić, Papić and Perić, 2020. Seaton & Campos 2011, on the other hand, observed the differences between 4 goalkeepers of different quality teams regarding the accuracy of ball distribution. In the pre-determined 9 zones on the field goalkeeper from the most successful team had the best accuracy score. Differences were also found in the variable *inactive play with ball A1*. Possible reasons for these results are that MSG are often required to play with the ball in the opening phase of the play while LSG are more likely to try longer passes toward attackers. This study findings and results from previous studies clearly indicate increasing usage of the goalkeepers in the opening phase of the game and need to have excellent ball control.

CONCLUSION

The obtained results suggest differences in team quality where the goalkeepers of less successful teams are more often exposed to the attacks of opposing teams and therefore receive more shots than the goalkeepers of more successful teams. On the other hand, goalkeepers from more successful teams had more touches and possession of the ball in zone 1 (within 20 m of the goal). Goalkeepers need to be technically sound because they are increasingly used in the opening phase of the play as an additional option when coming out of opposition pressing and as a part of possession play. In modern soccer, playing with feet is one of the greatest goalkeeping qualities that can separates better goalkeepers from the rest. Future research should include a larger sample of players, matches and teams in order to obtain a more reliable insight into the situational effectiveness of soccer goalkeepers.

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Frequency of Injuries in Professional Sports and the Importance of Sports Injury Prevention

*Mark Tomaj[1], Ivona Barić Tomašić[2], Anamarija Milun[3]

[1]University of Applied Sciences Ivanić-Grad, Faculty of Kinesiology Zagreb, Croatia, [2]Special hospital for medical rehabilitation Krapinske toplice, Croatia, [3]Neuropsychiatric Hospital "Dr. Ivan Barbot", Croatia

*Corresponding author

ABSTRACT

Sports injuries represent a significant challenge in professional sports, and preventing these injuries is crucial for preserving athletes' health and careers. Therefore, injuries among professional athletes in Croatia were investigated regarding their frequency, localization, and types, as well as the factors influencing their occurrence and recovery. The study included athletes from five sports: soccer, handball, swimming, basketball, and weightlifting, to identify the specificities of each sport that may affect injuries. Data were analyzed on the frequency of injuries, their localizations, types, and factors such as fatigue, flexibility, technique, conditions and equipment. Soccer and handball players were most frequently injured in the knees and shoulder girdle, while swimmers had the lowest incidence of injuries. Basketball players often sustained injuries to the ankle and foot. The types of injuries ranged from muscle ruptures and strains to ligament injuries and bone fractures, with handball players often suffering from muscle and ligament injuries, while basketball players were prone to nerve impingements. The average number of injuries per athlete was highest in handball. The results emphasize the importance of tailored preventive strategies that consider the specificities of each sport to reduce the frequency and severity of injuries and to accelerate athletes' recovery. Physical therapy is often used for treating injuries, while immobilization is more commonly applied in basketball and weightlifting. Understanding the epidemiology of sports injuries is essential for improving sports medicine and injury prevention, providing a foundation for further research and optimal resource allocation in sports rehabilitation and prevention.

Keywords: career, types of injuries, physical therapy, rehabilitation

INTRODUCTION

Contact injuries can occur from collisions with other players or impacts, while non-contact injuries happen during falls and sudden movements. It is important to know the conditions of the sports activity, the type of surface, the training modality, and the rules of the game. Injury prevention requires knowledge of joint anatomy, injury mechanisms, and the specifics of movement structures in the sport (Solomon & Brown, 2014). Timely recognition of the cause and type of injury is crucial for preventing progression, effective treatment, and preventing recurrence (Pećina, 2004). Professional athletes spend most of their day practicing skills and achieving better results, with their main source of income being the club they play for. A sports career can significantly impact an athlete's psychological state, as they can be seen as a hero or a loser, an inspiration or a tool for superiors to achieve goals (Hägglund et al., 2013). It is important to define the reasons for injuries for prevention, considering internal and external risk factors such as gender, age, body composition, sport conditions, aids, and game rules (Pećina, 2004). Despite preventive measures, injuries are common among athletes, and their impact depends on the severity of the injury, the stage of the career, the importance of the sport, the reaction of the environment, and social support. Injuries should also be viewed from a psychological perspective as they affect the success of recovery (Arvinen-Barrow & Walker, 2015). Recent studies have emphasized the importance of neuromuscular training programs in reducing the risk of knee injuries among athletes, particularly in sports like soccer and basketball (Hewett et al., 2006). Furthermore, the role of psychological resilience in recovery from sports injuries has been increasingly recognized, highlighting the need for mental health support as part of injury management strategies (Rice et al., 2016).

The aim of this research is to analyze the frequency of injuries among professional athletes, including football players, handball players, basketball players, swimmers, and weightlifters, and to highlight the importance of injury prevention due to their negative impact on athletes and their careers (Pećina, 2004). Based on this, the following hypotheses were formulated: (H1) that the prevalence of sports injuries is highest in contact sports, and (H2) that the frequency of injuries is lowest among swimmers compared to other respondents.

METHODS

Professional athletes from five popular sports in Croatia participated in the study: football, handball, swimming, basketball, and weightlifting. The participants were members of Football Clubs Rudeš and Istra, Basketball Club Vinkovci, Zagreb Swimming Club, and Handball Clubs Spačva from Vinkovci and Đakovo, as well as weightlifters from Zagreb. In total, there were 150 male participants, with 30 from each of the mentioned sports. The data on injuries were collected over the entire 2022/2023 season. This timeframe allowed for a comprehensive assessment of injury occurrence and frequency across different sports disciplines. The convenience sample consisted of athletes who were selected based on their availability and willingness to participate in the study. It is important to note that the swimmers' group comprised both injured and uninjured athletes, whereas all other groups included only athletes who had sustained injuries. This distinction is crucial, as it may affect the study's conclusions and should be considered when interpreting the results.

Before the study began, all athletes were informed about the purpose and methodology of the research and gave written consent to participate in accordance with ethical principles. A survey questionnaire was used to collect data. The questionnaire included information on the personal characteristics of the participants, details about their sports activities, and specific information about injuries: injury location, type of injury, time and period of occurrence, cause, number of previous injuries, type of treatment, and recovery duration. The questionnaire was designed for athletes whose injuries were a result of training or competition, not activities outside of sports. Athletes whose injuries were exclusively due to training or competition and who were prevented from normal training processes due to the injury were included. Categorical data were analyzed using absolute and relative frequencies, while numerical data were described with the median and interquartile range. All statistical analyses were conducted using the MedCalc software system (version 14.12.0, MedCalc Software bvba), with the significance level set at α=0.05.

RESULTS

Each group of athletes has different levels of injuries, with swimmers being the least injured. Right arm or leg dominance is most pronounced in swimmers and basketball players, while left dominance is prevalent among soccer players and handball players (Table 1).

Table 1: Comparison of the examined parameters among athletes

	Number (%) of participants					P
	Soccer	Handball	Swimming	Basketball	Weightlifting	
	Proportion of injured athletes by sport					
Injured	30 (100.0)	30 (100.0)	16 (53.3)	30 (100.0)	30 (100.0)	
Without injury	0	0	14 (46.7)	0	0	<0.001*
	Dominant hand or foot					
Left	11 (36.7)	5 (16.7)	3 (10.0)	3 (10.0)	9 (30.0)	
Right	19 (63.3)	25 (83.3)	27 (90.0)	27 (90.0)	21 (70.0)	0.03†
Total number of athletes	30 (100.0)	30 (100.0)	30 (100.0)	30 (100.0)	30 (100.0)	

Comparison of body part injuries shows statistically significant differences among athletes (Table 2). Handball players often suffer from knee and shoulder injuries, while basketball players frequently injure their ankles and feet. Swimmers are rarely injured compared to other groups. Differences in types of injuries are significant among athletes (Table 3). Handball players often have muscle and ligament injuries, while basketball players are prone to ankle injuries and nerve impingement.

Table 2: Comparison of injury to specific body parts among athletes

	Number (%) of participants					P*
	Soccer	Handball	Swimming	Basketball	Weightlifting	
back of the thigh	4 (13.3)	5 (16.7)	0	0	3 (10.0)	0.03
front of the thigh	4 (13.3)	2 (6.7)	0	0	0	0.02
hip	3 (10.0)	4 (13.3)	0	0	0	0.01
groin area	5 (16.7)	5 (16.7)	1 (3.3)	9 (30.0)	0	0.002
pelvis	0	0	1 (3.3)	3 (10.0)	0	0.13
abdomen	3 (10.0)	2 (6.7)	1 (3.3)	0	0	0.31
back	5 (16.7)	7 (23.3)	3 (10.0)	15 (50.0)	6 (20.0)	0.007
knee	11 (36.7)	15 (50.0)	5 (16.7)	9 (30.0)	3 (10.0)	0.005
shin	1 (3.3)	3 (10.0)	0	3 (10.0)	0	0.15
Achilles tendon	2 (6.7)	4 (13.3)	0	0	0	0.02
ankle joint	7 (23.3)	15 (50.0)	4 (13.3)	27 (90.0)	3 (10.0)	<0.001
foot	3 (10.0)	8 (26.7)	1 (3.3)	9 (30.0)	0	<0.001
shoulder girdle	3 (10.0)	11 (36.7)	7 (23.3)	3 (10.0)	3 (10.0)	0.03
arm	2 (6.7)	7 (23.3)	4 (13.3)	3 (10.0)	3 (10.0)	0.43
hand	1 (3.3)	6 (20.0)	0	0	6 (20.0)	0.001
head/neck	2 (6.7)	4 (13.3)	0	3 (10.0)	0	0.08
total number of athletes	30 (100.0)	30 (100.0)	30 (100.0)	30 (100.0)	30 (100.0)	

Table 3: Comparison of injury types among athletes

	Number (%) of participants					P*
	Soccer	Handball	Swimming	Basketball	Weightlifting	
muscle rupture	7 (23.3)	8 (26.7)	2 (6.7)	3 (10.0)	3 (10.0)	0.12
muscle strain	11 (36.7)	16 (53.3)	5 (16.7)	9 (30.0)	0	<0.001
overuse syndrome	4 (13.3)	3 (10.0)	2 (6.7)	3 (10.0)	6 (20.0)	0.67
nerve impingement	2 (6.7)	6 (20.0)	3 (10.0)	9 (30.0)	0	0.004
ligament rupture	5 (16.7)	11 (36.7)	1 (3.3)	9 (30.0)	3 (10.0)	0.005
ligament strain	12 (40.0)	15 (50.0)	8 (26.7)	18 (60.0)	9 (30.0)	0.05
bone fracture	4 (13.3)	8 (26.7)	2 (6.7)	6 (20.0)	0	0.01
stress fracture	0	2 (6.7)	0	0	0	0.20
contusion	1 (3.3)	2 (6.7)	0	3 (10.0)	0	0.31
dislocation	0	3 (10.0)	2 (6.7)	3 (10.0)	6 (20.0)	0.11
Other	5 (16.7)	5 (16.7)	0	12 (40.0)	0	<0.001
Total number of athletes	30 (100.0)	30 (100.0)	30 (100.0)	30 (100.0)	30 (100.0)	

Injuries are classified according to period (competition period or preparatory period) and timing of injury (during skill development training, technique, or warm-up). Among basketball players, the highest number of injuries occurs during the summer competition period, while swimmers are less prone to injuries in any period (Table 4). Statistically significant differences were observed between sports (P < 0.001).

Table 4: Comparison of injury periods and timing among athletes

	Number (%) of participants					P*
	Soccer	Handball	Swimming	Basketball	Weightlifting	
Injury onset period						
Competitive period-summer	18 (60.0)	19 (63.3)	2 (6.7)	24 (80.0)	7 (23.3)	<0.001
Preparatory period-summer	19 (63.3)	7 (23.3)	5 (16.7)	3 (10.0)	17 (56.7)	<0.001
Competitive period-winter	13 (43.3)	18 (60.0)	2 (6.7)	18 (60.0)	0	<0.001
Preparatory period-winter	7 (23.3)	6 (20.0)	9 (30.0)	6 (20.0)	3 (10.0)	0.45
Injury timing						
Training-fitness development	9 (30.0)	8 (26.7)	13 (43.3)	9 (30.0)	21 (70.0)	0.003
Training - technique	1 (3.3)	7 (23.3)	0	9 (30.0)	3 (10.0)	0.001
Training - warm-up	6 (20.0)	1 (3.3)	2 (6.7)	3 (10.0)	0	0.06
Competition	20 (66.7)	26 (86.7)	2 (6.7)	24 (80.0)	3 (10.0)	<0.001
Total number of athletes	30 (100.0)	30 (100.0)	30 (100.0)	30 (100.0)	30 (100.0)	

High levels of fatigue were a significant factor in basketball (60.0%) and handball (46.7%), while inadequate flexibility had a similar impact in soccer (16.7%) and handball (26.7%). Personal negligence was the predominant cause of injuries in basketball (70.0%) compared to other sports. Statistical tests revealed significant differences among sports regarding injury causes (Table 5).

Table 5. Causes of injury among different athletes

	Number (%) of participants					P*
	Soccer	Handball	Swimming	Basketball	Weightlifting	
Poor execution technique	0	2 (6.7)	1 (3.3)	0	3 (10.0)	0.31
Poor conditions	4 (13.3)	7 (23.3)	0	6 (20.0)	0	0.001
Own negligence	3 (10.0)	8 (26.7)	4 (13.3)	21 (70.0)	6 (20.0)	<0.001
High level of fatigue	13 (43.3)	14 (46.7)	5 (16.7)	18 (60.0)	6 (20.0)	0.001
Insufficient flexibility	5 (16.7)	8 (26.7)	6 (20.0)	6 (20.0)	6 (20.0)	0.94
Inadequate warm-up	1 (3.3)	5 (16.7)	7 (23.3)	0	3 (10.0)	0.01
Poor physical fitness	5 (16.7)	5 (16.7)	0	12 (40.0)	0	<0.001
Other (equipment...)	11 (36.7)	6 (20.0)	2 (6.7)	3 (10.0)	3 (10.0)	0.02
Total number of athletes	30 (100.0)	30 (100.0)	30 (100.0)	30 (100.0)	30 (100.0)	

Physical therapy is a frequently applied treatment modality in soccer (83.3%) and handball (63.3%), while immobilization is more common in basketball (70.0%) and weightlifting (60.0%). Surgery is more often performed in basketball (30.0%) and handball (26.7%). Regarding recovery duration, athletes often recover within one month, with similar results observed in soccer (66.7%) and handball (66.7%) (Table 6).

Table 6: Comparison of treatment modalities and recovery duration among athletes

	Number (%) of participants					P*
	Soccer	Handball	Swimming	Basketball	Weightlifting	
Type of injury treatment based on complexity						
Rest	14 (46.7)	24 (80.0)	10 (33.3)	27 (90.0)	18 (60.0)	<0.001
Physical therapy	25 (83.3)	19 (63.3)	10 (33.3)	6 (20.0)	12 (40.0)	<0.001
Immobilization	3 (10.0)	10 (33.3)	1 (3.3)	21 (70.0)	0	<0.001
Medication	4 (13.3)	5 (16.7)	0	6 (20.0)	0	0.006
Surgery	9 (30.0)	8 (26.7)	1 (3.3)	9 (30.0)	3 (10.0)	0.01
Recovery duration after injury						
One week	7 (23.3)	7 (23.3)	2 (6.7)	9 (30.0)	3 (10.0)	0.10
Up to one month	20 (66.7)	20 (66.7)	7 (23.3)	15 (50.0)	18 (60.0)	0.03
Up to three months	4 (13.3)	10 (33.3)	6 (20.0)	6 (20.0)	3 (10.0)	0.22
Three to six months	4 (13.3)	5 (16.7)	1 (3.3)	0	3 (10.0)	0.12
More than six months	3 (10.0)	3 (10.0)	0	9 (30.0)	0	<0.001
Total number of athletes	30 (100.0)	30 (100.0)	30 (100.0)	30 (100.0)	30 (100.0)	

The highest percentage of athletes experiencing fewer than 5 injuries was observed among soccer players (63.3%) and weightlifters (80.0%). Handball players had the highest percentage of athletes with five or more injuries, with 36.7% of athletes having between 5 and 10 injuries. The average number of injuries per athlete varies between sports, with the highest average of 3.3 injuries per athlete in handball, and the lowest average of 0.9 injuries per athlete in weightlifting (Table 7).

Table 7. Comparison of injury quantity among athletes by sport type and injury frequency per athlete

	Number (%) of participants	P*

	Soccer	Handball	Swimming	Basketball	Weightlifting	
			Injury quantity			
Less than 5	*19 (63.3)*	*13 (43.3)*	*13 (81.3)*	*6 (20.0)*	*24 (80.0)*	
Five to ten	*10 (33.3)*	*11 (36.7)*	*2 (12.5)*	*15 (50.0)*	*6 (20.0)*	
Five to fifteen	*1 (3.3)*	*2 (6.7)*	*0*	*3 (10.0)*	*0*	
More than 15	*0*	*4 (13.3)*	*1 (6.3)*	*6 (20.0)*	*0*	*<0.001*
Total number of injured athletes	*30 (100.0)*	*30 (100.0)*	*16 (100.0)*	*30 (100.0)*	*30 (100.0)*	
			Total number of all injuries			
Total number of injuries	*56*	*98*	*27*	*84*	*27*	
Average injuries per injured athlete	*1.9*	*3.3*	*1.7*	*2.8*	*0.9*	
Average injuries per surveyed athlete	*1.9*	*3.3*	*0.9*	*2.8*	*0.9*	

DISCUSION

Frequency of injuries in professional sports is a subject of numerous studies aiming to determine injury prevalence in specific sports and minimize their occurrence. Injuries are prevalent across all sports covered in this study, to varying degrees. Engebretsen and colleagues investigated injury and illness rates at the 2012 Olympic Games, identifying high levels of injuries and illnesses among athletes, particularly in taekwondo, soccer, handball, mountain biking, athletics, weightlifting, ice hockey, and badminton, while lowest in archery, canoeing, sprinting, cycling, rowing, shooting, and equestrian sports (Engebretsen et al., 2013). These results confirm the frequency of injuries in soccer and handball, which, along with basketball players, exhibit significantly higher injury rates compared to swimmers and weightlifters in this study.

Among weightlifters, back and hand injuries are most common. Jonasson and colleagues found hip pain to be prevalent among weightlifters (Jonasson et al., 2011). Gjurić (1989) describes muscle and spinal joint injuries as characteristic of older weightlifters and those with improper body posture during activities.

Handball players experience the highest number of injuries, most commonly affecting the knees, ankles, and shoulder girdle. Strains are the most common type of injury, often occurring during competitive periods due to high fatigue levels. Gjurić (1989) describes shoulder muscle injury as the most frequent in handball.

Soccer players commonly injure their knees, most often due to ligament strains. Radman and colleagues (2011) identified the knee as the most common site of injury, with the same type of injury prevailing. Junge and Dvořák (2015) analyzed injury rates at the 2014 FIFA World Cup, confirming strains as the most frequent type of injury.

Among professional swimmers, shoulder girdle injuries, particularly ligament strains, are prevalent (Rodeo et al., 2016). Gjurić (1989) describes shoulder injury as the most common among swimmers, leading to tendon changes in muscle. The surveyed swimmers most often treated injuries with rest. Basketball players rank second in injury frequency, with ankle injuries being most common. Gjurić (1989) also lists ankle injuries as the most frequent among basketball players. Injuries most often occur during competitions, primarily due to carelessness.

Higher injury rates in team sports have been confirmed, supporting the first hypothesis of the study. Developing preventive programs is crucial to reduce injuries, with high levels of fatigue being the most common cause of injury. Gjurić (1989) confirms that in 51% of cases, athletes themselves are responsible for injuries due to negligence, poor technique, inadequate training, and fatigue, while opponents caused injuries in 27% of cases.

Among participants, the lowest injury and absenteeism rates from training and competition were recorded among swimmers, confirming the second hypothesis of the study. Gjurić (1989) describes swimming as a sport with relatively few injuries among professionals. Injuries in swimming depend on the technique used by the swimmer, as certain body parts are more prone to injury depending on the technique.

CONCLUSION

In conclusion, this study provides a comprehensive analysis of injury frequencies among professional athletes in football, handball, swimming, basketball, and weightlifting. The findings confirm higher injury rates in contact sports like football and handball compared to swimming, supporting the need for targeted injury prevention strategies tailored to each sport. Factors such as fatigue, inadequate flexibility, and personal negligence were identified as significant contributors to injuries across all sports. By addressing these specific risk factors through enhanced training protocols and athlete education, sports organizations can potentially reduce injury rates and optimize athlete performance and longevity. Future research should focus on longitudinal studies to track injury trends over extended periods and explore innovative preventive measures tailored to specific sports and athlete demographics.

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Differences of Ventilatory Parameters Across Track and Field Disciplines

Vučetić Vlatko[1], Šaponja Alen[2]

[1]Faculty of Kinesiology, University of Zagreb, Croatia, [2]Faculty of Kinesiology, University of Zagreb, Croatia

*Corresponding author:

ABSTRACT

The most used respiratory parameter for assessing aerobic energy capacities is maximal oxygen consumption. Maximal oxygen consumption can be defined as the maximum amount of oxygen a person can absorb and utilize one minute during intense aerobic exercise. Previous studies have not provided consistent and precise data of difference in ventilatory parameters during incremental running test. In recent studies there is no precise data of difference at percentage values of ventilatory parameters. The aim of this study was to determine the relations between parameters of speed on incremental running test on running treadmill and oxygen consumption parameters on track and field athletes, also as to determine the values attained by athletes in different track and field disciplines. In this study participated 83 male track and field athletes (twenty-four long distance runners [LD], eighteen middle distance runners [MD], eleven sprinters [S] and thirty 400m and 800m distance runners [S4-8]). Participants underwent a protocol of incremental running test and parameters of treadmill speed (maximum speed and speed at ventilatory aerobic threshold) were considered, alongside with absolute and relative maximum oxygen consumption results, as well as absolute and relative oxygen uptake at ventilatory aerobic threshold and calculated percentage of few ventilatory parameters. Results showed a strong linear correlation between all speed parameters with the parameters of relative oxygen consumption ($Speed_{max}$ and RVO_{2max} r=0,73; RVO_{2vt} r=0,76, $Speed_{vt}$ and RVO_{2max} r=0,78; RVO_{2vt} r=0,82).On the other hand the speed parameters were weakly or moderately correlated with absolute oxygen consumption values ($Speed_{max}$ and VO_{2max} r=0,28; VO_{2vt} r=0,37, $Speed_{vt}$ and VO_{2max} r=0,28; VO_{2vt} r=0,38). Likewise, there is no significant difference between disciplines in parameters of $\%HR_{vt}$ and $\%VO_{2vt}$, but there is significant difference in LD- and MD and S (p=0.0002; p=0.0002) and S4-8 (p=0.0001; p=0.0002) runners. There is significant difference in %FVC LD and MD runners also (p=0.0015). These findings suggest that for track and field athletes test results may be better interpreted through relative measures of oxygen consumption. Furthermore, training could be programmed based on the maximal treadmill speed and the speed at ventilatory aerobic threshold. Additionally disciplines in track and field differ from one another and athletes themselves vary among each other accordingly, therefore they should be specially trained in the way each discipline demands.

Keywords: aerobic capacity, relative oxygen consumption, absolute oxygen consumption, ventilatory aerobic threshold

INTRODUCTION

Understanding of energy systems and their roles in athletes' body is crucial for designing effective training programs that target specific energy pathways to optimize athletic endurance and performance. The role of energy systems is to convert chemical energy into a usable form (adenosine triphosphate, ATP) for all cellular functions. To replenish ATP and maintain its constant concentration in muscle cells, energy is derived from chemical sources that release energy without oxygen, known as anaerobic energy processes, as well as from chemical sources that require oxygen, known as aerobic energy processes (Guyton & Hall, 2022). Functional diagnostics of athletes covers a wide range area and measurement of its parameters is routinely applied in sports. It provides data on specific physiological and biochemical reactions. The most used parameters for assessing aerobic energy capacities are absolute and relative maximal oxygen consumption and anaerobic threshold. Alongside of anaerobic thresholds, ventilatory thresholds are also frequently considered. Aerobic capacity is defined as the ability to perform work over an extended period under conditions of aerobic metabolism. Parameters for measuring aerobic capacity commonly include: i) maximal oxygen consumption, ii) anaerobic threshold, iii) ventilatory threshold. Maximal oxygen consumption is defined as the level of oxygen uptake per minute at which further increases in workload do not lead to further increases in oxygen uptake. It can be expressed in absolute terms (litter of oxygen per minute, LO2/min) or in relative values (mlO2/kg/min) (Vučetić, 2007). Regular physiological testing and monitoring are often prescribed to inform training planning and adjustment for maximal adaptation and prevent undertraining or overtraining (Jensen et al., 2021). Intense interval training paradigms such as high-intensity interval training (HIIT) and sprint interval training (SIT) can improve maximal oxygen consumption (Milanović et al., 2015; Raleigh et al., 2018), but in addition these it can be improved by many others type of training such as distance running, fartlek training, training based on anaerobic or ventilatory threshold, and others. The importance of maximal oxygen consumption is well known as that endurance-running performance is predicted by maximal oxygen uptake, but also with running economy and fractional utilization of oxygen uptake (Pastor et al., 2022). Professional athletes use maximal oxygen uptake (VO_{2max}) as one of the most important parameters to assess their training status and progress (Kleinloog et al., 2021). It is crucial for coaches to understand the concept of ventilatory threshold both for comprehension and for planning and programming training, especially for track and field athletes. The VT (ventilatory threshold) is the point at which ventilation reaches its maximum linear increase relative to VO2 (Peronnet, F. & Meyer T.,1988). That is the point during exercise where ventilation increases disproportionately to oxygen consumption due to accumulation of carbon dioxide in the blood from anaerobic metabolism. VT serves as an indicator of aerobic capacity and the body’s ability to efficiently eliminate CO2, essential for optimizing performance during prolonged efforts. Also, it can also serve as a metric for assessing fitness and progress in aerobic training. Through VT, coaches can program training to achieve optimal pulmonary adaptations and aerobic function, critical for achieving peak athletic performance (Bassett, D.R., 2000).

METHODS

Previous studies have not provided consistent and precise data on differences in ventilatory parameters during the incremental running test among various track disciplines. The aim of this study is to determine the values attained by athletes in different track and field disciplines during the incremental running test, ascertain whether athletes differ across disciplines in specific ventilatory parameters, and establish the correlation between maximal speeds and speeds at the ventilatory threshold with oxygen uptake parameters.

Participants

In this study participated 83 male track and field athletes (age: 22,25$\pm$4,90 years, height: 180,16$\pm$6,30 cm, weight: 70,07$\pm$7,70 kg).

All participants were active track and field athletes at the moment, and there participated twenty-four long distance runners [LD], eighteen middle distance runners [MD], eleven sprinters [S] and thirty 400m and 800m runners [S4-8]. All the data was collected through past few years with participants unrelated with each other. Participants are all different athletes, and one athlete underwent one measurement, there were not repeated measurements. All tests were conducted in Sports diagnostics centre at the University of Zagreb, Faculty of Kinesiology, Croatia. This study has been approved by the Ethics committee of Faculty of Kinesiology.

Table 1 Descriptive parameters of participants (n=83)

	Mean±SD (min-max)
Age (yrs)	*22.25±4.90 (17.00-36.00)*
Height (cm)	*180.16±6.30 (165.60-195.20)*
Weight (kg)	*70.07±7.70 (54.80-85.50)*

Legend: yrs – years old, cm- centimetres, kg- kilograms, min- minimum, max - maximum

Experimental procedure

This study consisted of one performed maximal incremental running test to volitional exhaustion on motorized running treadmill. Maximal oxygen uptake and other respiratory parameters were measured during it, so as heart rate values and speed of treadmill. Equipment used for data collection were motorized running treadmill (Pulsar 3p 190/65 h/p/ Cosmos Sport&Medical, Nussdorf, Germany) and heart rate monitor (Polar H9 or H10). For oxygen uptake were used Quark CPET system (Cosmed, Rome, Italy) with associated software. All measurements were conducted under the supervision of trained crew in the controlled environment in Sports diagnostics centre. Every one of the participants were introduced with protocol.

Incremental running test: The tests were performed in laboratory conditions on a motorized running treadmill. At the beginning of the test participants started with walking 2 minutes at 3km/h and the speed was thereafter increased every 30 seconds by 0.5km/h. At the speed of 6km/h all participants started with running. The test was performed until volitional exhaustion. The grade of the motorized running treadmill was set out to 1%. Respiratory gas exchange parameters were measured breath-by-breath throughout the entire test via Quark CPET system. The highest VO2 response recorded during a 30 second time epoch was defined as VO2max. Heart rate was measured during the test with heart rate monitor (Polar). Every participant expressed their Rating of perceived exertion during testing.

Statistical analysis

The Statistica software were used for data processing (Statistica 14.0.1.25). For the evaluation of normality of distribution, a Shapiro-WIlk test was performed. Descriptive statistics in the text is expressed as mean result ± standard deviation (minimum-maximum). Evaluation of Pearson’s coefficient of correlation were performed after Shapiro-Wilk tests. Among statistical methods, descriptive statistics were used to obtain basic statistical parameters, namely: arithmetic mean, standard deviation, minimum and maximum scores. Pearson's coefficient of correlation was used to determine the association between required variables. One-way ANOVA was used to determine statistically significant differences between ventilation parameters and track and field running disciplines. Levene's test was used to determine the significance of variance. If the variance was statistically significant, non-parametric statistics were used, specifically the Kruskal-Wallis test.

RESULTS

In Table 2 it could be seen main variables and descriptive statistics of it by disciplines. All results are expressed as mean $\pm$ standard deviation (minimum – maximum).

Table 2 Descriptive statistics of variables included in this study - by disciplines

VARIABLE	ALLGROUPS(N=83) MEAN±SD (MIN-MAX)	LD(N=24) MEAN±SD (MIN-MAX)	MD(N=18) MEAN±SD (MIN-MAX)	S(N=11) MEAN±SD (MIN-MAX)	S4-8(N=30) MEAN±SD (MIN-MAX)
FVC (L)	6.01±0.76 (4.64-7.66)	6.03±0.80 (4.64–7.40)	5.69±0.84 (4.66–7.66)	6.14±0.60 (5.24–7.11))	6.12±0.72 (4.66–7.57)
FEV_1 (L)	4.97±0.62 (3.54-6.98)	4.81±0.71 (3.54–6.09)	4.92±0.59 (4.06–6.11)	5.21±0.54 (4.57–5.89)	5.06±0.57 (4.06–6.98)
%FVC (%)	83.37±5.85 (70.00–96.50)	80.66±6.11 (70.00–96.10)	87.19±5.17 (78.60–96.50)	84.76±4.28 (77.60–91.70)	82.72±5.36 (73.20–92.20)
$\%HR_{vt}$ (%)	91.19±2.67 (81.82–95.26)	91.37±2.86 (85.71–95.26)	92.34±1.73 (90.00–95.07)	90.46±3.25 (81.82–94.30)	90.61±2.61 (85.29–94.47)
$Speed_{max}$ (KM/H)	20.66±1.96 (15.00–24.00)	21.79±1.26 (19.00–24.00)	21.69±1.11 (19.50-23.50)	17.64±2.07 (15.00–22.50)	20.23±1.43 (18.00–24.00)
$Speed_{vt}$ (KM/H)	15.96±2.36 (11.00–20.00)	17.54±1.54 (14.50–20.00)	17.42±1.64 (14.00–20.00)	12.86±1.94 (11.00–18.00)	14.95±1.72 (12.00–18.50)
$\%V_{vt}$ (%)	76.95±5.55 (63.17–88.63)	80.41±3.95 (72.50–86.95)	80.15±4.44 (70.00–88.64)	72.83±4.47 (65.79–80.00)	73.76±4.79 (63.16–86.05)
VO_{2max} (LO2/MIN)	4.51±0.42 (3.43–5.54)	4.69±0.49 (3.81–5.54)	4.45±0.44 (3.43–5.04)	4.38±0.27 (4.07–4.85)	4.45±0.38 (3.77–5.30)
RVO_{2max} (MLO2/KG/ MIN)	64.85±7.13 (51.45–79.51)	70.63±9.93 (62.98–78.66)	67.84±6.12 (60.42–79.51)	57.16±5.22 (52.09–69.37)	61.43±5.67 (51.45±77.70)
VO_{2vt} (LO2/MIN)	3.89±0.41 (2.91–4.92)	4.09±0.45 (3.22–4.92)	3.87±0.40 (2.91–4.30)	3.66±0.29 (3.05–4.02)	3.84±0.35 (3.15–4.52)
RVO_{2vt} (MLO2/KG/ MIN)	55.95±6.74 (41.53–71.32)	61.29±4.56 (51.27–71.32)	58.93±5.58 (50.33–68.87)	47.63±4.06 (41.53–57.57)	52.95±4.84 (44.41–64.29)
$\%RVO_{2vt}$ (%)	86.31±3.78 (73.41–95.63)	87.24±3.16 (81.41–95.63	86.83±1.97 (81.66–89.80)	83.46±4.22 (75.00–87.69)	86.31±4.48 (73.42–92.98

Legend: FVC (forced vital capacity), FEV1 (forced expiratory volume in first second), $\%HR_{max}$ (percentage of maximum heart rate), $Speed_{max}$ (Maximal speed on incremental running test), $Speed_{vt}$ (speed at ventilatory aerobic threshold), VO_{2max} (absolute maximal oxygen uptake), RVO_{2max} (relative maximal oxygen uptake), VO_{2vt} (absolute oxygen uptake at ventilatory aerobic threshold) RVO_{2vt} (relative oxygen uptake at ventilatory aerobic threshold) $\%RVO_{2vt}$ (percentage of relative maximal oxygen uptake and oxygen uptake at ventilatory aerobic threshold)

In Table 3 it could be seen statistical analysis of Pearson coefficient of correlation for speed parameters correlated with parameters of oxygen consumption. Each parameter includes its corresponding statistical significance value.

Table 1 Correlation coefficients of respiratory and speed parameters

	VO_{2max} (lO_2/min)	RVO_{2max} (mlO_2/kg/min)	VO_{2vt} (lO_2 /min)	RVO_{2vt} (mlO_2/kg/min)
$Speed_{max}$ (km/h)	0,29 p= 0.0088	0,73 p=0.0000	0,37 p=0.0006	0,76 p=0.0000
$Speed_{vt}$ (km/h)	0,28 p=0.0106	0,78 p=0.0000	0,38 p=0.0004	0,82 p=0.0000

VO_{2max} (absolute maximal oxygen uptake), RVO_{2max} (relative maximal oxygen consumption), VO_{2vt} (absolute oxygen uptake at ventilatory aerobic threshold), RVO_{2vt} (relative oxygen uptake at ventilatory aerobic threshold), $Speed_{max}$ (maximal speed at incremental running test), $Speed_{vt}$ (speed at ventilatory aerobic threshold), p (statistically significant difference)

In Figure 1 it can be seen the difference in disciplines in various parameters. For each parameter, the normality of distribution was checked prior to the ANOVA test. Before applying the ANOVA method, the significance of the variance was assessed using Levene's test, which determined whether to use parametric or nonparametric statistics.

Table 1 Statistically significant difference of forced vital capacity expressed as percentage value (Leven's test p=0.71)- ANOVA

%FVC (P=0.0022)	*LD*	*MD*	*S*	*S4-8*
LD		*0.0015*	*0.1716*	*0.5230*
MD	*0.0015*		*0.6496*	*0.0372*
S	*0.1716*	*0.6496*		*0.71240*
S4-8	*0.5230*	*0.0372*	*0.7124*	

Table 2 Statistically significant difference of heart rate at ventilatory threshold expressed as percentage value (Levene's test p=0.34)- ANOVA

$\%HR_{VT}$ (P=0.1494)	LD	MD	S	S4-8
LD		0.6362	0.8844	0.7146
MD	0.6362		0.3643	0.1279
S	0.8844	0.3643		0.99998
S4-8	0.7146	0.1279	0.99998	

Table 3 Statistically significant difference of speed at ventilatory threshold expressed as percentage value (Levene's test p=0.81)- ANOVA

$\%V_{VT}$ (P=0.0000)	LD	MD	S	S4-8
LD		0.9976	0.0002	0.0001
MD	0.9976		0.0004	0.0002
S	0.0002	0.0004		0.9351
S4-8	0.0001	0.0002	0.9351	

Table 4 Statistically significant difference of oxygen uptake ventilatory threshold expressed as percentage value (Leven's test p=0.02) - Kruskal-Wallis test

$\%VO_{2vt}$ *(P=0.1066)*	*LD*	*MD*	*S*	*S4-8*
LD		*1.0000*	*0.1149*	*1.0000*
MD	*1.0000*		*0.2325*	*1.0000*
S	*0.1149*	*0.2325*		*0.2274*
S4-8	*1.0000*	*1.0000*	*0.2274*	

Legend: $\%VO_{2vt}$ (percentage of crossing relative oxygen uptake at ventilatory threshold), $\%V_{vt}$ (percentage of crossing speed at ventilatory threshold), $\%HR_{vt}$ (percentage at crossing heart rate at ventilatory threshold), $\%FVC$ (percentage of forced vital capacity).

DISCUSSION

This is the study to report the difference of respiratory parameters and their percentage values, aiming the main variables of oxygen consumption defined after performing the maximal incremental running test and its related speeds, also with respiratory parameters. Pearson's correlation coefficient shows significant and strong positive linear correlation between the variables of maximal speed incremental running test and maximal relative oxygen consumption (r=0,73, p=0.00), so as relative oxygen consumption at ventilatory aerobic threshold (r= 0,76, p=0.00). The main hypothesis of this study is confirmed through these values, so it could be said that there is strong connection between relative oxygen consumption and maximal speed at incremental running test considered track and field athletes. This can be described through the requirements of the sport which use a very similar operator in training and competition. Therefore, it could be said that the gold standard of measuring oxygen consumption for track and field athletes is a good predictor of performance for athletes. In Table 2 it can be seen that the highest values of relative maximal oxygen consumption have a long and middle distance athletes, and it indicates that also during the programming of training for middle and long-distance runners, attention should be paid to optimizing aerobic capacity through various combinations of training methods, proper periodization, and of course, adequate recovery to maximize oxygen uptake and improve running performance, as well as running economy.

On the other side, relations between maximal speed at incremental running test and absolute maximal oxygen uptake (r=0,29, p=0.0088) or oxygen uptake at ventilatory aerobic threshold (r=0,37, p=0.0006) was evaluated. Relations between $Speed_{max}$ and VO_{2max} (r=0,29) are weakly positive. On the other side, relations between $Speed_{max}$ and VO_{2vt} shows moderate positive correlation, which is stronger compared to VO_{2max}, but still considered not high enough. These correlations indicate the strength and direction of linear relationship but does not imply causation and it's specific to the linear association between variables. The relations between speed at ventilatory aerobic threshold and absolute oxygen consumption also resulted positive but through weak linear correlation (r=0,28, p=0.0106). Between $Speed_{vt}$ and VO_{2vt} there is moderate linear correlation (r=0,37, p=0.0004). On the other hand, there is strong linear correlation between speed at ventilatory aerobic threshold and relative parameters of oxygen consumption. $Speed_{vt}$ and RVO_{2max} are strong correlated (r=0,78, p=0.0000), so as $Speed_{vt}$ and RVO_{2vt} (r=0,82, p=0.0000). If it's known that training on ventilatory threshold represents the exercise intensity at which lactate begins to accumulate, indicating a shift to anaerobic metabolism, training at ventilatory threshold would enhances the body's ability to clear lactate and improves endurance performance by increasing the efficiency of energy production (Smith and al., 1999). Moreover, it could help to delay the onset of fatigue, allowing athletes to maintain higher intensities for longer periods.

Forced vital capacity (FVC) is an important parameter in assessing pulmonary function, and it is especially crucial for runners because a greater lung capacity allows an athlete to supply the body with a larger amount of oxygen, which is essential for runners of all disciplines. Additionally, a high FVC can indicate better endurance and muscle oxygenation during prolonged activity (Kippelen & Anderson, 2012; Degens & Rittweger, 2018). In Figure 1, it is evident that there is a statistically significant difference (p=0.0015) between LD and MD runners in the percentage of forced vital capacity (%FVC). This difference likely arises because LD runners are more focused on low-intensity training, which better adapts pulmonary capacities and leads to an increase in FVC. In contrast, MD runners, in addition to a high level of aerobic activity, also engage in higher intensity and types of training (often interval training, etc.), which can result in different pulmonary adaptations. On the other hand, it is evident that there is no statistically significant difference between LD and MD runners compared to sprinters and 400 and 800-meter runners. This is probably because these athletes are exposed to maximal intensity, which increases oxygen demands during training and competition, thereby enhancing their pulmonary capacities (Powers et al., 1984).

In $\%HR_{vt}$ there is no statistically significant difference grouped by disciplines. It can be considered by side that ventilatory threshold (VT) typically occurs before the anaerobic threshold (AT). VT is the point during exercise where ventilation increases disproportionately compared to oxygen consumption (VO2), primarily due to increased production of carbon dioxide (CO2) from aerobic metabolism. On the other hand, AT is the exercise intensity at which lactate begins to accumulate in the blood, marking the shift from predominantly aerobic to anaerobic metabolism. The ventilatory response to rising CO2 levels happens before significant lactate accumulation, hence VT occurs prior to AT. The researches showed that the point of increased ventilation (ventilatory threshold) happens at a lower exercise intensity compared to the point where lactate begins to accumulate rapidly (anaerobic threshold), supporting the sequence where VT precedes AT.

In terms of the percentage of speed at the ventilatory threshold, there is a statistically significant difference between disciplines, specifically between LD runners and S (p=0.0002), and between S4-8 runners (p=0.0001), as well as between MD runners and S (p=0.0004), and S4-8 runners (p=0.0002). This can likely be attributed to the greater endurance and higher aerobic capacity of LD and MD runners compared to sprinters and short-distance runners. Additionally, the nature of short distances is such that these athletes (especially sprinters) do not sustain prolonged activity, which also affects the speed at the ventilatory threshold (Tanaka, K. & Matsuura, Y., 1984). Additionally, in terms of the percentage of oxygen uptake at the ventilatory threshold, there is no statistically significant difference, which is understandable because the ventilatory threshold typically occurs at a high percentage of maximal oxygen uptake in all elite athletes (Bourgois J. & Vrijens, J., 1998). From Table 2, it is evident that in elite athletes across different disciplines, the percentage of oxygen uptake at the ventilatory threshold is around 86%.

CONCLUSION

The incremental running treadmill test is primarily carried out for measuring maximal oxygen uptake (VO2max) as a metric of the maximum amount of oxygen an individual can absorb, transport, and utilize during intense aerobic physical exertion. Maximal oxygen consumption represents aerobic capacity of athletes. This study demonstrated basic findings and ranges of values obtained through an incremental running test. It highlighted the correlation between speed and oxygen uptake values and illustrated differences in various parameters presented as percentages across running disciplines. Based on these findings, future research could investigate the impact of training based on anaerobic threshold and training based on ventilatory threshold, which may contribute more significantly to athletes' aerobic capacities. This study highlights the importance of considering specific physiological thresholds and parameters in assessing athletes' aerobic fitness and designing targeted training interventions. Further investigations could explore the nuanced relationships between exercise testing parameters and training outcomes to optimize athletes' performance and aerobic conditioning. Also, in future it would be valuable to investigate the impact of training based on the speed of maximal oxygen consumption and the speed of ventilatory aerobic threshold and to compare these two methods.

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Correlations Between Morphological Characteristics and Motor Skills In Early School-Aged Children

*Zvonimir Tomac[1], Biljana Trajkovski[2] , Bojan Babin[3]

[1]*Faculty of Kinesiology, University of Osijek, Croatia;* [2]*Faculty of Teacher Education, University of Rijeka, Croatia*

*Corresponding author

ABSTRACT

Aim of the research was to apply three variables of morphological characteristics and five variables of motor abilities with the aim of determining their correlations in order to create the most rational procedures when diagnosing, planning, and programming teaching content. Determining the relationships between variables was performed using the correlation analysis method, that is, Pearson's correlation coefficient.The results of the correlation analysis showed that there are statistically significant correlations at the p= .05 level between the majority of applied morphological and motor variables in the total sample of participants. It was also observed that the connections are not equal in boys and girls. This practically means that slightly different motoric content must be applied in working with boys and girls. Negative correlation was observed between body height and the muscle strength.

Keywords: students, morphological characteristics, strength, connection

INTRODUCTION

The early schooling period is a favorable time for stimulating the development of the entire kinanthropological status and the time for increasing the optimal reach of biotic motor knowledge. For this reason, the child's development is best monitored through motor expression. Given that the success of an exercise was also confirmed in laboratory conditions (children who practiced walking had better results than children who did not) (Vasta et al., 2005), it can be argued that regular organized exercise has a positive effect on motor development as early as in preschool-aged children (Živčić et al. 2008, Tomac et al., 2021). The earliest period in one' life, that is, the period from the first to the third year of life is in experts' opinion (pediatricians, speech therapists, defectologists, pedagogues, psychologists, and kinesiologists) the most important period in a child's life. In other words, in that period, the best foundations can be laid for further development, which should be built on systematically, continuously, and efficiently during the preschool and early school years. Monitoring the development of morphological, motor, and functional variables and their interrelationships and the usefulness of organized physical exercise for children of early school age builds on the research of preschool-aged children (Hraski and Živčić, 1994; Sindik, 2009; Trajkovski Višić, 2004; Trajkovski 2011) and continues even when children enroll in elementary school (Miš Čak et al., 2020, Babin et al., 2020). It is known that during this period missed opportunities to influence the development of the quality and quantity of all knowledge and abilities cannot be compensated in later periods of life, no matter how much development incentives are intensified, both in the family as an autonomous educational environment, and in all forms outside of family education. (Pejčić and Malacko, 2005). Many authors have concluded that success in motor manifestations depends to a large extent on morphological characteristics (Blašković, 1979), but the relationships between these two sets of variables were mainly monitored on school children (Kondrič et al., 2002) and child athletes (Malina et al., 2004). However, recently, this has been researched in preschool children as well, whereby it was established that there are correlations and that the length of the legs and the total height have the most influence on the result in tests evolving running or jumping, while body weight is negatively related to strength and positively related to flexibility (Trajkovski et al., 2008). Also, Bala et al. (2009) determined that there is a correlation between two sets of variables, but more significantly in boys who are more physically active. The correlation between morphological and motor variables and the manifestation of aerobic endurance was also established (Pejčić et al., 2012).

This research aimed to determine statistically significant correlations between the system of morphological and motor variables in children aged 8.5 years to better understand how to organize kinesiological activities for children of that age, that is, how to determine the most rational procedures when diagnosing, planning, and programming kinesiological content.

METHODS

Sample of participants

The sample of participants consisted of 54 female and 60 male elementary school students from the city of Rijeka, with an average age of 8.51 years (SD=0.66). The research was conducted at the beginning of the 2022/2023 school year, in September and October. All children were healthy during the research and written consent was obtained from the parents for the children to participate in the research.

Sample of variables

The following variables were used to assess the morphological characteristics: *longitudinal dimensionality of the skeleton* – body height (HEIGHT), *body mass and volume* – body weight (WEIGHT) from which the body mass index (BMI) was subsequently calculated. Morphological characteristics were measured using the standard procedure according to the international biological program, and measures that are standardly used in kinanthropometric procedures (Mišigoj-Duraković, 2008).

The following variables were used to assess motor abilities: *mechanism of regulating the intensity and duration of excitation* – standing long jump (JUMP), bent-arm hang (HANG), sit-ups for 15 seconds (SITUP15), squat hold (SQUAT), and PLENK.

Data processing methods

Basic descriptive parameters (arithmetic mean, standard deviation, minimum and maximum score) were calculated in all variables separately by gender. Pearson's correlation coefficient was used to determine the relationship between the variables. All analyses were calculated with a significance level of $p = 0.05$.

RESULTS AND DISCUSION

Analysis of Table 1, which shows the basic descriptive parameters in the entire sample, reveals that the children have an average height of 138 cm, their body weight is 32 kg, while their body mass index is 17.8 kg/m², which indicates that the children are borderline overweight (Cole et al., 2000). It is, therefore, necessary to prevent obesity by including children in daily physical activities. The results are satisfactory in the test that researched the repetitive trunk strength because, based on the results obtained, it is possible to assume that the children could perform 30 sit-ups in one minute. Regarding the test that explores the static arm and shoulder girdle strength (HANG), the children are below average compared to children in the Republic of Croatia from 30 years ago, while in the test that explores the explosive leg strength legs (JUMP), they achieved average results (Findak et al. 1996). In the test that explored whole-body strength (PLANK), children could hold the position for an average of 85 seconds to failure, while in the wall squat to failure test, which checks the static leg strength (SQUAT), the children could hold the position for 78 seconds, which are satisfactory results.

Table 1. Basic descriptive parameters of the total sample

	Mean	*SD*	*Min*	*Max*
HEIGHT	*137.747*	*6.991*	*122.000*	*159.000*
WEIGHT	*32.384*	*6.342*	*21.000*	*50.000*
BMI	*17.786*	*8.802*	*13.200*	*101.000*
SITUP15	*16.464*	*4.623*	*3.000*	*26.000*
HANG	*15.725*	*15.083*	*0.000*	*70.000*
SQUAT	*78.170*	*47.863*	*10.000*	*210.000*
PLANK	*85.000*	*55.641*	*9.000*	*273.000*
JUMP	*145.000*	*24.627*	*75.000*	*210.000*

Tables 2 and 3 show the results in all variables separately for girls and boys, whereby it is observable that boys fall into the overweight category compared to girls, that they have similar results in the expression of repetitive trunk strength (SITUP15) and explosive leg strength (JUMP), which would mean that girls are stronger than boys because even in the PLANK and SQUAT tests, girls achieve slightly better results than boys. Boys have a better result than girls only in the bent-arm hang test, which was to be expected.

Table 2. Basic descriptive parameters of the total sample of male students

	Mean	*SD*	*Min*	*Max*
HEIGHT	*138.462*	*5.837*	*125.000*	*154.000*
WEIGHT	*33.577*	*6.118*	*23.000*	*50.000*
BMI	*18.993*	*11.871*	*13.610*	*101.000*
SITUP15	*16.425*	*5.012*	*3.000*	*25.000*
HANG	*18.325*	*17.911*	*0.000*	*70.000*
SQUAT	*73.441*	*44.699*	*13.000*	*180.000*
PLANK	*78.417*	*53.871*	*9.000*	*242.000*
JUMP	*147.550*	*26.048*	*75.000*	*210.000*

Table 3. Basic descriptive parameters of the total sample of female students

	Mean	*SD*	*Min*	*Max*
HEIGHT	*136.957*	*8.071*	*122.000*	*159.000*
WEIGHT	*31.064*	*6.388*	*21.000*	*48.000*
BMI	*16.450*	*2.318*	*13.200*	*23.470*
SITUP15	*16.517*	*4.111*	*5.000*	*26.000*
HANG	*12.138*	*9.094*	*0.000*	*35.000*
SQUAT	*83.434*	*51.068*	*10.000*	*210.000*
PLANK	*92.315*	*57.153*	*18.000*	*273.000*

JUMP	141.483	22.487	100.000	180.000

Table 4 shows the correlations in the total sample, while Tables 5 and 6 show the results separately by gender.

Table 4. Correlation matrix and descriptive parameters of the total sample

	AS	SD	HEIGHT	WEIGHT	BMI	SITUP15	HANG	SQUAT	PLANK	JUMP
HEIGHT	137.732	6.997	1.000	0.749*	0.220	0.086	0.010	-0.033	0.021	-0.286*
WEIGHT	33.203	6.734	0.749*	1.000	0.394*	-0.088	-0.175	-0.075	-0.207	-0.462*
BMI	18.535	10.369	0.220	0.394*	1.000	0.138	-0.016	0.259*	0.018	-0.208
SITUP15	16.464	4.623	0.086	-0.088	0.138	1.000	0.479*	-0.015	0.392*	0.063
HANG	15.725	15.083	0.010	-0.175	-0.016	0.479*	1.000	-0.064	0.492*	0.148
SQUAT	74.609	42.088	-0.033	-0.075	0.259*	-0.015	-0.064	1.000	-0.063	0.157
PLANK	81.623	45.959	0.021	-0.207	0.018	0.392*	0.492*	-0.063	1.000	0.132
JUMP	145.000	24.627	-0.286*	-0.462*	-0.208	0.063	0.148	0.157	0.132	1.000

*denotes significant correlation

Table 5. Correlation matrix and descriptive parameters of male students

	AS	SD	HEIGHT	WEIGHT	BMI	SITUP15	HANG	SQUAT	PLANK	JUMP
HEIGHT	138.600	6.238	1.000	0.656*	0.229	-0.089	-0.007	0.095	0.196	-0.182
WEIGHT	33.650	6.331	0.656*	1.000	0.418*	-0.320*	-0.283	-0.003	-0.072	-0.435*
BMI	19.437	13.456	0.229	0.418*	1.000	0.163	-0.039	0.326*	0.067	-0.229
SITUP15	16.425	5.012	-0.089	-0.320*	0.163	1.000	0.586*	0.141	0.504*	0.189
HANG	18.325	17.911	-0.007	-0.283	-0.039	0.586*	1.000	-0.101	0.565*	0.154
SQUAT	74.475	46.754	0.095	-0.003	0.326*	0.141	-0.101	1.000	-0.097	0.180
PLANK	84.625	49.912	0.196	-0.072	0.067	0.504*	0.565*	-0.097	1.000	0.077
JUMP	147.550	26.048	-0.182	-0.435*	-0.229	0.189	0.154	0.180	0.077	1.000

*denotes significant correlation

Table 6. Correlation matrix and descriptive parameters of female students

	AS	SD	HEIGHT	WEIGHT	BMI	SITUP15	HANG	SQUAT	PLANK	JUMP
HEIGHT	136.534	7.883	1.000	0.837*	0.480*	0.331	-0.055	-0.221	-0.244	-0.484*
WEIGHT	32.586	7.322	0.837*	1.000	0.878*	0.252	-0.035	-0.193	-0.434*	-0.546*
BMI	17.291	2.479	0.480*	0.878*	1.000	0.085	-0.036	-0.122	-0.509*	-0.449*
SITUP15	16.517	4.111	0.331	0.252	0.085	1.000	0.220	-0.364	0.162	-0.178
HANG	12.138	9.094	-0.055	-0.035	-0.036	0.220	1.000	0.062	0.267	0.053
SQUAT	74.793	35.459	-0.221	-0.193	-0.122	-0.364	0.062	1.000	0.013	0.114
PLANK	77.483	40.363	-0.244	-0.434*	-0.509*	0.162	0.267	0.013	1.000	0.218
JUMP	141.483	22.487	-0.484*	-0.546*	-0.449*	-0.178	0.053	0.114	0.218	1.000

*denotes significant correlation

From the obtained results of correlations of morphological characteristics, the body mass index, and the five variables of muscle strength, it is noticeable that there are statistically significantly negative correlations of body weight and height and explosive strength in the total sample of participants, while the present negative correlation between the body mass index and the same motor ability is not statistically significant. In boys, there are also negative correlations between morphological characteristics and explosive strength, but only the negative correlation between body weight and explosive strength is statistically significant. In girls, all three morphological variables, explosive strength, and static body strength are statistically negatively correlated, while other correlations are not statistically significant.

The apparently negative correlations of body height and explosive strength in the entire sample are contributed by the high negative correlation observed in girls, and it can be concluded that the length of the extremities in this developmental phase during a movement such as the standing long jump represents a coordination problem with a lack of muscle strength that does not follow development longitudinal bones.

There are also significant positive correlations of the body mass index and static leg strength (squat hold test) in the entire sample, again, due to the high correlation obtained in boys. Given that the body mass index is calculated as the ratio of height and weight, without insight into the body composition, it is possible that it is not a matter of a significant amount of fat tissue in boys, but a greater share of muscle mass, which is used to express strength. Similar results were obtained by Nikolić, Furjan Mandić, and Kondrič, whereby they determined that a larger amount of fat tissue in the lower extremities causes poorer results in motor tasks that require explosiveness and a quick change of direction of movement, while Pelemmis, Pelemis, Mitrovic and Dzinovic (2014) determined the association of morphological characteristics only with agility. However, different results were obtained by Kondrič, Mišigoj Duraković, and Metikoš (2002) on a sample of children aged 7 and 9 years. They established positive relations between morphological characteristics and dimensions of the excitation intensity regulation mechanism (horizontal jump, medicine throw ball, and grip strength).

In the domain of motor skills, positive correlations between static arm and trunk strength and repetitive trunk strength are noticeable, especially in boys.

From the results obtained, we should ensure that our early-school-aged children exercise regularly (every day at school for 45 minutes), that they attend at least three extracurricular or extra-school physical activities for 60 minutes, three times a week, and that they are more physically active in their free time (walking, running, cycling, swimming, hiking) with their peers or with their parents.

CONCLUSION

The results of this research indicate that a higher body weight causes weaker results in tests assessing muscle strength and power, especially in relative working conditions when one's own body weight is overcome. This research determined that morphological characteristics can significantly influence the manifestations of motor abilities, their structure, and development. Therefore, it is necessary to organize physical exercise at this age, which will be aimed at optimal motor and morphological development in order to prevent excessive body weight and obesity, which cause inferior results in motor manifestations.

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Economic Effects of Sporting Events on The Local Community

*Tvrtko Galić[1]

[1]Faculty of Kinesiology Osijek, Josip Juraj Strossmayer University of Osijek, Croatia

*Corresponding author

ABSTRACT

The sports industry is undoubtedly having an increasing influence on the global economy. When analyzing the economic effects of sports events, it is necessary to see them as direct economic effects and indirect effects, and at the same time the effects can be short-term or they can have a long-term effect on the local community. This paper will highlight the importance of sports events on the local community. The paper analyze the income and expenses of the organization of sports events and analyzes the share of income and expenses related to the local community. In doing so, publicly available data on the economic effects of the organization of sports events will be analyzed, both in terms of expenditure and income in different time periods and in different stages of implementation. The results of the research of publicly available data show that the organization of large sports events is extremely expensive and that it requires large investments, first of all, in the construction of infrastructure, which clearly represents a large burden on the local community in the context of maintenance and servicing costs. While, on the other hand, positive economic effects are visible in the short term due to the increased volume of consumption during the sports event, and the income generated by the contractors who participate in the process of preparation and organization of the sports event. From all this it can be concluded that the acceptance of the organization and hosting of a major sports event is certainly of great importance for the local sports community in the context of sports because it can be the driver of increased interest in a particular sport, while in the economic context it is very important to manage well all segments and all stages of organizing a sports event so that it not only has short-term, but also long-term positive economic effects on the local community.

Keywords: economic growth, sports industry, sports infrastructure, profitability of a sports event, investment in sports

INTRODUCTION

The sports industry undoubtedly has an increasing influence on the global economy, regardless of whether you look at it through the recreational sports industry or through the professional sports industry. Each of the industrial branches contributes in a different way to the global economy, but also to the economy of the local community. The development of sports tourism in an area contributes to the extension of the tourist season, the overcoming of the seasonal nature of tourism, and the increase in non-boarding consumption. (Petrovic et al., 2017). This paper will highlight the importance of sports events on the local community. When analyzing the economic effects of sports events, it is necessary to see them as direct economic effects and indirect effects, and at the same time the effects can be short-term or they can have a long-term effect on the local community. Table 2 shows the economic effects of the organization of a sports event in a particular phase of the organization (Bartoluci, 2013).

Table 1. Presentation of economic benefits and costs for the organizer:

PERIOD OF ECONOMIC BENEFIT COSTS	*PERIOD OF ECONOMIC BENEFIT COSTS*	*PERIOD OF ECONOMIC BENEFIT COSTS*
BEFORE THE GAMES	*Tourism* *Construction activities*	*Preparatory operating costs Investing in investments* *Lost benefits from projects that chose another location because of the Olympics*
DURING GAMES	*Tourism* *Stadiums and infrastructure* *Olympic affairs* *Revenues from tickets, TV rights, sponsorships, etc.*	*Operational costs* *Pollution* *Lost benefits from projects that chose another location* *Lost tourist traffic due to those who avoid large crowds*
AFTER THE GAMES	*Tourism and international reputation* *Stadiums and infrastructure* *Urban renewal* *Human capital*	*Stadium and infrastructure maintenance* *Lost benefits from projects that chose another location because of the Olympics*

Depending on the type of sports event and its size, the effects can refer to a different increase in consumption before and during the sports event, employment growth, investment in sports infrastructure, all of which can have positive economic effects and generate economic growth through them. Of course, each of the sports events in the preparatory phase requires financial investments, which are usually not small, so the question then arises of long-term profitability and smart cost management in the phase of organizing a sports event with the aim of positive business for the organizer of the sports event or the local community if it participates in it. In addition to these two phases, the phase of preparation and the phase of realization of the sports event, the last phase, the phase after the end of the sports event, which is often the most challenging because it has the task of reflecting, ensuring adequate content and future purpose for all the infrastructure that was built for the needs of someone, is also very important. of a major sporting event. In order to make them easier to detect, Table 2 shows the economic effects of sports tourism with regard to their structure (Bartoluci, 2013).

Table 2. Classification of the economic effects of sports tourism

PHYSICAL EFFECTS	*The number of overnight stays, the number of accommodation facilities, the number of tourists, the use of means of transport and others - are calculated by counting physical units.*
FINANCIAL EFFECTS	*Value of GDP, consumption of tourists, income from tourist tax, price movement of catering services, price movement of travel agencies*
DIRECT ECONOMIC EFFECTS	*Direct tourism consumption (consumption in the destination) - catering, transport, trade*
INDIRECT ECONOMIC EFFECTS	*Growth in real estate prices, construction of residential buildings*
POSITIVE ECONOMIC EFFECTS	*GDP growth, income growth, income growth, employment growth, living standards growth*
NEGATIVE ECONOMIC EFFECTS	*Seasonal jobs, price and cost growth, environmental damage, pollution*

Sports tourism is already an established niche business in the tourism industry , whether it is professional athletes or administrators attending games and matches or spectators travelling to a nation to see an international sports competition (Higham & Hinch, 2018)

METHODS

For the purposes of this work, using the secondary research method, publicly available data were searched in the form of reports, decisions, obtained data tables, which were processed, compared and interpreted in order to obtain conclusions about the research topic using the deduction method. Available soureces (Preuss, 2022), (Flyvbjerg et al., 2020, 2016), (Flyvbjerg & Stewart, 2012 compare date based on a custom-built database from public sources, so this article compares the revenues and costs of the Olympic Games and World Cups between 1964 and 2018 (N = 43). In order to show the comparison of income and costs as clearly as possible, in the final part of the research, income and expenditure, which at the same time constitute the basic elements of the sports event budget, were correlated.

RESULTS and DISCUSION

When analyzing the economic effects of hosting sports events, emphasis was placed on the World Cup in football, and the summer and winter Olympic Games. Despite the complexity of the structure of income and costs of the organization of such large sports events, certain categories still prevail. This is how certain authors take it into account (Müller et al., 2022):

- Revenue from broadcasting rights
- Revenue from (domestic and international) sponsorship
- Revenue from ticket sales

Also research has found that these three revenue sources account for more than 90% of total revenues in recent Olympic Games and World Cups (Baade and Matheson, 2016: 206; Matheson, 2018: 23) and therefore allow a robust approximation of revenues. Furthermore, the organization of the 1976 Summer Olympics in Montreal cost 1.5 billion dollars and it took almost 30 years to recoup that money. (Quebec's Big Owe Stadium Debt Is Over, 2006). While some sources claim that the organization of the Winter Olympic Games in Beijing in 2022 cost a whopping 38.5 billion dollars (Stonington, 2022).

On the economic level, the results show that the World Cup and the Olympic Games are not financially viable in and of themselves. In other words, the IOC and FIFA would long have gone bankrupt, if they had to shoulder the direct costs of their events from the revenues these events create. If these events still continue today, this is because they receive subsidies external to the event itself, mostly for venue construction. In theory, these subsidies could come from private sources, for example from clubs or investors planning to operate stadiums profitably. Research indicates, however, that these are often public subsidies, as many stadiums cannot operate at a profit after the event (Alm et al., 2016). As shown in Figure 1 and Figure 2 (Müller et al., 2022) in the past more than half a century, only a few major sporting events have had a positive return on investment.

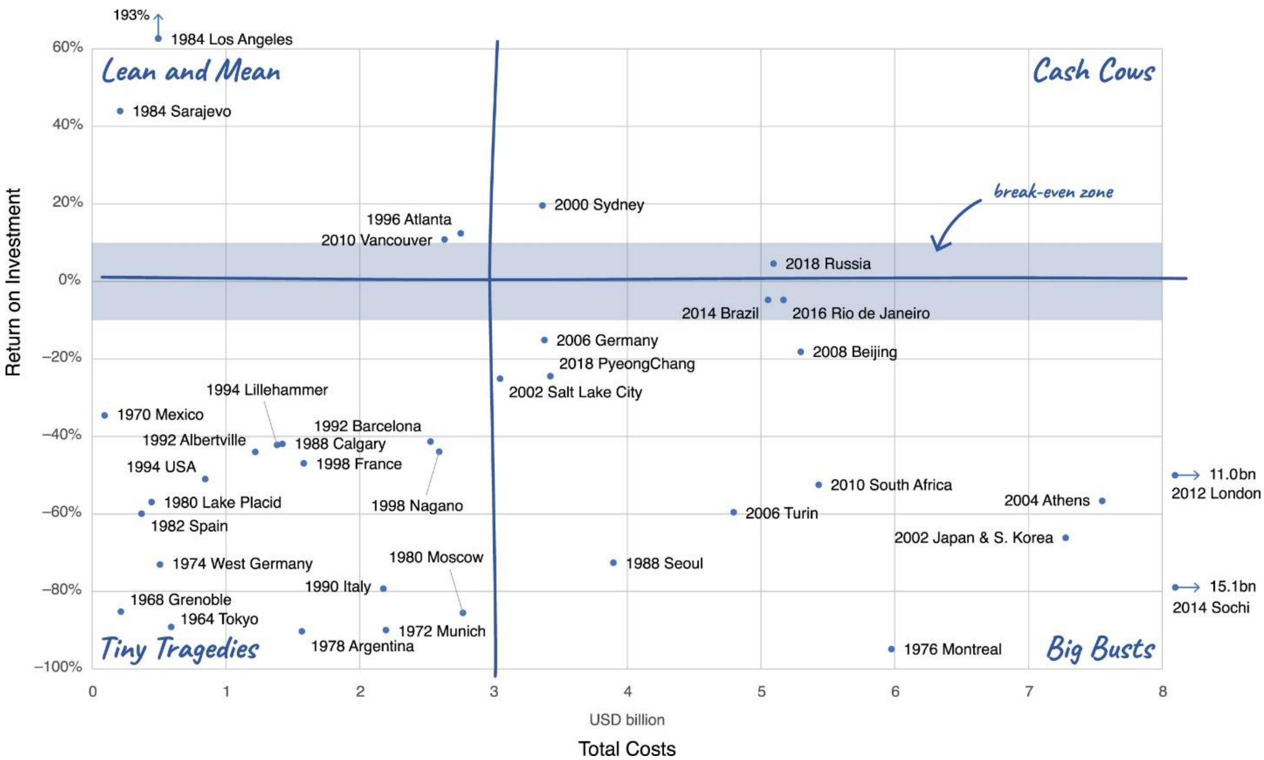

Figure 1: Return on investment of the Olympic Games and the Football World Cups, 1964–2018

If we compare Figure 1 and Figure 2, we can see that the amount of the investment is not a measure of the success of the return of invested funds. The data in the presented graphs show that only the Olympic Games in Sarajevo, Los Angeles, Vancouver, Atlanta and Sydney and the World Soccer Championship in Russia had a positive return on the investment of the organization of a major sports event.

The graph below clearly shows both the structure of income and expenditure, where it is evident that the largest share of income is from media rights, and the smallest from sold tickets, which clearly defines the market for such sports events. On the cost side, the largest share of the cost refers to infrastructure costs.

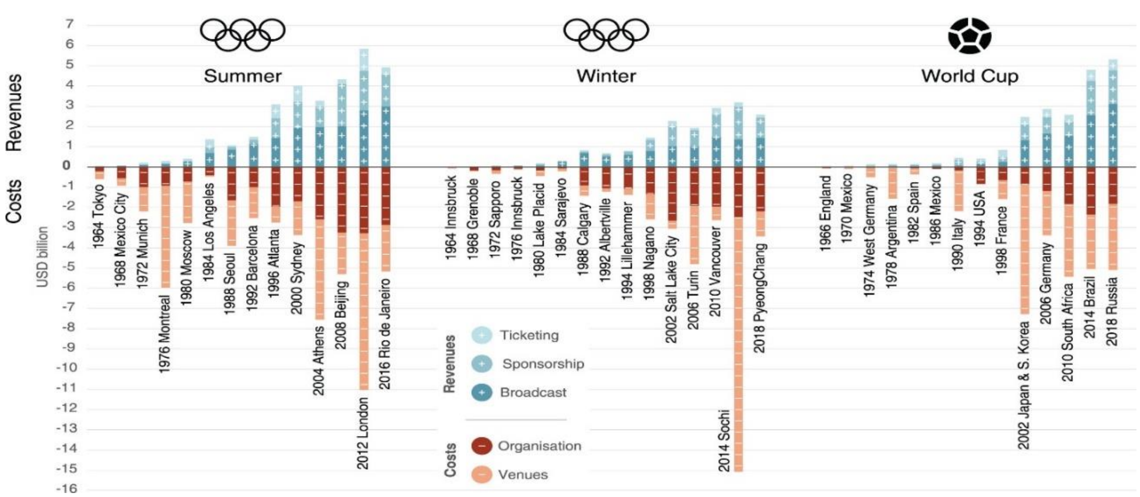

Figure 2: Cost and revenues of the Olympic Games and the Football World Cups, 1964–2018

CONCLUSION

The research showed that of the 43 major sports events analyzed, only a few of them had a positive final balance. It is also evident that the largest part of the expenditure was related to the construction of infrastructure (fighting arenas, accommodation facilities, transport infrastructure) and it is precisely these items that are the biggest burden for the host cities after the end of the sports event, because they are left with the burden of maintaining all this infrastructure. It is also important to note that the largest share of income is income from media rights, which ultimately does not end up in the budget of the city or country of the organizer, but in the account of the umbrella world federation (IOC and FIFA). It is very important to emphasize that there is a big difference in the cost structure of organizing a sports event such as the Olympic Games, in which all events are located in one city, compared to the organization of the World Cup, in which competitions take place in several cities or even in several countries. For example, the World Football Championship 2030 will be held in even two continents and six countries. Event tourism is noted to be one of the fastest growing sectors of the tourism industry. Mega events such as the FIFA World Cup are sought after by countries for numerous reasons in particular to boost their image as tourism destinations, to promote investment and to gain benefit from their associated positive economic impacts (Matsuoka, 2015). Hosting major sport events can cause positive shifts in tourism demand on a long-term basis, but the additional revenues might not counterbalance the invest-ment costs that are required of the host destination (Solberg & Preuss, 2007). Mega-events are far from the economic engines they are touted to be. It is almost a universal experience that these events engender more short-run costs than short-run revenues, and that the expected long-run gains in tourism, trade and foreign investment are not forthcoming. Depending on the event and the host city or country, the actual economic outcome can range from significantly negative, to neutral, to modestly positive. The modestly positive experiences, however, are few and far between and necessitate special circumstances (Zimbalist, 2016).

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Sports and Recreational Offers in Selecting A Tourist Destination

Katija Kovačić [1], Eli Marušić[2]

[1]The Faculty of Kinesiology, University of Split, Split, Croatia; [2]Faculty of Maritime Studies, University of Split, Split, Croatia

*Corresponding author

ABSTRACT

Sports and recreation play a vital role in society, from creating quality of people's health and life to developing societal and business ventures, attracting much attention to the rising tourism industry worldwide. Besides, the number of tourists looking for a sports and recreation experience in a destination is growing, too. Therefore, tourist destinations worldwide tend to integrate sports and recreation services and amenities in their offers, appeal, and competitive image. This paper investigates the relevance /importance of the sports and recreation content in selecting a tourist destination. The paper uses secondary data, i.e., the desk research method, to identify and compare elements of sports and recreation in a destination relative to other offerings to determine the role of sports and recreation in choosing a destination. Secondary data is gathered from the available survey reports on the attitudes and expenditures of tourists in Croatia. The importance of sports and recreation activities, attractions, and amenities, as well as sports in general, in choosing a tourist destination is growing. Sports and recreation are some of the motives influencing the choice of tourist destinations. Tourists practice sports and recreation activities during their travels and are ready to spend part of their budget on sports and recreation. The research in this paper confirms that tourists significantly consider sports and recreation amenities, activities, and attractions when choosing a tourist destination. However, the share of tourists involved in sports and recreation activities and the economic effects of sports and recreation in tourism in many destinations are minimal and require additional efforts by the destinations regarding market supply and market demand.

Keywords: sports and recreation, choice of tourist destinations, tourism offer

INTRODUCTION

Tourists decide on their preferred destinations influenced by various personal motivations and market-related stimuli. Some tourists prefer recognizable and highly branded market offers, while others prefer less-known destinations with safe and peaceful locations. The literature shows that selecting a travel destination is complex (Pan et al. 2021). Also, tourists make decisions influenced by different changeable factors, such as their needs and habits (Mihai et al., 2023), motivation, and destination offers. Individuals visit destinations motivated by specific reasons such as attending and participating in events, sports and recreation, entertainment, culture, gastronomy, religion, etc. Travel for leisure and pleasure could involve many human emotions and drives that may be difficult to explain (Camille, 2017). Through the choice of destination, tourists satisfy their individual needs. Regardless of how or why individuals travel, travelers expect fundamental requirements from destinations, such as access, accommodation, attractions, activities, and amenities (Camille, 2017). Sports attractions, activities, and amenities are integral to the destination's offerings worldwide in the contemporary tourist markets.

Many researchers (Gibson, 1998; Getz, 2003; Mollah et al., 2021) investigated and connected diverse sports and tourism dimensions. Besides, sports tourism is considered one of the fastest-growing segments of the travel and tourism industry (Hritz & Ross, 2010). Furthermore, numerous scholars (Green & Scott, 2011; Kwiatkowski & Könecke, 2017; Bazzanella et al., 2023) have studied sports events as attractions and their impact on the economy and society. Happ (2021) analyzed tourism destination competitiveness with a particular focus on the sports and recreation dimension and concluded that sports strongly influence the destination's competitiveness. Still, the impact varies from sport to sport (Happ, 2021). Chen et al. (2022) analyzed sports tourists' behaviors through different traveling stages - before, during, and after traveling. For all three stages, they identified determinants that influence sports tourists' behaviors (Table 1).

Table 1. The decision-making determinants impacting tourist behavior (Chen et al., 2022)

	Travelling stage		
	Before travelling	*During travelling*	*After travelling*
Determinants	• *Nostalgia* • *Attitude* • *Motivation* • *Behavioral intention*	• *Event quality* • *Destination image* • *Tourist satisfaction* • *Perceived value*	• *Future intention* • *Destination loyalty* • *Place attachment*

However, the role of sports and recreation activities, attractions, and amenities, as well as sports and recreation as a motivation for choosing a tourist destination, has been investigated to a very limited extent. Therefore, this paper investigates tourists' motivation, activities, satisfaction, and expenditures related to sports and recreation. The paper uses published data from the available surveys on the attitudes and consumption of visitors in Croatia (Institute for Tourism, 2020, 2023).

METHODS

This research aims to determine sports and recreation's role in tourists' destination selection. Also, it aims to identify the importance of tourists' sports and recreation activities, their expenditures while visiting a place, and satisfaction with sports and recreation content in the destination. The paper uses secondary data related to the research problem from available survey reports conducted by the Croatian Institute for Tourism in 2019 and 2022/2023, i.e., the TOMAS survey on tourists' attitudes and expenditures in Croatia[1]. The number of respondents in 2019 was 13852; in 2022/2023, there were 14632 respondents (Institute for Tourism, 2020, 2023). The paper identifies sports and recreation activities and amenities in the Croatian tourism offerings in the two observed periods (2019 and 2022/2023). It compares them to other offered items in Croatia as a tourist destination to determine the significance of sports and recreation in tourists' motivation, activities, satisfaction, and expenditures.

[1]. The Croatian Institute for Tourism periodically conducts the longitudinal TOMAS survey on tourists' attitudes and expenditures in Croatia.

RESULTS AND DISCUSSION

This research shows that sports and recreation are important motivational factors in selecting a destination, as shown in Croatia's tourism example. Also, the number of tourists considering sports amenities, activities, and attractions as significant elements of the analyzed tourist offer is constantly growing in some sports and recreation categories. Table 2. shows tourists' motives for visiting Croatia as a destination (Institute for Tourism, 2020, 2023). It is important to note that in the TOMAS survey questions related to the motives of selecting Croatia as the destination, tourists could choose a maximum of three items from the total number of offered answers (i.e., motives). Therefore, the total sum of percentage scores exceeds 100%. In other words, the sum of all motive items (1-13) for both observed years (2019, 2022/2023) from Table 2. is over 100%.

Table 2. Motives for visiting Croatia (2019, 2022/2023)

Motives	*2019 (%)*	*2022/2023 (%)*
1. Sea	*85.5*	*89.3*
2. Nature	*57.8*	*64.3*
3. Gastronomy	*6.5*	*18.3*
4. City break	*23.9*	*17.4*
5. Touring/Sightseeing	*19.9*	*10.4*
6. Events	*4.4*	*8.4*
7. Entertainment and Festivals	*5.8*	*7.5*
8. Other Sport and Recreation	*11.4*	*7.2*
9. Culture and Art	*11.8*	*6.9*
10. Village/Rural area	*4.5*	*4.9*
11. Hiking/Walking	*2.7*	*3.6*
12. Welness/Spa	*3.2*	*1.2*
13. Cycling/Mountain biking	*1.6*	*1.1*
Sport and Recreation Total	*15.7*	*11.9*

Source: Institute for Tourism: TOMAS surveys Croatia 2019 and Croatia 2022/2023

According to the analyzed data from the TOMAS survey (Table 2.), 15,7% of respondents selected sport and recreation activities (i.e., hiking/walking, cycling/mountain biking, and other sports and recreation) as a motivation for choosing the tourist destination (Croatia) in 2019. In the 2022/2023 survey report, the number of tourists who selected sport and recreation as a motive for choosing the destination has decreased (Table 2.). Also, 11,9% of respondents have chosen sports and recreation activities as a motive for selecting Croatia as their destination in 2022/2023, which is 3,8 % less compared to 2019. The lower percentage of respondents in 2022/2023 compared to 2019 indicates a decrease in sports and recreation trips.

However, some sports and recreation activities probably fall under the category "events".

Furthermore, the TOMAS survey in 2019 and 2022/2023 (Institute for Tourism, 2020, 2023) listed a set of the following sport and recreation activities: swimming and bathing, hiking, jogging/running, tennis, diving, fishing, cycling on marked bicycle paths, golf, sailing, visiting sports events, hiking, adventure sports, mountain biking, indoor sports, hunting, horseback riding, and rafting. The number of tourists who participated in sport and recreation activities in 2022/2023, compared to 2019, has changed (Table 3.), i.e., the number of tourists involved in sports activities has increased significantly in several categories - cycling (8%), visiting sports events (5,5%), and other water-based sports (9,8%). On the other hand, a significant decrease in 2022/2023 compared to 2019 is evident in swimming and bathing (2.4%) and diving (1.5%). It should be noted that the activity "other water-based sports" was not listed in 2019, and the share of tourists who practiced the mentioned activity in 2022/2023 is significant.

It is also essential to highlight the substantial increase in the number of tourists who visited sports events during their stay in the destination (5.5%). The analysis of this paper confirms the findings of previous research (e.g. Gibson, 1998, Hritz & Ross, 2010, Mollah et al., 2021) that indicate the importance of sports and recreation as an influential part of a destination's tourist offer.

Table 3. Activities during the stay at the destination

Activities	*2019 %*	*2022/2023 %*	*Change %*
Swimming and bathing	*75.2*	*72.8*	*-2.4*
Hiking	*14.1*	*14.2*	*0.1*
Jogging/running	*12.5*	*12.3*	*-0.2*
Tennis	*9.7*	*11.7*	*2.0*
Diving	*8.4*	*6.9*	*-1.5*
Fishing	*6.2*	*10.1*	*3.9*
Cycling	*5.0*	*13.0*	*8.0*
Golf	*3.7*	*4.0*	*0.3*
Sailing	*3.5*	*3.7*	*0.2*
Visiting sports events	*3.3*	*8.8*	*5.5*
Hiking	*2.8*	*3.8*	*1.0*
Adventure sports	*2.5*	*2.8*	*0.3*
Mountain biking	*2.4*	*2.3*	*-0.1*
Indoor sports	*1.5*	*1.5*	*0.0*
Hunting	*1.4*	*0.5*	*-0.9*
Horseback riding	*1.4*	*1.4*	*0.0*
Rafting	*1.3*	*2.3*	*1.0*
Other water-based sports	-	*9.8*	*9.8*

Source: Institute for Tourism, 2020, 2023

Furthermore, the TOMAS survey 2019 and 2022/2023 collected data on tourist satisfaction with the observed tourist offer. Tourists' satisfaction with the destination offers related to sports and recreation in 2022/2023 compared to 2019 has increased (Table 4.). The respondents expressed the highest satisfaction with hiking paths and slightly lower satisfaction with sports facilities and cycling routes. However, the level of tourist satisfaction with the last two elements (Table 4.) is still lower than the level of satisfaction with the overall tourist offer, indicating the need for further investments in aspects of the tourist offer related to sports and recreation.

Table 4. The level of tourists' satisfaction with the elements of the tourist offer

The element	*2019*	*2022/2023*	*Change %*
Hiking paths	*74.1 High*	*83.6 Very high*	*9.5*
Sports facilities	*62.6 Intermediate*	*79.6 High*	*17.0*
Cycling routes	*66.9 Intermediate*	*78.5 High*	*11.6*

Source: Institute for Tourism, 2020, 2023

According to the analyzed data (Institute for Tourism, 2020, 2023), the average daily tourists' spending on sports and recreation increased from 2.70 Euros in 2019 to 3.8 Euros in 2022/2023. However, along with the growth of consumption in absolute terms, there was also a decline in the share in the structure of total daily average spending from 2.76% in 2019 to 2.7% in 2022/2023. Considering that the total average daily expenditures of tourists in 2022/2023 was 140,2 Euros, it should be concluded that tourists' allocations for sports and recreation are limited. All findings confirm that sports and recreation can significantly motivate tourist trips. The destinations with a differentiated offer and investments in diverse sports and recreation facilities could generate better growth in the tourism sector, i.e., an increase in the number of tourists and their consumption and satisfaction with the destination.

CONCLUSION

This paper investigated the importance of the sports and recreation content in selecting a tourist destination. The research results confirm that sports and recreation are essential motivators when choosing a tourist destination. The number of tourists who select a destination based on the available sports and recreational activities, amenities, and attractions is variable. The variability is related to different sports and recreation activities and tourists' satisfaction with the tourist offer in the destination. Tourist consumption related to sports and recreation in the overall structure of tourist consumption is relatively low. Further research focusing on sports and recreation in tourism should provide a more precise and comprehensive definition and classification of sports and recreation activities, amenities, and attractions and their influence on tourists' decisions in selecting a destination.

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Analysis of Self-Perception of Physical Appearance Among Students of the Faculty of Kinesiology and the Faculty of Education in Osijek

*Iva Macan[1], Josip Cvenić[1], Jurica Lovrinčević[2], Petra Rajković Vuletić[3]

[1]Faculty of Kinesiology Osijek, University of J.J. Strossmayer in Osijek, Osijek, Croatia; [2]Faculty of Education, University of J.J. Strossmayer in Osijek, Osijek, Croatia; [3]Faculty of Kinesiology, University of Split, Split, Croatia

*Corresponding author

ABSTRACT

Body image perception encompasses how individuals assess their body size, estimate attractiveness, and perceive their body shape and size. This perception is not static but evolves throughout life due to physical and psychological changes. This study involved 84 students from the Faculty of Kinesiology and the Faculty of Education. The Body Shape Questionnaire (BSQ) was used to assess body satisfaction. Statistically significant differences ($p<0.05$) were found in 32 questions (1-25,27-31,33-34), with students from the Faculty of Kinesiology reporting higher levels of satisfaction with their appearance then students from Faculty of Education.

Keywords: Body image, Physical Appearance, Self-Perception

INTRODUCTION

Body image perception encompasses evaluating body size, estimating body desirability, and perceiving one's body shape and size (Toselli et al.,2023). It includes body size assessment (how a person perceives their body), body attractiveness estimation (the type of body a person considers most attractive), and perceptions related to one's body shape and size (Grogan,2010). Throughout life, individuals undergo physical and psychological changes that impact their body image perception. Consequently, body image is not a static concept but a dynamic characteristic shaped by one's self-perceptions (Markey,2010).

Body image perception has been influenced by the media. Anderson and DiDomenico (1992) found that media representation of the 'thin ideal' is linked to widespread body image dissatisfaction and dieting disorders. The issue of body image is more complex due to the constant stream of media messages that today's youth encounter, dictating how they should look in terms of body shape and form. Globally, the health of young people has largely been overlooked in public health discussions, as this age group is generally presumed to be healthy (Gore, Bloem, Patton, Ferguson, & Joseph, 2011). The relationship between body image construction and mental health levels in college students has become an urgent issue requiring thorough investigation. In contemporary society, body image formation is closely linked to various micro-level social interactions and is highly dynamic (Wang, Lu & Niu,2023). Individuals undergo notable variations in social comparisons and psychological changes across different settings. This topic is interesting because the students of the Faculty of Education are quite active, and the majority engage in recreational sports. The entire sample of respondents consists of young active women, making their perspectives on personal satisfaction with appearance particularly intriguing. Additionally, within the same environment, differences in family resources and the development of information-gathering skills significantly shape the diverse processes of body image construction (Wang, Lu & Niu,2023).

The aim of this study is to determine differences in body image satisfaction among college students between the Faculty of Kinesiology and the Faculty of Education in Osijek.

METHODS

In the research, 84 students participated, 44 from the Faculty of Kinesiology in Osijek and 40 from the Faculty of Education in Osijek. Students were asked to complete an online questionnaire regardless of their academic year of study.

The Body Shape Questionnaire (BSQ; Cooper, Taylor, Cooper, Fairburn, 1987) was employed to evaluate body image satisfaction. This questionnaire comprises 34 items that gauge satisfaction or dissatisfaction with body shape over the past month. Participants respond on a 6-point Likert scale (never, rarely, sometimes, often, very often, always), and the overall score is obtained by summing the items. A higher score signifies greater body dissatisfaction. The previous study determined questionnaire reliability of 0.93 in the sample of 112 individuals receiving permanent disability pensions primarily for obesity. (Thompson, Penner, Altabe, 1990). The items included in the questionnaire are as follows:1. Has feeling bored made you brood about your shape?, 2. Have you been so worried about your shape that you have been feeling that you ought to diet?, 3. Have you thought that your thighs, hips or bottom are too large for the rest of you?, 4. Have you been afraid that you might become fat (or fatter)?, 5. Have you worried about your flesh not being firm enough?, 6. Has feeling full (e.g., after eating a large meal) made you feel fat?, 7. Have you felt so bad about your shape that you have cried?, 8. Have you avoided running because your flesh might wobble?, 9. Has being with thin women made you feel self-conscious about your shape?, 10. Have you worried about your thighs spreading out when sitting down?, 11. Has eating even a small amount of food made you feel fat?, 12. Have you noticed the shape of other women and felt that your own shape compared unfavourably?, 13. Has thinking about your shape interfered with your ability to concentrate (e.g., while watching television, reading, listening to conversations)?, 14. Has being naked, such as when taking a bath, made you feel fat?, 15. Have you avoided wearing clothes which make you particularly aware of the shape of your body?, 16. Have you imagined cutting off fleshy areas of your body?, 17. Has eating sweets, cakes, or other high calorie food made you feel fat?, 18. Have you not gone out to social occasions (e.g., parties) because you have felt bad about your shape?, 19. Have you felt excessively large and rounded?, 20. Have you felt ashamed of your body?, 21. Has worry about your shape made you diet?, 22. Have you felt happiest about your shape when your stomach has been empty (e.g., in the morning)?, 23. Have you thought that you are the shape you are because you lack self-control?, 24. Have you worried about other people seeing rolls of flesh around your waist or stomach?, 25. Have you felt that it is not fair that other women are thinner than you?, 26. Have you vomited in order to feel thinner? 27. When in company have you worried about taking up too much room (e.g., sitting on a sofa or a bus seat)?, 28. Have you worried about your flesh being dimply?, 29. Has seeing your reflection (e.g., in a mirror or shop window) made you feel bad about your shape?, 30. Have you pinched areas of your body to see how much fat there is?, 31. Have you avoided situations where people could see your body (e.g., communal changing rooms or swimming baths)?, 32. Have you taken laxatives to feel thinner?, 33. Have you been particularly self-conscious about your shape when in the company of other people?, 34. Has worry about your shape made you feel you ought to exercise?

For this research, an online survey was designed using Microsoft Forms, which participants completed online. Participation in the survey was both anonymous and voluntary, taking approximately 10 minutes to finish. Data analysis was performed using Tibco Statistica Enterprise software (version 14.0.1.25). The Kolmogorov-Smirnov test was applied to check the normality of the distribution. Given that the variables did not follow a normal distribution, a nonparametric Mann-Whitney U test was utilized to identify differences between students of two faculties.

RESULTS

A statistically significant ($p<0.05$) difference was found in 32 questions (1-25,27-31,33-34). There was no statistically significant difference found between students in these two questions: Have you vomited to feel thinner? ($p=0.70$), Have you taken laxatives to feel thinner? ($p=0.83$). In this context, a higher sum in the SUM variable indicates a worse outcome, as the questionnaire was based on a Likert scale where 1 represented "never" and 6 represented "always" as responses. We can see in the results that students from the Faculty of Education have a poorer perception of their own appearance compared to students from the Faculty of Kinesiology (Table 1).

Table 1. Display of basic statistical parameters and results of the Mann-Whitney U tests.

	MEAN±SD(MIN-MAX)	*FOOZOS SUM*	*KIFOS SUM*	*p*
1	*2.88±138(1.00-6.00)*	*2126.50*	*1443.50*	*0.01*
2	*2.83±1.61 (1.00-6.00)*	*2052.50*	*1517.50*	*0.01*
3	*2.07±1.54(1.00-6.00)*	*2116.00*	*1454.00*	*0.01*
4	*2.90±1.81(1.00-6.00)*	*2184.50*	*1385.50*	*0.01*
5	*3.24±1.73(1.00-6.00)*	*2356.50*	*1213.50*	*0.01*
6	*2.56±1.70(1.00-6.00)*	*2222.50*	*1347.50*	*0.01*
7	*1.81±1.40(1.00-6.00)*	*2038.00*	*1448.00*	*0.01*
8	*1.37±1.00(1.00-6.00)*	*2008.00*	*1562.00*	*0.01*
9	*2.55±1.76(1.00-6.00)*	*2180.00*	*1390.00*	*0.01*
10	*1.71±1.28(1.00-6.00)*	*2098.50*	*1471.50*	*0.01*
11	*1.57±1.16(1.00-6.00)*	*2030.00*	*1540.00*	*0.01*
12	*2.24±1.56(1.00-6.00)*	*2097.50*	*1472.50*	*0.01*
13	*1.54±1.09(1.00-6.00)*	*1950.50*	*1619.50*	*0.02*
14	*2.06±1.57(1.00-6.00)*	*2323.00*	*1247.00*	*0.01*
15	*2.26±1.67(1.00-6.00)*	*2081.00*	*1489.00*	*0.01*
16	*1.60±1.29(1.00-6.00)*	*1958.50*	*1611.50*	*0.02*
17	*2.29±1.66(1.00-6.00)*	*2136.00*	*1434.00*	*0.01*
18	*1.36±0.95(1.00-6.00)*	*1907.50*	*1662.50*	*0.06*
19	*1.61±1.19(1.00-6.00)*	*2137.00*	*1433.00*	*0.01*
20	*1.82±1.14(1.00-6.00)*	*2216.50*	*1353.50*	*0.01*
21	*2.27±1.52(1.00-6.00)*	*2110.50*	*1459.50*	*0.01*
22	*1.68±1.20(1.00-6.00)*	*2010.50*	*1559.50*	*0.01*
23	*2.14±1.46(1.00-6.00)*	*2177.50*	*1392.50*	*0.01*
24	*1.80±1.28(1.00-6.00)*	*2062.00*	*1508.00*	*0.01*
25	*1.54±1.18(1.00-6.00)*	*2082.50*	*1487.50*	*0.01*
26	*1.04±0.24(1.00-6.00)*	*1744.00*	*1826.00*	*0.70*
27	*1.25±0.79(1.00-6.00)*	*1920.00*	*1650.00*	*0.05*
28	*1.75±1.20(1.00-6.00)*	*2148.00*	*1422.00*	*0.01*
29	*2.31±1.55(1.00-6.00)*	*2223.50*	*1346.50*	*0.01*
30	*2.26±1.35(1.00-6.00)*	*1891.50*	*1678.50*	*0.09*
31	*1.95±1.42(1.00-6.00)*	*2216.00*	*1354.00*	*0.01*
32	*1.07±0.37(1.00-6.00)*	*1724.00*	*1846.00*	*0.83*
33	*2.38±1.53(1.00-6.00)*	*2189.00*	*1381.00*	*0.01*

34	*2.21±1.31(1.00-6.00)*	*2102.00*	*1468.00*	*0.01*

Legend: Mean - arithmetic mean, SD - standard deviation, MIN - minimum score, MAX - maximum score,, p - significance of the Mann-Whitney U test, FOOZOS SUM- Faulty of Education, KIFOS SUM-Faculty of Kinesiology

DISCUSSION

The results of this study are consistent with those of others that obtained similar findings. In the study by Aknarbegloo et al. (2010), it was found that perceived body image concern among students was moderate (57.47 ± 5.6). There was a statistically significant difference observed between medical and non-medical groups ($p < 0.0001$), as well as between married and unmarried students ($p < 0.004$). According to Wang, Lu & Niu (2023), there is a direct relationship: the higher the individual's acceptance of their body image, the better their mental health, and conversely. They also identified a significant correlation between college students' body image perception bias and mental health, highlighting that students in humanities and social sciences may experience greater psychological burden due to negative body image. Yahia et al. (2011) researched to explore the dieting methods university students employ to achieve their desired body weight and to assess levels of body dissatisfaction related to weight status in a sample of 252 students. Based on the BSQ results, most students showed little concern regarding their body image perception. In this study, there were more female participants than male participants, as the questionnaire was completed by the Faculty of Education.

El Anasari et al. (2010) conducted a cross-sectional study on body image concern (BIC) among Egyptian university students, finding that BIC affected around 40% of female students and 25.6% of male students, with no significant difference between genders. BIC was closely linked with BMI, perceptions of being overweight, and depressive symptoms in both sexes. However, a greater percentage of females reported moderate to severe levels of BIC, approximately double that of males. Gualdi-Russo et al. (2022) study involved 960 university students from Italy and explored potential dissatisfaction and uncertainty regarding the ideal body image considered attractive by the opposite sex. Females expressed higher levels of body dissatisfaction compared to males, concerning both their own ideal body and the physical appearance they believed to be attractive to the opposite sex. Both genders held misconceptions about the ideal body type for the other gender, with females exhibiting a greater degree of misunderstanding.

CONCLUSION

This paper argues that the construction of body image and mental health level of college students can not only rely on schools and students but also need the whole society to create a “healthy and beautiful” standard. While our study anticipated differences between students from the Faculty of Kinesiology and the Faculty of Education, concerns arise regarding ongoing dissatisfaction with body image among student-athletes, reflected in discomforting responses to certain questions. There is a need to enhance educational standards that guide college students toward cultivating a healthy and positive body image. Future research could expand by utilizing the same questionnaire across various academic years and gender demographics.

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Effectiveness of the EMMETT Technique on Balance and Range of Motion in Young Football Players: A Pilot Study

*Teo Radić[1], Duje Radman[2], Jelena Pausic[3]

[1]Clinical Hospital Šibenik, Croatia; [2]CFC Hajduk, Split, Croatia; [3]Faculty of Kinesiology, University of Split, Croatia

*Corresponding author

ABSTRACT

This pilot study investigates the impact of the EMMETT technique on balance and range of motion (ROM) in young, asymptomatic football players. Manual Therapy (MT) is increasingly used for improving tissue extensibility, ROM, and balance. The EMMETT technique involves applying light finger pressure at specific points on the body to release muscle tension and enhance flexibility. This study aims to determine if the EMMETT technique can improve ankle ROM and balance in elite adolescent football players. Fifteen players from a first national league club, aged 14-16, participated in the study. Ankle ROM (plantar and dorsiflexion) and unilateral balance were measured before and after applying the EMMETT technique using an EasyAngle goniometer and a Biodex Balance system, respectively. The treatment involved three corrections targeting foot balance, gastrocnemius muscle, and ankle joint restrictions. Results showed significant improvements in both balance and ROM after the treatment. Specifically, post-treatment measurements revealed reduced oscillations in balance tests and increased ROM. Four out of six balance tests demonstrated statistically significant improvements ($p < 0.05$). ROM improvements were also statistically significant, with plantar flexion increasing from 5.53 degrees on the right ankle to 5.29 degrees on the left ankle, and dorsiflexion improving on both ankles from 3.98 degrees to 4.94 degrees. These findings suggest that the EMMETT technique is an effective non-invasive intervention for enhancing balance and mobility in young athletes. However, further research with a larger sample size and long-term follow-up is recommended to validate these preliminary results and explore the technique's potential benefits comprehensively.

Keywords: Soccer, young athletes, plantarflexion, dorsiflexion, manual therapy

INTRODUCTION

In the realm of kinesiology, particularly within kinesiotherapy, manual therapy is gaining increasing popularity. Manual Therapy (MT) involves skilled hand movements aimed at improving tissue extensibility, increasing range of motion (ROM), inducing relaxation, modulating pain, and reducing soft tissue swelling, inflammation, or restriction (Association, 2001). It has been reported that MT can lead to strength gains in peripheral muscles (Chingai et al., 2016) and improve lower limb balance in both asymptomatic subjects (Yuen et al., 2017) and individuals with chronic ankle instability (Terada et al., 2024). It also presents a valid modality for enhancing balance and other physiological parameters in healthy individuals (Espí-López et al., 2017).

One of the manual techniques that has often been used recently to increase the ROM of the ankle and improve foot balance is the EMMETT technique (Schleip et al., 2013). The EMMETT technique, developed by Ross Emmett, is a unique body therapy that entails applying light finger pressure at specific points on the body. This technique is purported to release muscle tension, enhance flexibility, and improve ROM. The EMMETT technique is grounded in the concept that applying gentle pressure on specific points, 3 times in the same place for 5-20 seconds, can elicit a relaxation response in muscles and fascia, leading to immediate enhancements in mobility and reduction of pain. The purpose of the first pressure is to check/assess the tissue itself, the second is its correction, and the third serves as a confirmation to make a change on the body. These points, known as Emmett Points, are believed to engage with the body's nervous system to reset muscle memory. The result is often an immediate physical change where new movement patterns are created on the spot, without pain and with better balance (Emmett, 2012).

The ankle plays a significant role in supporting the weight of the human body during static and dynamic activities. Its proper biomechanical function is crucial for maintaining postural control and developing movement strategies (Spink et al., 2011). However, as individuals age, joint function diminishes (An et al., 2017). Common constraints include reduced strength and increased stiffness, while the ROM tends to fall below normal levels in younger populations (Vaillant et al., 2009). The primary limitation in ROM occurs in the sagittal plane (i.e., plantarflexion to dorsiflexion movement) and is attributed to several age-related physiological and morphological changes in the foot and ankle (An et al., 2017). The restriction of ankle ROM has been documented to negatively impact balance and functional capacity (Venturini et al., 2007), consequently increasing the risk of falls (Sibley et al., 2015). According to prior research, ankle joint mobilization techniques have been shown to potentially increase ROM, leading to positive effects on balance (Bok et al., 2013).

Given the factors mentioned above, this study is aimed at determining whether a MT intervention based on the EMMETT technique can lead to an increase in ankle ROM in asymptomatic young football players and if this improvement could positively impact their balance.

METHODS

Pilot study is conducted on a sample of 15 elite adolescent football players, aged 14-16, from a first national league club. All participants were free of injuries, especially in the ankle joints, and feet. The exclusion criteria were (1) any cardiovascular, respiratory, abdominal, neurological, musculoskeletal, or other chronic disease and (2) any symptoms that could affect the musculoskeletal system. The Ethical Board of the University of Split, Faculty of Kinesiology, Split, Croatia, approved the study (Ref. no:2181-205-02-05-22-001, Date of approval: 05/01/2022).

The sample of variables contains 20 measurements. First was measured ankle ROM (plantar and dorsiflexion) with EasyAngle goniometer, while for unilateral balance was measured with Biodex Balance system and the Athletic Single Balance Test. Eight ROM variables, plantar flexion of left and right foot (ROM_PF, L- left, R-right, PRE – pre EMMETT measurement, POST – post EMMETT measurement); dorsal flexion of left and right foot measurement (ROM_DF, L- left, R-right, PRE – pre EMMETT measurement, POST – post EMMETT measurement). Twelve variables got it from the Athletic Single Balance Test. Variables formatted according to the total of oscillation in mm (OSI), anterior-posterior oscillation in mm (API), medial-lateral oscillation for right (R) and left (L) foot in mm (MLI).

After all tests were measured for the first time (PRE) the EMMETT protocol was conducted and immediately after finishing it all variables measured again. The EMMETT protocol contains the application of 3 corrections (Foot balance, Gastrocs, and Ankle joint restriction). All corrections were performed with the subjects lying on their backs in a relaxed position, and the technique was applied on both legs. Foot balance correction was applied by finding the spots on the calcaneus underneath both the malleolus and the dorsum of the foot applying “switches“ with the middle fingers and thumbs. Gastrocs correction was applied by finding the spots on the muscles gastrocnemius, tibialis anterior, and on the tendon extensors of the foot fingers applying “switches“ with the middle fingers and thumbs. Ankle joint restriction correction was applied by finding the fossa popliteal and spot where is os talus and applying light pressure to the tissue perpendicular to the body with the middle finger or thumb. “Switches“ on the first two corrections were done with a quick and targeted movement that lasted 2-3 seconds. The pressure for the last correction was held for 5-15 seconds, or until the “first jump” was felt. The application of all corrections lasted 3 minutes per person. It is important to note that all corrections were applied 3 times in the same place, and the pause between each repetition was 5-10 seconds. After the last repetition, the subjects would lock the movement through the activities by making certain movements with the treated muscle group (bending and extending feet from the ankle and foot fingers, squats, walking around the room).

Data was analyzed with t-test for the dependent sample (Statistica, TIBCO Software Inc). Basic descriptive statistics were calculated, and the t-test was conducted to determine the differences between preand post variables in order to identify any potential differences.

RESULTS AND DISCUSSION

Table 1 presents the descriptive statistics of means and standard deviations for both initial (pre-treatment) and final (post-treatment) measurements across all balance test variables and ROM tests. It is evident that the means of post-treatment balance tests on both legs are lower compared to pre-treatment measurements. Out of six balance tests, four showed statistically significant improvements in balance. In two tests on the left leg (total oscillation and anterior-posterior oscillation), although the results did not reach statistical significance, there is a noticeable reduction in oscillation post-treatment. This suggests a potential positive effect of EMMETT treatment on balance, despite the small sample size of this pilot study. Future research with a larger sample is recommended to validate these findings.

Table 1: T-test for dependent samples between pre and post EMMETT treatment measurement of Athletic Single Balance test (OSI – total of oscillation, API – anterior-posterior oscillation, MLI – medial-lateral oscillation for right (R) and left (L) foot (p level < 0,05 *)

Variables	*Mean*	*Std.Dv.*	*t*	*df*	*p*
BALANCE_R_OSI_PRE	*2.41*	*1.07*			
BALANCE_R_OSI_POST	*1.93*	*0.67*	*2.68*	*13*	*0.02**
BALANCE_R_API_ PRE	*1.69*	*0.87*			
BALANCE_R_API_ POST	*1.39*	*0.56*	*2.32*	*13*	*0.04**
BALANCE_R_MLI_ PRE	*1.42*	*0.55*			

BALANCE_R_MLI_ POST	*1.12*	*0.33*	*2.45*	*13*	*0.03**
BALANCE_L_OSI_ PRE	*2.60*	*1.57*			
BALANCE_L_OSI_ POST	*2.05*	*0.71*	*2.04*	*13*	*0.06*
BALANCE_L_API_ PRE	*1.81*	*1.10*			
BALANCE_L_API_ POST	*1.51*	*0.63*	*1.71*	*13*	*0.11*
BALANCE_L_MLI_ PRE	*1.58*	*0.95*			
BALANCE_L_MLI_ POST	*1.14*	*0.32*	*2.420*	*13*	*0.03**

As shown in Table 2, all ROM tests indicated significant improvement after the EMMETT therapy treatment. Plantarflexion increased from 5.53 degrees on the right ankle to 5.29 degrees on the left ankle. Dorsiflexion also showed improvement on both ankles (from 3.98 degrees to 4.94 degrees). All changes were statistically significant ($p < 0.05$).

The results across all variables indicate positive changes in balance and ROM following the application of the EMMETT technique. It is important to note that research on the effects of this technique is still in its early stages, but existing studies already point to its positive impact on relaxing the ITB ligament (Radić et al, 2024). Other manual techniques also show significant effects on improving balance and increasing joint mobility (Venturini et al. 2007). According to Miller et al. (2017), athletes with superior dorsiflexion demonstrated enhanced performance in balance assessments and agility exercises, suggesting improved stability.

When examining specific variables and tests for unilateral balance and mobility in young soccer players, we can confirm that the EMMETT technique is effective. It demonstrates a quick and efficient way to enhance these motor skills.

*Table 2: T-test for dependent samples between pre and post EMMETT treatment measurement of plantar (PF) and dorsiflexion (DF) range of motion (ROM) (p level < 0.05 *)*

Variables	*Mean*	*Std.Dv.*	*t*	*df*	*p*
ROM_PF_R_ PRE	*46.60*	*4.57*			
ROM_PF_R_ POST	*52.13*	*4.34*	*-5.27*	*14*	*0.01**
ROM_PF_L_ PRE	*43.95*	*3.57*			
ROM_PF_L_ POST	*49.24*	*4.96*	*-4.68*	*14*	*0.01**
ROM_DF_R_ PRE	*27.22*	*4.67*			
ROM_DF_R_ POST	*31.20*	*4.97*	*-6.74*	*14*	*0.01**
ROM_DF_L_ PRE	*25.88*	*3.72*			
ROM_DF_L_ POST	*30.82*	*5.95*	*-4.66*	*14*	*0.01**

CONCLUSION

The EMMETT technique leads to significant increases of ankle dorsiflexion and plantarflexion ROM and better unilateral balance results of adolescent football athletes, suggesting its potential as a beneficial intervention for athletes suffering balance issues ad as well smaller ankle mobility. These findings support the use of the EMMETT technique as a non-invasive and effective MT method. Despite the positive results, this study has several limitations. Firstly, the sample size was relatively small, consisting of only 15 participants, which may limit the generalizability of the findings. Additionally, the study focused exclusively on young male football athletes, making it difficult to apply the results to other populations, such as females, older individuals, or athletes from different sports. Furthermore, the short-term nature of the study means that long-term effects of the EMMETT technique on balance and ROM were not assessed. The absence of a long-term follow-up limits the understanding of the durability of the observed improvements.

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