ЗБОРНИК РАДОВА

12. МЕЂУНАРОДНА НАУЧНА КОНФЕРЕНЦИЈА „АНТРОПОЛОШКИ И ТЕОАНТРОПОЛОШКИ ПОГЛЕД НА ФИЗИЧКЕ АКТИВНОСТИ“

BOOK OF PROCEEDINGS

12th INTERNATIONAL SCIENTIFIC CONFERENCE “ANTHROPOLOGICAL AND THEO-ANTHROPOLOGICAL VIEW ON PHYSICAL ACTIVITY”

КОПАОНИК, 20.-22. март 2025.

12. Међународна научна конференција
„АНТРОПОЛОШКИ И ТЕОАНТРОПОЛОШКИ ПОГЛЕД НА ФИЗИЧКЕ АКТИВНОСТИ“

Зборник радова: Публикација је финансирана средствима Министарства за науку, технолошки развој и иновације Републике Србије

Издавач:

Факултет за спорт и физичко васпитање у Лепосавићу, Универзитет у Приштини – Косовска Митровица

За издавача:

Декан, проф. др Љубиша Лилић

Уредници:

проф. др Верољуб Станковић, Факултет за спорт и физичко васпитање, Универзитет у Приштини – Косовска Митровица, Србија
проф. др Топлица Стојановић, Факултет за спорт и физичко васпитање, Универзитет у Приштини – Косовска Митровица, Србија
проф. др Љубиша Лилић, Факултет за спорт и физичко васпитање, Универзитет у Приштини – Косовска Митровица, Србија
проф. др Борислав Цицовић, Факултет физичког васпитања и спорта, Универзитет у Источном Сарајеву, Република Српска, БиХ

Лектор:

доц. др Миљан Миљковић

Компјутерска обрада:

проф. др Топлица Стојановић

Дизајн корица:

Сиграф - Крушевац

Штампа:

Сиграф – Крушевац, издање 2025. године

Тираж:

50 копија

ISBN 978-86-82329-93-0

12th International Scientific Conference
„ANTHROPOLOGICAL AND THEO-ANTHROPOLOGICAL VIEW ON PHYSICAL ACTIVITY”

Book of Proceedings: The publication was funded by the Ministry of Science, Technological Development and Innovation of the Republic of Serbia

Publisher:

The Faculty of Sport and Physical Education in Leposavić, University of Priština – Kosovska Mitrovica

For the publisher:

Faculty dean, prof. Ljubiša Lilić, PhD

Editors:

prof. Veroljub Stanković, PhD, Faculty of Sport and Physical Education, Uneversity of Priština – Kosovska Mitrovica, Serbia
prof. Toplica Stojanović, PhD, Faculty of Sport and Physical Education, Uneversity of Priština – Kosovska Mitrovica, Serbia
prof. Ljubiša Lilić, PhD, Faculty of Sport and Physical Education, Uneversity of Priština – Kosovska Mitrovica, Serbia
prof. Borislav Cicović, PhD, Faculty of Physical Education and Sport, University of East Sarajevo, Republic of Srpska, B&H

Lecturer:

assoc. Miljan Miljković, PhD

Computer editor:

prof. Toplica Stojanović, PhD

Cover design:

Sigraf - Kruševac

Printed by:

Sigraf – Kruševac, year 2025 edition

Circulation:

50 copies

ISBN 978-86-82329-93-0

Honorary committee

Nebojša Arsić, *PhD, University of Priština-Kosovska Mitrovica*
Milan Kulić, *PhD, University of East Sarajevo*
Kristina Pantelić Babić, *PhD, University of Banja Luka*
Branislav Antala, *PhD, Comenius University in Bratislava*
Milovan Bratić, *PhD, State University of Novi Pazar*
Dragan Popović, *PhD, University of Priština-Kosovska Mitrovica*
Serkan Hazar, *PhD, University of Sivas*
Branko Vujović, *Prof, University of Novi Sad*
Milan Čoh, *PhD, University of Ljubljana*
Vlatko Nedelkovski, *PhD, University „St. Ciril and Methodius" of Skopje*

Organizing committee

Veroljub Stanković, *PhD, University of Priština-Kosovska Mitrovica*
Nenad Živanović, *PhD, University of Niš*
Ljubiša Lilić, *PhD, University of Priština-Kosovska Mitrovica*
Borislav Cicović, *PhD, University of East Sarajevo*
Tomislav Okičić, *PhD, University of Niš*
Toplica Stojanović, *PhD, University of Priština-Kosovska Mitrovica*
Filip Vešović, *Prof, ASFA, Belgrade*

Scientific committee

Vladimir Koprivica, *PhD, "Union" University of Belgrade, Faculty of Sport*
Nikolae Okiana, *PhD, University "Vasile Alecsandri" of Bacau, Department of Physical Education and Sports Performance*
Danijela Daševa, *PhD, University of Sofia, National Sports Academy*
Zoran Milošević, *PhD, University of Novi Sad, Faculty of Sport and Physical Education*
Jelena Ilić Petrović, *PhD, University of Defence, Military academy, Belgrade*
Fedor Ivanovič, *PhD, University of Belgorod, Faculty of Physical Education,*
Siniša Karišik, *PhD, University of East Sarajevo, Faculty of Physical Education and Sport*
Slađana Mijatović, *PhD, University of Belgrade, Faculty of Sport and Physical Education*
Goran Bošnjak, *PhD, University of Banja Luka, Faculty of Physical Education and Sport*
Nenad Stoiljković, *PhD, University of Niš, Faculty of Sport and Physical Education*
Svetoslav Stefanov, *PhD, St. Cyril and St. Methodious University of Veliko Tarnovo, Theory and Methodology of Physical Education* Department
Dejan Ćeremidžić, *PhD, University of East Sarajevo, Faculty of Physical Education and Sport*
Milan Čoh, *PhD, University of Ljubljana, Faculty of Sport*
Miran Kondrič, *PhD, University of Ljubljana, Faculty of Sport*
Saša Jovanović, *PhD, University of Banja Luka, Faculty of Physical Education and Sport*
Jovan Bazić, *PhD, University of Priština-Kosovska Mitrovica, Teacher Education Faculty*
Gordana Furjan-Mandić, *PhD, Faculty of Sports of Zagreb, Department of Kinesiology*
Hristo Andonov, *PhD, University of Sofia, National Sports Academy*
Milivoj Dopsaj, *PhD, University of Belgrade, Faculty of Sport and Physical Education*
Gyuri Balint, *PhD, University "Vasile Alecsandri" of Bacau, Department of Physical Education and Sports Performance*
Izet Rađo, *PhD, University of Sarajevo, Faculty of Sport and Physical Education*
Ioan Turcu, *PhD, Transilvania University of Brasov, Faculty of Physical Education and Mountain Sports*
Castellar Otin Carlos, *PhD, University of Saragosa, Faculty of Health and Sports Sciences*
Pradas de la Fuente Francisco, *PhD, University of Saragosa, Faculty of Health and Sports Sciences*
Vujica Živković, *PhD, University „St. Ciril and Methodius", Faculty of Physical Education, Sport and Health, Skopje*
Alexe Dan Lulian, *PhD, University "Vasile Alecsandri" of Bacau, Department of Physical Education and Sports Performance*
Tohanean Dragos Ioan, *PhD, Transilvania University of Brasov, Faculty of Physical Education and Mountain Sports*
Goran Prebeg, *PhD, University of Belgrade, Faculty of Sport and Physical Education*
Darko Stojanović, *PhD, University of Niš, Pedagogical Faculty in Vranje*
Radenko Dobraš, *PhD, University of Banja Luka, Faculty of Physical Education and Sport*
Talaghir Laurentiu-Gabriel, *PhD, University of Dunarea de Jos Galati, Faculty of Sport and Physical Education*
Nikola Stojanović, *PhD, University of Niš, Faculty of Sport and Physical Education*
Željko Sekulić, *PhD, University of Banja Luka, Faculty of Physical Education and Sport*
Borko Petrović, *PhD, University of Banja Luka, Faculty of Physical Education and Sport*

Advisory committee

Zvezdan Savić, *PhD, University of Niš, Faculty of Sport and Physical Education*
Gabriela Okiana, *PhD, University "Vasile Alecsandri" of Bacau, Department of Physical Education and Sports Performance*
Evagelia Boli, *PhD, University of Priština-Kosovska Mitrovica, Faculty of Sport and Physical Education*
Slađan Karaleić, *PhD, University of Priština-Kosovska Mitrovica, Faculty of Sport and Physical Education*
Vesko Milenković, *PhD, University of Priština-Kosovska Mitrovica, Faculty of Sport and Physical Education*
Branimir Mekić, *PhD, University of Priština-Kosovska Mitrovica, Faculty of Sport and Physical Education*
Žarko Kostovski, *PhD, University „St. Ciril and Methodius", Faculty of Physical Education, Sport and Health*
Nebojša Ranđelović, *PhD, University of Niš, Faculty of Sport and Physical Education*
Ratko Stanković, *PhD, University of Niš, Faculty of Sport and Physical Education*
Radomir Arsić, *PhD, University of Priština-Kosovska Mitrovica, Teacher Education Faculty*
Biljana Vitošević, *PhD, University of Priština-Kosovska Mitrovica, Faculty of Sport and Physical Education*
Zoran Savić, *PhD, University of Priština-Kosovska Mitrovica, Faculty of Sport and Physical Education*
Violeta Šiljak, *PhD, University MB, Faculty of Business and Law*
Dragana Aleksić, *PhD, University of Priština-Kosovska Mitrovica, Faculty of Sport and Physical Education*
Lazar Toskić, *PhD, University of Priština-Kosovska Mitrovica, Faculty of Sport and Physical Education*
Hadži Miloš Vidaković, *PhD, University of Priština-Kosovska Mitrovica, Faculty of Sport and Physical Education*
Saša Bubanj, *PhD, University of Niš, Faculty of Sport and Physical Education*
Goran Nešić, *PhD, University of Belgrade, Faculty of Sport and Physical Education*
Saša Pantelić, *PhD, University of Niš, Faculty of Sport and Physical Education*
Dalibor Stević, *PhD, University of East Sarajevo, Teacher Education Faculty*
Elena Mocrousov, *PhD, Kišinjev State University, Faculty of Physical Education and Sports*
Natalia Bumarskova Nikolaevna, *Moscow State University of Civil Engineering, Department of Physical Education and Sport*
Ludmila Rudiuk, *Moscow State University of Civil Engineering, Department of Physical Education and Sport*
Elena Moldovan, *PhD, Transilvania University of Brasov, Departament of Motoric Performance*
Dalibor Fulurija, *PhD, University of East Sarajevo, Faculty of Physical Education and Sport*
Milomir Trivun, *PhD, University of East Sarajevo, Faculty of Physical Education and Sport*
Tatjana Ćeremidžić, *PhD, University of East Sarajevo, Faculty of Physical Education and Sport*

САДРЖАЈ
CONTENTS

WELCOME SPEECH
POZDRAVNI GOVOR

Stanković Veroljub

Prof. Dr. Veroljub Stanković
Welcome speech at the opening of the XII International Scientific Conference:
Anthropological and Theo anthropological View on Physical Activity
March 20, 2025

Dear colleagues,
Ladies and gentlemen,
Dear students,

Welcome to the Twelfth International Scientific Conference: *Anthropological and Theo anthropological View on Physical Activity*

On behalf of the organizers, allow me, to greet the dear guests of our conference. First of all, the assistant minister for higher education, rectors, vice-rectors, fellow professors and students participating in this conference, representatives of the media who follow the work of our conference, as well as all other guests of this conference. Once again, I wish you all a warm welcome and a pleasant stay on Kopaonik.

This conference is held in cooperation with: the Faculty of Physical Education and Sports of the University of East Sarajevo, the Faculty of Physical Education and Sports of the University of Niš, the prestigious International Federation for Physical Education and Sports (FIEPS) and the Association Sport for All Serbia. In the preparation of this conference, we tried to provide conditions to discuss some current issues and present the results of the latest research concerning theoretical, physical, medical, methodical and other aspects of activities in physical education, sports, recreation and kinesitherapy. To this end, competent university teachers and researchers of relevant scientific fields from our country, the region and abroad to today's conference were invited. Therefore, I would like to thank those who responded to this call and who are attending the start of the conference today.

In physical education, sports, recreation and kinesitherapy researches there are very notable results, as well as questions that are constantly looking for well-thought-out answers and solutions. The purpose of this conference, as well as similar scientific gatherings, is to present the results of our research, to gain new knowledge, to inform each other and to discuss current issues. In the teaching of physical education and sports in the conditions of accelerated scientific and technological development and artificial intelligence, it is necessary to constantly look for better solutions and new models for the upcoming challenges. The necessity to elaborate the relevant issues of the immediate future, many of them are already in sight, such as: in which direction to direct children and young people when new technologies increasingly suppress people's physical activity, how to redefine existing social matrices in sports and arrive at new paradigms and how to define new models of social organization in physical education, recreation and sports, as well as the role of society in this.

Many of the mentioned issues deserve our attention, but on this occasion I would like to emphasize the issue of the impact of artificial intelligence (AI) in the teaching of physical education, physical recreation and sports. The impact of AI in the field of education is increasingly visible. AI is bringing, but is yet to bring, revolutionary changes in education, providing opportunities for personalization of teaching, more efficient organization of teachers' work and improvement of access to education. The possibilities offered by AI impose many challenges, from questions related to practical

application in the teaching of physical education and ethical issues of the use of artificial intelligence, questions of responsibility, the role of teachers, good and bad sides of technology and other challenges, opportunities and dangers. In past experiences, it has been noted that AI offers many solutions in physical education and that is why its use is expanding, especially in terms of organizing the work of teachers or coaches, organizing personalized teaching, practice or training, which contributes to a better understanding of the material and more efficient development of motor skills. Many AI-powered apps can monitor the health of a child, recreationist, or athlete and provide alerts about potential problems or injury prevention. However, AI still can't replace a physical education teacher or trainer, and accepting exercise advice from a Chabot could have unexpected consequences. The use of artificial intelligence for nutrition and health advice for students and athletes is also under scrutiny. On the other hand, it is evident that AI has made a lot of progress in the field of professional sports, especially in terms of assuming the role of a judge (Hawkeye, VAR, etc.). Then in fitness, it offers the exerciser a good schedule of physical activities for specific muscle groups, with good explanations, similar to what an experienced trainer or physiotherapist would do. About twenty days ago, Alex McFarland, a respected researcher in the field of artificial intelligence, published a list of the best exercise apps that are transforming the way we train, recover and stay motivated, such as: Fitbod, FitnessAI, Peloton Guide, Trainerize, Tempo, Caliber Fitness, Freeletics, JuggernautAI, Aaptiv and JEFIT.

Recently, Bill Gates, during the promotion of his autobiography "Source Code", pointed out that he believes that in the next ten years, artificial intelligence will replace us in everything, except for health and education, although these areas will also transform a lot and that it can be scary. In those coordinates, he emphasizes physical activity and sports, where he says "that people wouldn't want to watch computer play golf."

Artificial intelligence presents a big challenge for teachers and coaches. They already have to learn a lot and continuously educate and train themselves for their work in the AI environment. They will have to adopt new methods of teaching, practicing and training, to be trained in the use of new technologies and tools, but at the same time to acquire interdisciplinary knowledge, especially in the fields of medicine, nutrition science and informatics, in order to complete their competencies and be up to the task of their profession. In this, the role of us who teach at the sports and physical education faculties is extremely important. And we will have to learn much more and constantly acquire new knowledge in order to train our students, future teachers who will work in schools or trainers.

Dear colleagues,

Artificial intelligence is a big challenge for all of us. That is why the intention of this scientific conference is to provide answers to many professional questions of teaching physical education, physical recreation and sports, but at the same time to draw the attention of the public, that much more attention must be paid to physical activities. It is imperative for the health of society and the future of our biological existence.

I wish you much success in your work during this scientific conference, and especially in your daily work dealing with this very humane vocation, the imperative of which is to create a healthy, educated and educated person.

Thank you for your attention!

Prof. dr Veroljub Stanković

Pozdravni govor na otvaranju XII međunarodne naučne konferencije:
Antropološki i teoantropološki pogled na fizičke aktivnosti
20. mart 2025. godine

Drage koleginice i kolege,
Poštovane dame i gospodo,
Dragi studenti,

Dobro došli na Dvanaestu međunarodnu naučnu konferenciju: *Antropološki i teoantropološki pogled na fizičke aktivnosti*.

Ovu konferenciju održavamo u saradnji sa: Fakultetom za fizičko vaspitanje i sport Univerziteta Istočno Sarajevo, Fakultetom za fizičko vaspitanje i sport Univerziteta u Nišu, uglednom Međunarodnom federacijom za fizičko vaspitanje i sport (FIEPS) i Asocijacijom *Sport za sve Srbije*. U pripremi ove konferencije, nastojali smo da stvorimo uslove da se na njoj razmotre neka aktuelna pitanja i izlože rezultati najnovijih istraživanja koja se tiču teorijskog, fizičkog, medicinskog, metodičkog i drugih aspekata aktivnosti u fizičkom obrazovanju, sportu, rekreaciji i kineziterapiji. U tom cilju, na današnju konferenciju pozvali smo kompetentne univerzitetske nastavnike i istraživače releventnih naučnih oblasti iz naše zemlje, regiona i inostranstva. Zato vama, koji ste se odazvali ovom pozivu i koji danas prisustvujete početku rada konferencije, najlepše se zahvaljujem.

U dosadašnjim istraživanjima u fizičkom vaspitanju, sportu, rekreaciji i kineziterapiji ima veoma zapaženih rezultata, ali i pitanja koja stalno traže promišljene odgovore i rešenja. To je i smisao ove konferencije i sličnih naučnih skupova, da izložimo rezultate svojih istraživanja, da dođemo do novih saznanja, međusobno se informišemo i razgovaramo. Potrebno je stalno tražiti bolja rešenja i nove modele za predstojeće izazove u nastavi fizičkog vaspitanja i sporta u uslovima ubrzanog naučno-tehnološkog razvoja i veštačke inteligencije. Zato je potrebno elaborirati relevantna pitanja neposredne budućnosti, a mnoga od njih su već na vidiku, kao što su: u kom pravcu usmeravati decu i mlade ljude kada nove tehnologije sve više potiskuju fizičku aktivnost ljudi, kako redefinisati postojeće društvene matrice u sportu i doći do novih paradigmi i kako definisati nove modele društvene organizacije u fizičkom vaspitanju, rekreaciji i sportu, kao i ulogu društva u tome.

Mnoga od pomenutih pitanja zaslužuju našu pažnju, ali ovom prilikom istakao bih pitanje uticaja veštačke inteligencije (AI) u nastavi fizičkog vaspitanja, fizičke rekreacije i sporta. Uticaj AI je sve vidljiviji u oblasti obrazovanja i vaspitanja. AI donosi, ali će tek doneti revolucionarne promene u obrazovanju, pružajući mogućnosti za personalizaciju nastave, efikasniju organizaciju rada nastavnika i poboljšanje dostupnosti obrazovanja. Mogućnosti koje nam pruža AI nameće mnoštvo izazova, od pitanja vezanih za praktičnu primenu u nastavi fizičkog vaspitanja i etičkim pitanjima upotrebe veštačke inteligencije, pitanjima odgovornosti, ulogom nastavnika, dobrim i lošim stranama tehnologije i ostalim izazovima, šansama i opasnostima. U dosadašnjim iskustvima zapaženo je da AI nudi mnoga rešenja i u nastavi fizičkog vaspitanja i da je zbog toga njeno korišćenje u ekspanziji, naročito u pogledu organizovanja rada nastavnika ili trenera, organizovanja personalizovane nastave, vežbanja ili treninga, što doprinosi boljem razumevanju gradiva i efikasnijem razvoju motoričkih veština. Zatim, mnoge aplikacije sa veštačkom inteligencijom mogu pratiti zdravstveno stanje deteta, rekreativca ili sportiste i obezbeđuju upozorenja o potencijalnim problemima ili prevenciju od povreda. Međutim, AI još uvek ne može da zameni nastavnika fizičkog vaspitanja ili trenera i da bi prihvatanje saveta o vežbanju od čet-bota moglo da ima neočekivane posledice. Takođe, i korišćenje veštačke inteligencije za ishranu i savete u vezi sa zdravljem učenika i sportista je pod lupom. S druge strane, vidljivo je da je AI mnogo napredovala u oblasti profesionalnog sporta, naročito u pogledu preuzimanja uloge sudije (*oko sokolovo*, *var* i sl). Zatim u fitnesu, tako da vežbaču nudi dobar raspored fizičkih aktivnosti za određene grupe mišića, uz dobra objašnjenja, slično kao što bi uradio iskusan trener ili fizioterapeut. Pre dvadesetak dana Alex McFarland,

ugledni istraživač u oblasti veštačke inteligencije, objavio je listu najboljih aplikacija za vežbanje koje transformišu način na koji treniramo, oporavljamo se i ostajemo motivisani, kao što su: Fitbod, FitnessAI, Peloton Guide, Trainerize, Tempo, Caliber Fitness , Freeletics, JuggernautAI, Aaptiv i JEFIT.

Nedavno je i Bill Gates, prilikom promocije svoje autobiografije „Source Code", istakao da veruje kako će nas u narednih desetak godina veštačka inteligencija zameniti u svemu, osim u zdravstvu i obrazovanju, iako će i ove oblasti mnogo transformisati i da to može biti zastrašujuće. U tim koordinatama on ističe i fizičku aktivnost i sport, pri čemu kaže „da ljudi ne bi želeli da gledaju kako kompjuter igra golf".

Veštačka inteligencija je veliki izazov za nastavnike i trenere. Oni već sada moraju mnogo da uče i kontinuirano da se obrazuju i osposobljavaju za svoj rad u okruženju AI. Moraće da uče nove metode izvođenja nastave, vežbanja i treninga, da se osposobljavaju za korišćenje novih tehnologija i alata, ali istovremeno i da stiču interdisciplinarna znanja, naročito iz oblasti medicine, nauke o ishrani i informatike, kako bi upotpunili svoje kompetencije i bili na visini zadatka svoje profesije. U tome je izuzetno važna uloga nas koji držimo nastavu na fakultetima za sport i fizičko vaspitanje. I mi ćemo morati mnogo više da učimo i neprestano da stičemo nova znanja kako bi smo osposobili naše studente, buduće nastavnike koji će raditi u školama ili trenere.

Drage koleginice i kolege,

Veštačka inteligencija je veliki izazov za sve nas. Zato je intencija ove naučne konferencije da pruži odgovore na mnoga stručna pitanja nastave fizičkog vaspitanja, sportske rekreacije i sporta, ali ujedno i da skrene pažnju društvenoj javnosti, da se fizičkim aktivnostima mora posvetiti mnogo veća pažnja. To je imperativ zdravstvenog stanja društva i budućnosti naše biološke egzistencije.

Želim vam puno uspeha u radu tokom ove naučne konferencije, a posebno u vašem svakodnevnom radu baveći se ovim veoma humanim pozivom, čiji je imperativ stvoriti zdravog, vaspitanog i obrazovanog čoveka.

Hvala vam na pažnji!

ПОЗИВНА ПРЕДАВАЊА

INVITED LECTURES

EXPLORING THE PERSPECTIVES OF BASIC PUPILS' MOTOR AND SWIMMING COMPETENCIES IN THE DEVELOPMENT OF QUALITY PHYSICAL EDUCATION IN PRIMARY SCHOOLS

Antala Branislav, Luptáková Gabriela, Grznár Luboš, Labudová Jana
Faculty of Physical Education and Sports, Comenius University in Bratislava, Slovakia

ORIGINAL SCIENTEFIC ARTICLE
DOI: 10.5937/ATAVPA25006B

Abstract: *This study investigated the level of basic motor and swimming competencies in younger school-age children (grades 1–3, 1st cycle of primary school) to address recognized global deficits in Quality Physical Education (QPE), particularly the lack of specialized teacher training for accurate skill assessment. Two standardized test batteries were employed: the MOBAK test battery for motor skills (n=258, ages 6–9) and the Water Basic Competence (WABAC) test battery for swimming competency (n=1,875, grades 1–3). MOBAK results indicated complex, non-linear developmental trends in motor skills. While participants showed proficiency in Self-Movement skills (Mean 6.10/8), a chronic deficit was found in Throwing (stagnant low scores), and an unexpected performance decline after age seven was observed in Jumping and Catching. Conversely, WABAC results demonstrated a clear and significant improvement in swimming competence across all test items with increasing grade and age (mean item scores rose from 2.00–2.52 in Grade 1 to 2.41–2.68 in Grade 3), confirming the importance of systematic instruction. The findings affirm the suitability and efficacy of the MOBAK and WABAC batteries as tools for accurately differentiating pupil competency levels, highlighting specific skill deficits, and informing targeted interventions to improve QPE in primary schools.*
Key words: *motor competencies, swimming competencies, primary school, quality physical education*

INTRODUCTION

Quality Physical Education (QPE) is defined as the planned, progressive, and inclusive learning experience that forms an integral part of the curriculum across early years, primary, and secondary education. In this capacity, QPE serves as the foundation for a lifelong engagement in physical activity and sport, helping children and youth acquire the psychomotor skills, cognitive understanding, and social and emotional competencies required to sustain a physically active life (UNESCO 2015).

International organizations frequently implement projects to monitor QPE development and quality globally. The most significant recent project was the 4th PE Worldwide Survey on QPE, administered by UNESCO in cooperation with FIEPS and Loughborough University (2017–2024). The key findings, presented at the MINEPS VII conference in June 2023 and published in the official UNESCO report *The Global State of Play* (UNESCO 2024), identified four critical global deficits in the provision of QPE:

- Lack of Funding: 63.8% of countries allocate less of their education budget to PE.
- Lack of Time: Only 32.2% of upper secondary and 34.7% of lower secondary students meet the minimum criteria of 180 minutes of PE per week, while 52.6% of primary school students meet the minimum of 120 minutes per week.
- Lack of Inclusion: One in three students with disabilities lacks access to PE.
- Lack of Training: Only 44.7% of primary school PE teachers are specialists.

This lack of specialist training is directly related to the inadequate preparation of teachers to accurately assess basic motor and specific swimming competencies in pupils. Concepts for assessing the competences of the school population and their development are gaining increasing traction across the European context, often based on specific standardized models.

Assessment of Basic Motor Competencies

For the standardized assessment of basic motor competencies, the MOBAK test battery is widely used in European countries (Herrmann et al., 2015; Hermann, Gerlach, and Seeling, 2015; Scheuer et al., 2017; Herrmann, 2018; Scheuer, Herrmann, and Bund, 2019). The MOBAK battery provides a standardized and economical evaluation of the fundamental motor skill level for children aged 4–9 years in both preschool and primary school settings. The test captures basic motor competencies across two main domains:

Movement with One's Own Body and Movement with Equipment (Masaryková and Labudová 2018, Masaryková 2021).

The MOBAK test battery consists of four coherent, age-specific versions: MOBAK KG (kindergarten, ages 4–6), MOBAK 1–2 (primary school, grades 1–2, ages 6–7), MOBAK 3–4 (primary school, grades 3–4, ages 8–9), and MOBAK 5-6 (age 10-11) . Given that the test battery was designed for co-educational teaching, differences between boys and girls do not need to be considered during assessment (Boržíková, 2020; Mačura et al., 2020; Šeflová, 2021).

Assessment of Basic Swimming Competencies

A specific and critical area of motor competence is basic swimming competence, which directly impacts aquatic safety and reflects differences in drowning rates (Stempski et al., 2015). The shift from focusing merely on "swimming skills" to the broader concept of "water competence" (Stallman et al., 2017) emphasizes the role of schools in fostering aquatic safety and competence. Swimming also serves as a gateway to recreational pursuits, promoting a lifelong appreciation for physical activity and leisure (Merica and Pacanovská 2020; Labudová, 2024).

For the assessment of swimming competencies, the Water Basic Competence (WABAC) test battery is used (Labudová et al., 2024). The WABAC battery was specifically developed to evaluate the fundamental swimming skills and abilities crucial for ensuring safe aquatic movement among younger school-age children. This assessment tool comprises seven distinct test items: front floatation, 12.5-meter flutter kick using a kickboard, water entry via jumping, retrieving a submerged object, back floatation, submersion with controlled exhalation, and front gliding.

Aim of the Study

The primary aim of this study was to investigate the level of basic motor and swimming competencies in younger school-age children (grades 1–3, corresponding to the 1st cycle of primary school). By applying the MOBAK and WABAC test batteries, the study sought to demonstrate their availability and suitability as effective tools for assessing and differentiating the level of basic motor and swimming competencies among pupils at the primary level of education.

METHOD

Basic Motor Competencies: Participants and Data Collection

Testing was organized for a project focused on tandem teaching in primary school PE, specifically examining its impact on students' motor, cognitive, and emotional development. Data were collected at the beginning of the school year, in October 2025, from three primary schools located in the Bratislava region, Slovakia. The initial sample included students from grades 1 through 3. The final analysis focused on a cohort of 258 participants aged 6 to 9 years. The small number of older children (10-year-olds, n=7; 11-year-olds, n=1) was excluded to create a more focused and developmentally consistent dataset. Descriptive statistics for the entire cohort revealed a mean BMI of 16.22 kg/m^2, suggesting the participants were, on average, within a healthy weight-for-height ratio. The participants were divided into four distinct age groups for developmental trend analysis as follows:

- Age 6: 73 participants (n=73)
- Age 7: 74 participants (n=74)
- Age 8: 57 participants (n=57)
- Age 9: 54 participants (n=54)

Basic motor competencies were assessed using the MOBAK test battery, which evaluates eight distinct motor skills (Hermann et al., 2015). The assessment is structured into two main composite areas, each with a maximum score of 8 points:

- Self-Movement (Movement with One's Own Body): Consists of Balancing, Rolling, Jumping, and Running.
- Object Movement (Movement with Equipment): Consists of Throwing, Catching, Dribbling, and Bouncing.

A child's overall performance is summarized by a Total MOBAK Score, which is the sum of both competency areas, yielding a maximum score of 16 points.

All individual skills were scored on a scale of 0 to 2 points. The specific scoring mechanisms varied slightly by skill type:

- Skills Scored on Two Attempts (Binary Success):

For the skills of Dribbling, Rolling, Balancing, Jumping, Running, and Bouncing, the final score was determined by the number of successful attempts.

  - 0 points: Zero successful attempts.
  - 1 point: One successful attempt.
  - 2 points: Two successful attempts (maximum score).

- Skills Scored on Six Attempts (Range of Success):

For the skills of Throwing and Catching, participants completed six attempts.

  - 0 points: 1 to 2 successful attempts.
  - 1 point: 3 to 4 successful attempts.
  - 2 points: 5 to 6 successful attempts (maximum score).

The assessment of the composite basic motor competencies (Self-Movement and Object Movement) was calculated by summing the scores obtained from the four individual test items within each area (4 tests times 2 points = 8 points).

Swimming competencies: Participants and Data Collection

The study included 1,875 pupils from grades 1 to 3 of primary schools in Slovakia, who participated in organized swimming courses during 2023–2024 in cooperation with the *Sport Institute*. The participants had no prior systematic swimming instruction. Data was collected in indoor 25-meter pools during the first two lessons of each course. All testing procedures were supervised by certified swimming instructors trained in a unified protocol. The final sample consisted of 360 first-grade pupils (mean age = 7.2 years), 704 second-grade pupils (mean age = 7.9 years), and 811 third-grade pupils (mean age = 8.7 years).

The *Water Basic Competence* (WABAC) test battery was developed to assess fundamental swimming skills and abilities essential for safe aquatic movement in children of younger school age. Each test task was evaluated using a three-point rating scale reflecting the level of task performance: 1 point – not performed / unsuccessful, 2 points – partially performed / in progress, and 3 points – fully performed / successful. Thus, each participant could achieve a minimum total score of 7 points and a maximum of 21 points. The frequency and percentage analyses were used to evaluate the performance success of pupils across grade levels for each test item.

RESULTS AND DISCUSSION

Basic motor competencies

The analysis focused on a cohort of 258 participants aged 6 to 9 years, excluding the small number of 10- and 11-year-olds (n=7; n=1, respectively) to create a focused dataset. Descriptive statistics for this cohort were computed across anthropometric measures and motor skill scores using MOBAK test battery, assessing basic motor competencies (maximum score of 2 for individual skills, 8 for composite scores).

Overall, participants demonstrated strong proficiency in Self-Movement skills (Mean 6.10; Mode 6), but performance was lower in Object Movement skills (Mean 4.62; Mode 5). The mean BMI of 16.22 kg/m^2 suggests the cohort is, on average, within a healthy weight-for-height ratio (Table 1).

Table 1 Measures Descriptive Statistics for Anthropometric and Motor Skills (Ages 6–9)

Category	Mean	Median	SD	Mode
Height [cm]	129.28	130	8.22	-
Weight [kg]	27.29	27.1	5.62	-
BMI [kg/m^2]	16.22	15.74	2.31	-
Balancing [score]	1.8	2	0.46	2
Jumping [score]	1.03	1	0.8	1
Throwing [score]	0.64	1	0.68	0
Dribbling [score]	1.28	1	0.8	2

Age-Specific and Developmental Trend Analysis

Height and Weight show the expected consistent, linear increase across all four years. Nine-year-olds were, on average, 15.77cm taller and 7.47kg heavier than 6-year-olds. The BMI remained stable, indicating proportional growth (Mean 15.98 at 6 years vs. 16.46 at 9 years).

Interestingly, analysis of the four distinct age groups revealed that motor proficiency does not always improve linearly with age (Table 2). Results in all 8 tests of basic motor competencies by year of age are presented in Table 3.

- Peak Performance at 7 Years: The overall Total Object Movement Score (Mean 5.38) and individual skills like Catching (Mean 1.84) and Throwing (Mean 0.87) reached their highest mean scores at 7 years old.
- Stagnant Deficit: Throwing proficiency was a chronic deficit. Despite a brief peak at 7 years, the mean scores at 8 and 9 years remained low (mean approximately 0.50), with the Mode consistently at 0 for 6, 8, and 9-year-olds.
- Unexpected Decline: After peaking at 7 years, Jumping and Catching experienced a significant decline in performance, with the mean score dropping and the Mode shifting to 0 (lowest score) by 9 years for both skills (e.g., Catching Mean 1.84 at 7 years to 0.98 at 9 years).
- Consistent Improvement: Only Running, Dribbling, and Bouncing demonstrated clear, sustained improvement or maintenance of high performance across the 6-to-9 age range, with the Mode stabilizing at 2 for 9-year-olds in these skills.

Table 2 Comprehensive Age Trend Comparison (Mean and Mode for Ages 6, 7, 8, and 9)

Category	Mean (6 years)	Mode (6 years)	Mean (7 years)	Mode (7 years)	Mean (8 years)	Mode (8 years)	Mean (9 years)	Mode (9 years)
Height [cm]	121.6	-	127.92	-	133.23	-	137.37	-
Weight [kg]	23.7	-	26.84	-	28.82	-	31.17	-
Self-movement [score]	6.3	6	6.33	8	5.71	6	5.94	6
Object movement [score]	4.15	3	5.38	5	4.44	5	4.35	6

Table 3 Basic Motor Competencies by Age (6 to 9 years old)

Age 6 (n=73)	Balancing [score]	Rolling [score]	Jumping [score]	Running [score]	**Self-movement [score]**	Throwing [score]	Catching [score]	Dribbling [score]	Bouncing [score]	**Object movement [score]**
Median	2	2	1	2	6	0	2	1	1	4
Mean	1,80	1,79	1,23	1,48	6,30	0,55	1,51	0,95	1,15	4,15
Maximum	2	2	2	2	8	2	2	2	2	8
Minimum	0	0	0	0	0	0	0	0	0	0
Std. dev.	0,48	0,55	0,69	0,70	1,44	0,61	0,71	0,86	0,75	2,02
Mode	2	2	1	2	6	0	2	0	1	3

Age 7 (n=74)	Balancing [score]	Rolling [score]	Jumping [score]	Running [score]	**Self-movement [score]**	Throwing [score]	Catching [score]	Dribbling [score]	Bouncing [score]	**Object movement [score]**
Median	2	2	1	2	7	1	2	2	1	5
Mean	1,85	1,65	1,24	1,69	6,33	0,87	1,84	1,36	1,30	5,38
Maximum	2	2	2	2	8	2	2	2	2	8
Minimum	0	0	0	0	0	0	0	0	0	1
Std. dev.	0,40	0,59	0,76	0,58	1,74	0,73	0,44	0,75	0,75	1,66
Mode	2	2	2	2	8	1	2	2	2	5

Age 8 (n=57)	Balancing [score]	Rolling [score]	Jumping [score]	Running [score]	**Self-movement [score]**	Throwing [score]	Catching [score]	Dribbling [score]	Bouncing [score]	**Object movement [score]**
Median	2	2	0	2	6	0	1	2	2	5
Mean	1,90	1,59	0,75	1,56	5,71	0,50	1,15	1,44	1,35	4,44
Maximum	2	2	2	2	8	2	2	2	2	8
Minimum	1	0	0	0	0	0	0	0	0	0
Std. dev.	0,30	0,75	0,84	0,70	1,66	0,61	0,72	0,70	0,79	1,90
Mode	2	2	0	2	6	0	1	2	2	5

Age 9 (n=54)	Balancing [score]	Rolling [score]	Jumping [score]	Running [score]	**Self-movement [score]**	Throwing [score]	Catching [score]	Dribbling [score]	Bouncing [score]	**Object movement [score]**
Median	2	2	1	2	6	0	1	2	2	5
Mean	1,63	1,73	0,78	1,70	5,94	0,55	0,98	1,42	1,42	4,35
Maximum	2	2	2	2	8	2	2	2	2	8
Minimum	0	0	0	0	1	0	0	0	0	0
Std. dev.	0,61	0,61	0,82	0,54	1,60	0,69	0,82	0,79	0,74	2,03
Mode	2	2	0	2	6	0	0	2	2	2

Additionally, comparing the youngest and oldest groups revealed clear differences in physical size and a varied trajectory in motor skill acquisition. Firstly, nine-year-olds were significantly larger than 6-year-olds, with a mean increase of 15.77cm in height and 7.47kg in weight. The proportional increase meant that the mean BMI was only marginally higher for the older cohort (16.46 vs. 15.98). Secondly, throwing proficiency was a consistent and significant area of weakness, showing no change in mean score (0.55) or Mode (0) between 6- and 9-year-olds. This
suggests a persistent lack of skill acquisition over three years. Thirdly, clear developmental gains were observed in Dribbling (Mean 0.95 to 1.42) and Bouncing (Mean 1.15 to 1.42). The Mode for both skills shifted to 2 (maximum score) for the 9-year-olds, indicating greater mastery. Fourthly, counter-developmental trends were noted in Jumping (Mean 1.23 to 0.78, Mode 1 to 0) and Catching (Mean 1.51 to 0.98, Mode 2 to 0). This surprising drop in performance suggests specific difficulties with the administered tasks for the older, larger cohort. Finally, the Total Self-Movement Score was slightly higher for 6-year-olds (Mean 6.30) than for 9-year-olds (Mean 5.94). Conversely, the Total Object Movement Score was marginally higher for 9-year-olds (Mean 4.35 vs. 4.15), driven primarily by improved Dribbling and Bouncing scores.

To sum up, the results provide a robust picture of motor development, clearly distinguishing between skills that demonstrate consistent gains (Running, Dribbling, Bouncing), those with a stagnant deficit (Throwing), and those exhibiting a counter-developmental decline after age seven (Jumping, Catching). These non-linear trends, particularly the decline in Jumping and Catching, represent the most surprising and significant findings.

Swimming competencies

A total of 1,875 pupils from grades 1 to 3 completed the WABAC testing. The results showed a clear improvement in performance across all test items with increasing grade and age (Table 4).

Table 4 Frequency and percentage analysis of success in WABAC test items

		number	mean age	average	n 1p	% 1p	n 2p	% 2p	n 3p	% 3p
T1 Floating on the front	1. grade	360	7,2	2,22	62	17,22	156	43,33	142	39,44
	2. grade	704	7,9	2,41	119	16,9	177	25,14	408	57,95
	3. grade	811	8,7	2,61	49	6,04	215	26,51	547	67,44
T2 12.5 m flutter kicking with a kickboard	1. grade	360	7,2	2,12	132	36,66	51	14,16	177	49,16
	2. grade	704	7,9	2,21	222	31,53	113	16,05	369	52,41
	3. grade	811	8,7	2,66	96	11,83	82	10,11	633	78,05
T3 Jump into the water	1. grade	360	7,2	2,34	87,00	24,16	65	18,05	208	57,77
	2. grade	704	7,9	2,38	190,00	26,98	54	7,67	460	65,34
	3. grade	811	8,7	2,67	110	13,56	48	5,91	653	80,51
T4 Catching an object from the depth	1. grade	360	7,2	2,00	129	35,83	102	28,33	129	35,83
	2. grade	704	7,9	2,10	247	35,08	137	19,46	320	45,45
	3. grade	811	8,7	2,41	175	21,58	126	15,54	510	62,89
T5 Floating on the back	1. grade	360	7,2	2,16	78	21,67	148	41,11	134	37,22
	2. grade	704	7,9	2,24	173	24,57	192	27,27	339	48,18
	3. grade	811	8,7	2,53	110	13,56	163	20,1	538	66,34
T6 Immersion and exhalation in water	1. grade	360	7,2	2,52	67	18,61	38	10,56	255	70,83
	2. grade	704	7,9	2,47	129	18,32	117	16,62	458	65,06
	3. grade	811	8,7	2,68	82	10,11	94	11,59	635	78,3
T7 Gliding on the front	1. grade	360	7,2	2,11	86	23,88	150	41,66	124	34,44
	2. grade	704	7,9	2,20	186	26,42	194	27,55	324	46,02
	3. grade	811	8,7	2,51	96	11,83	207	25,52	508	62,63

In grade 1, the average point scores for each item ranged from 2.00 to 2.52. The lowest performance was recorded in *Catching an object from the depth* (mean = 2.00), while the best result was achieved in *Immersion and exhalation in water* (mean = 2.52). The proportion of fully successful performances (3 points) varied between 34% and 71%, indicating that only about one-third to two-thirds of younger pupils were able to complete each task successfully.

In grade 2, the average point scores for each item ranged from 2.10 to 2.47. The percentage of fully successful performances increased in most areas, ranging from 46% to 65%. The highest success rates were found again in *Immersion and exhalation in water* (65%) and *Floating on the front* (58%).

In grade 3, pupils reached the best overall results, with mean scores between 2.41 and 2.68. The proportion of fully successful performances exceeded 60% of all test items. The most successful tasks were *Jump into the water* (80.5%), *Immersion and exhalation in water* (78.3%), and *12.5 m flutter kicking with a kickboard* (78.1%).

Overall, the results confirm a steady and significant improvement in swimming competence with higher school grades and age. The most easily mastered skills were *jumping into the water* and *basic breathing and immersion*, while the most demanding tasks for younger pupils were *Catching an object from the depth*, *floating on the front*, and *Gliding on the front*, which required effective body control and buoyancy management. These skills showed the lowest mean scores and the smallest proportion of fully successful performances across all grades.

The findings demonstrate a clear developmental progression in basic swimming competencies among primary school pupils. Performance across all WABAC test items improved consistently from grade 1 to grade 3, indicating both maturation effects and increasing aquatic experience. These results are consistent with previous studies emphasizing the gradual development of aquatic motor skills during early school age (Stallman et al., 2017).

The highest success rates were observed in *Jump into the water* and *Immersion and exhalation in water*, suggesting that elementary water orientation and breathing control are acquired relatively early. Conversely, tasks such as *Catching an object from the depth* and *Floating on the front* required more complex motor control and confidence, resulting in lower achievement rates, particularly among younger pupils.

The WABAC test battery proved effective in distinguishing between competence levels, confirming its potential as a valid assessment tool for evaluating swimming proficiency in children. The results underscore the importance of systematic early swimming instruction as a foundation for water safety and the development of lifelong aquatic competence.

CONCLUSIONS

This study successfully achieved its primary aim by investigating the developmental level of basic motor and swimming competencies in younger primary school pupils (Grades 1–3) and demonstrating the utility of the MOBAK and WABAC standardized test batteries as effective assessment tools. The findings provide objective, evidence-based data crucial for informing curriculum development and improving the QPE provision.

The analysis of motor competencies in the 6-to-9 age cohort revealed a complex, non-linear developmental trajectory, highlighting critical areas of concern within the current QPE structure:

- The MOBAK battery proved effective in differentiating performance, demonstrating that while pupils generally maintain high scores in Self-Movement skills (e.g., Balancing), significant weaknesses exist in Object Movement skills (Mean 4.62/8).
- The data identified a persistent and stagnant deficit in throwing proficiency across all age groups (mean score remaining near 0.55), indicating a systematic failure of current instruction to adequately develop this foundational gross motor skill in pupils between the ages of six and nine.
- The most surprising finding was the unexpected decline in performance in jumping and catching after the age of 7. This counter-developmental trend suggests either a lack of skill retention or an inadequacy in the task criteria or instructional methods for physically larger, older children.

The assessment using the WABAC battery on a large cohort (n=1,875) clearly confirmed the positive impact of systematic instruction:

- There was a clear, significant, and consistent improvement in all seven basic swimming competencies from Grade 1 through Grade 3, validating the effectiveness of organized swimming courses in building fundamental water competency.
- Analysis of the WABAC results identified the most challenging tasks for younger pupils, specifically Retrieving a submerged object and buoyancy control skills (Front floatation and Front gliding), as demonstrated by their lowest success rates. This crucial data allows instructors to strategically target teaching resources toward these demanding, safety-critical skills.

In conclusion, the ability of the MOBAK and WABAC batteries to generate reliable, granular, and differentiating data fulfils a major requirement for addressing the UNESCO-identified deficit in QPE quality, particularly concerning the lack of teacher specialization and skill assessment. Implementation of these standardized diagnostic tools is crucial for moving QPE from general activity provision toward data-driven, targeted interventions, ensuring that all primary school pupils acquire the essential motor and aquatic competencies necessary for lifelong physical engagement and safety.

ACKNOWLEDGEMENT

The study is supported by Agency of the Ministry of Education, Research, Development and Youth of the SR with project VEGA: 1/0213/23 and title "Teaching of Tandem Physical and Sports Education in Primary School and its Impact to Motor, Cognitive and Emotional Development of Pupils" and with project VEGA: 1/0427/23: Swimming Competencies of the School Population and their Assessment".

REFERENCES

1. Boržíková, I., (2020). *Pohybové kompetencie ako atribút konceptuálneho modelu pohybovej gramotnosti v mladšom školskom veku*. Habilitačná práca. Prešovská univerzita v Prešove.
2. Herrmann, C., (2018). *Test zur Erfassung motorischer Basiskompetenzen für die Klassen 1–4 (MOBAK*) (Hogrefe Schultests). Göttingen: Hogrefe.
3. Herrmann, C., A. Bund, E. Gerlach, D. Kurz, U. Lindemann, S. Rethorst, S. et al. (2015). A review of the assessment of basic motor qualifications and competencies in school. *International Journal of Physical Education*, 52(3), 2-13. ISSN 0341-8685
4. Herrrmann, C., E. Gerlach & H. Seeeling (2015). Development and validation of a test instrument for the assessment of basic motor competencies in primary school. In: *Measurement in Physical Education and Exercise Science*, **19**(2), 80-90. https://doi.org/10.1080/1091367X.2014.998821.
5. Labudová, J. (2024). Osobitosti pohybu vo vodnom prostredí. Bratislava: Slovenská vedecká spoločnosť pre telesnú výchovu a šport, 2024. – 96 s. ISBN (elektronické) 978-80-8251-020-4
6. Labudová, J., Procházková, E., Benčúriková, Ľ. Grznár, Ľ & Putala, M. (2024). Possibilities of evaluating the basic swimming competences of the school population. **In:** *Current trends and innovations in kinesiology research* [elektronický dokument] : 10. proceedings from International scientific conference on kinesiology. Záhreb (Chorvátsko) : Sveučilište u Zagrebu. Kineziološki fakultet, 2024. – ISBN (elektronické) 978-953-317-081-7, s. 277-283 [online] International scientific conference on kinesiology, 10 [Opatija, Chorvátsko, 12.09.2024-15.09.2024]
7. Mačura, P. et al., (2020). Basic motor competencies in the 1st and 2nd grade elementary school children in Slovakia. In Cacek, J., Sajdlová, Z. & Šimková, K. (eds.) *Proceedings of the 12th International Conference on Kinanthropology: Sport and Quality of Life*. 1. vyd. Brno: Masaryk University Press, online, s. 74-83.
8. Masaryková, D., (2021). *Pohybové kompetencie v predprimárnom a primárnom vzdelávaní*. Trnava: Typi Universitatis Tymaviensis. ISBN 978-80-568-0224-3
9. Masaryková, D. & J. Labudová, (2018). Basic motor competencies of primary school children in Slovakia. In: *Abstract book*. Istanbul: Marmara University Press, s.51. ISBN 978-975-400-418-2.
10. Merica, M. & J. Vargová, (2019). Swimming of children in primary schools. In *Sportivnye igry v fizičeskom vospitanii, rekreacii i sporte: zborník z medzinárodnej vedeckej konferencie.* Smolensk: SGAFKST 2019. s. 297–300, ISBN 978-5-94578-172-6.
11. Scheuer, C., A. Bund, W. Becker & C. Herrmann, (2017). *Development and validation of a survey instrument for detecting basic motor competencies in elementary school children*. Cogent Education, 4, 1337544.
12. Scheuer, C., C. Herrmann & A. Bund, (2019). Motor tests for primary school aged children: A systematic review. In: *Journal of Sports Sciences*, 37(10), 1097–1112. ISSN 0264-0414
13. Stallman, R. K., Moran, K., Quan, L., & Langendorfen, S. (2017). From swimming skill to water competence: Towards a more inclusive drowning prevention future. *International Journal of Aquatic Research and Education*, 10(2), 3. https://doi.org/10.25035/ijare.10.02.02
14. Stempski, S., Liu, L., Grow, H. M., Pomietto, M., Chung, C., Shumann, A., & Bennett, E. (2015). *Everyone Swims: a community partnership and policy approach to address health disparities in drowning and obesity*. Health Education & Behavior, 42(1 Suppl), 106S–114S. https://doi.org/10.1177/1090198115570047
15. Šeflová, I., (2021). Analýza diagnostických prostredku k hodnocení motorické kompetence v mladším školním veku. *Gramotnost, pregramotnost a vzdelavaní, 5*, č. 2, s. 79—97, ISSN 2533-7882
16. UNESCO, (2015). Quality Physical Education: Guidelines for Policy Makers, [cit. 2021-07-07] Dostupné z: https://unesdoc.unesco.org/ark:/48223/pf0000231101
17. UNESCO, (2024). State of Play – Report and Recommendation on Quality PE.

САОПШТЕЊА

ANNOUNCEMENTS

MULTIVARIATE ANALYSES ON THE VARIANCE OF PSYCHOLOGICAL CHARACTERISTICS IN KARATE COMPETITORS AND KARATE NATIONAL TEAM PLAYERS

Soklevska Ilievski Elena, Kostovski Žarko
Faculty of Physical Education, Sport, and Health, University "Ss. Cyril and Methodius", Skopje, North Macedonia

ORIGINAL SCIENTEFIC ARTICLE
DOI: 10.5937/ATAVPA25015S

Abstract: *This survey was conducted on a deliberate sample of 32 respondents, 16 karate competitors and 16 karate representatives, members of the national team, male, senior (according to WKF) from the Republic of North Macedonia. The main objective of the research was to analyze the multidimensional manifestations or latent spaces of psychological characteristics in both groups of respondents. In the study,* a total of 13 variables of psychological characteristics were used: one variable for assessing general intellectual abilities, three variables for assessing specific intellectual abilities, six variables for assessing emotional characteristics, and three variables for assessing motivational dispositions. *The basic descriptive statistics for the two groups of respondents were applied separately to determine the basic statistical parameters. Since most of the kinesiological information obtained from this type of research is multivariate, it means that a number of factors, whether motor, psychological, or sociological, are influenced by one anthropological feature. Therefore, a multivariate analysis of variance MANOVA was used for this purpose, which basically analyzes only one variable but vector variables whose elements are variables in the research area. The results obtained in the study show statistically significant differences in 11 out of 13 variables examined.*
Key words*: psychological characteristics, karate competitors and representatives, MANOVA, descriptive statistic*

INTRODUCTION

The value of research of this type in the field of karate sport is essential for several reasons such as different levels of mental resilience, self-confidence, motivation, self-control, etc. It is important to note that these are general observations and there are individual differences in both national team and regular competitors (Macovei et al., 2014). Furthermore, the specific psychological demands of karate, such as controlled aggression and close physical contact, can affect the psychological profiles of athletes in this sport (Ayyildiz, T., Gökyürek, B., 2017). Understanding these differences helps coaches and professionals to adapt training methods to suit individual psychological profiles. Mental attributes such as perception, stress management, and aggression control play a key role in competitive karate. Identifying psychological differences allows for targeted mental conditioning, leading to improved performance. An essential starting point for conducting in-depth analyses of the personality of athletes at every level of their athletic career are new empirical arguments. To effectively reflect the social and health purpose of sport, this information must be supplemented by research on other predispositions and adaptive effects (Piepiora P, Witkowski K, Piepiora Z, 2018). Building on the previous research, the same authors (2022) conducted another study in which they concluded that older karatekas probably manifest greater openness to experience, which is a result of their high sporting level and experience. On the other hand, good emotional adaptation of karatekas is strictly related to conscientiousness. Monitoring psychological growth and eliminating deficiencies over time ensures the development of karatekas not only physically, but also mentally, which is crucial for long-term success in sports. More research is needed to specifically compare national team players and other karate competitors to fully understand the psychological factors that separate elite karate players from competitors.

METHODS OF WORK

The research was conducted on a purposive sample of a total of 32 respondents divided into two subsamples, of which 16 karate competitors and 16 karate representatives, members of the national team, male, seniors (according to WKF) from the Republic of Macedonia. The respondents were subjected to tests to determine psychological characteristics that were conducted in the clubs where the competitors conduct their daily training.

A total of 13 variables of psychological characteristics were applied in the research (according to the doctoral dissertation of Aleksovska, V., L. 2002), divided into 4 areas, of which:

- one variable for assessing general intellectual ability - IQ Test
- three variables for assessing specific intellectual abilities - F1, F2, S1
- six variables for assessing emotional traits - anxiety (TAI), aggressiveness (T-15), extraversion/introversion, neuroticism, psychoticism, social desirability (EPQ)
- three variables for assessing motivational dispositions - P2, F+, F2

The data obtained from this research according to the characteristics and size of the selected sample were processed with adequate statistical programs. For the needs of this research, the following were calculated: Mean - arithmetic mean, SD - standard deviation, Min., Max. - the minimum and maximum result, Skew - symmetry of the distribution of results, Kurt - homogeneity of results in a certain variable, K-S - Kolmogorov - Smirnov method that determines the normal distribution of results and MANOVA - multivariate analysis of variance.

RESULTS AND DISCUSSION

Table 1 Basic descriptive statistical parameters of the psychological characteristics among the respondents - competitors

	M	Std. Dev.	Min.	Max.	Skew.	Kurt.	K-S	Sig.
PM	51.56	1.75	50.00	56.00	**1.20***	1.26	0.76	0.62
F1	28.81	2.23	25.00	33.00	0.06	-0.48	0.63	0.82
F2	17.00	1.93	15.00	22.00	**1.39***	1.84	1.00	0.27
S1	20.94	2.11	18.00	26.00	**1.01***	0.80	0.95	0.32
TAI	35.75	3.40	30.00	41.00	-0.39	-0.81	0.57	0.90
P	2.75	0.86	1.00	4.00	-0.18	-0.32	0.96	0.32
N	11.31	2.24	7.00	16.00	0.08	0.38	0.62	0.84
E	11.00	2.13	7.00	15.00	0.05	-0.18	0.53	0.94
L	11.56	2.50	7.00	15.00	-0.30	-1.03	0.62	0.84
P2	20.56	2.31	17.00	25.00	0.35	-0.74	0.75	0.62
F+	3.94	1.29	2.00	6.00	0.34	-0.58	0.92	0.36
F-	7.13	1.20	5.00	9.00	0.25	-0.63	0.92	0.37
T-15	32.81	4.52	26.00	40.00	0.11	-1.25	0.54	0.93

Legend: Mean - arithmetic mean, Std.Dev. - standard deviation Min. - minimum score, Max. - maximum score, Skew. – symmetry of distribution, Kurt. - skewness of distribution of scores, K-S - Kolmogorov – Smirnov

Table 2 Basic descriptive statistical parameters of the psychological characteristics among the respondents - national team members

	M	Std. Dev.	Min.	Max.	Skew.	Kurt.	K-S	Sig.
PM	55.13	2.45	51.00	59.00	-0.04	-1.07	0.52	0.95
F1	31.94	1.65	30.00	34.00	0.21	-1.69	0.86	0.45
F2	20.56	1.93	17.00	24.00	0.27	-0.59	0.96	0.32
S1	26.63	1.82	24.00	29.00	0.11	-1.44	0.79	0.57
TAI	30.31	2.44	27.00	35.00	0.53	0.08	0.56	0.92
P	2.31	**0.87***	1.00	4.00	-0.02	-0.55	0.89	0.41
N	9.25	2.54	4.00	14.00	-0.46	0.42	0.84	0.48
E	13.06	1.91	10.00	16.00	-0.23	-1.13	0.63	0.83
L	11.13	2.25	6.00	14.00	-0.74	0.15	0.86	0.46
P2	23.13	1.36	21.00	25.00	-0.07	-1.19	0.71	0.69
F+	3.00	**1.10***	1.00	5.00	0.00	-0.80	0.78	0.58
F-	8.63	1.15	7.00	11.00	0.56	-0.40	1.08	0.20
T-15	27.63	4.27	21.00	38.00	0.94	1.15	0.73	0.66

Analyzing the data from the basic descriptive statistical parameters of the psychological variables among the competitors and the junior and senior national team members presented in Table 1 and 2, it is concluded that the standard deviation of all the examined variables is with normal values, i.e. they are less than 1/3 of the arithmetic means. The lower and upper limits of the range in which the results move (Min. - Max.) are expected in relation to the treated variables in both the competitors and the national team members.

A statistically significant deviation of the asymmetry of the values of the results of Skew, in the competitors, is noticeable only in two variables: progressive matrices (PM=1.20) and speed of observation of perceptual structures (F2=1.39), while in the test (S1=1.01) that measures the ability to visualize spatial relations, a value was obtained slightly above the upper limit. In the remaining variables, the results shown are within the limits of the recommended values. If we look individually for each statistical parameter in the representative respondents, it can be concluded that the values of the standard deviation (Std.Dev), in the variables psychoticism (P=0.87) and the variable (F+=1.10) that examines the degree of positive emotional engagement and emotional self-control in situations of sports achievement, show very little deviation. Also, in them, a statistically significant deviation of the asymmetry of the values of the results of Skew., has not been observed in any of the variables whose values mainly move around zero, which tells us that the data are normally distributed. By analyzing the values of the degree of curvature of the Gaussian curve, it is concluded that the majority of the applied variables are distributed along the width of the horizontal axis in both groups of respondents. The normal distribution of the results obtained with the Kolmogorov - Smirnov method shows that there is no deviation in any of the psychological variables in both groups of respondents.

Table 3 presents the results of the values for the squared arithmetic mean (Mean Square), the F approximation and the level of statistical significance (Sig.) between the dependent variables of the treated groups. Significant significance is observed for all examined variables with the exception of two variables (L - social desirability and P - psychoticism) which we will also comment on in further analyses.

Table 3 Multivariate analysis of variance (MANOVA) of psychological characteristics among the participants, competitors and national team players

	Dependent Variable	Type III Sum of Squares	Mean Square	F	Sig.
G2	PM	101,53	101,53	22,44	**,00**
	F1	78,12	78,12	20,31	**,00**
	F2	101,53	101,53	27,21	**,00**
	S1	258,78	258,78	66,53	**,00**
	TAI	236,53	236,53	27,03	**,00**
	P	1,53	1,53	2,04	,16
	N	34,03	34,03	5,92	**,02**
	E	34,03	34,03	8,30	**,00**
	L	1,53	1,53	,27	,60
	P2	52,53	52,53	14,63	**,00**
	F+	7,03	7,03	4,91	**,03**
	F-	18,00	18,00	13,01	**,00**
	T15	215,28	215,28	11,13	**,00**

Legend: DV-зависна варијабла, Mean square-квадрирана аритметичка средина, F – value of the Wilks test for analyzing the significance of the difference between the centroid of groups, Sig. - significance coefficient

Analyzing the obtained results (table 4), which presents the values from the multivariate analysis of variance of the entire examined space for assessing the psychological characteristics between the competitors and representatives, it can be noted that there is a statistically significant difference in the arithmetic means between the competitors and representatives. The difference is determined based on the values of Wilks' lambda which is .12 in conjunction with the value of the F approximation of .39, degrees of freedom df=13, and the number of degrees of freedom associated with the errors of the model Error df=18 is significant at the level of Sig.=.00 (p<.05).

Table 4 Multivariate differences across the entire examined space of psychological characteristics

	Value	F	df	Error df	Sig.
Pillai's trace	.87	9,39[a]	13.00	18.00	**.00**
Wilks' lambda	.12	9,39[a]	13.00	18.00	**.00**
Hotelling's trace	6.78	9,39[a]	13.00	18.00	**.00**
Roy's largest root	6.78	9,39[a]	13.00	18.00	**.00**

Legend: F – the value of the Wilks test for analyzing the significance of the difference between the centroid of groups; Effect df, Error df – degrees of freedom, Sig. - significance coefficient

The obtained results presented in table 5, give us the values of the comparisons of the pairs of dependent variables between the examined groups, where the difference in the arithmetic means (Mean Difference), the standard errors of the arithmetic means (Std. Error), the significant level (Sig.) and the lower and upper limits of the confidence interval for the differences are presented. It has been determined that in 11 out of a total of 13 examined variables, there are statistically significant differences at the level of p<.05. The two variables that are exceptions are the variables L=.60 (social desirability) and P=.16 (psychotism). As confirmation of these results, a comparison can be made with the research conducted by Soltani, H., and Reddy.,K S. (2013), in which, using ANOVA, they determined that there are significant differences between the levels of somatic anxiety, cognitive anxiety and self-confidence between elite and non-elite karatekas.

Table 5 Multivariate comparisons of psychological characteristics variables between the groups of respondents and representatives - Pairwise Comparisons

Dependent Variable			Mean Difference (I-J)	Std. Error	Sig.[b]	95% Confidence Interval for Difference[b]	
						Lower Bound	Upper Bound
PM	1,00	2,00	-3,56)*	.75	**.00**	-5.09	-2.02
	2,00	1,00	3,56*	.75	**.00**	2.02	5.09
F1	1,00	2,00	-3,12)*	.69	**.00**	-4.54	-1.70
	2,00	1,00	3,12*	.69	**.00**	1.70	4.54
F2	1,00	2,00	-3,56)*	.68	**.00**	-4.95	-2.16
	2,00	1,00	3,56*	.68	**.00**	2.16	4.95
S1	1,00	2,00	-5,68)*	.69	**.00**	-7.11	-4.26
	2,00	1,00	5,68*	.69	**.00**	4.26	7.11
TAI	1,00	2,00	5,43*	1.04	**.00**	3.30	7.57
	2,00	1,00	-5,43)*	1.04	**.00**	-7.57	-3.30
P	1,00	2,00	.43	.30	.16	-.18	1.06
	2,00	1,00	-.43	.30	.16	-1.06	.187
N	1,00	2,00	2,06*	.84	**.02**	.33	3.7
	2,00	1,00	-2,06)*	.84	**.02**	-3.79	-.33
E	1,00	2,00	-2,06)*	.71	**.00**	-3.52	-.60
	2,00	1,00	2,06*	.71	**.00**	.60	3.52
L	1,00	2,00	.43	.84	.60	-1.28	2.15
	2,00	1,00	-.43	.84	.60	-2.15	1.28
P2	1,00	2,00	-2,56)*	.67	**.00**	-3.93	-1.19
	2,00	1,00	2,56*	.67	**.00**	1.19	3.93
F+	1,00	2,00	,93*	.42	**.03**	.07	1.80
	2,00	1,00	-,93)*	.42	**.03**	-1.80	-.07
F-	1,00	2,00	-1,50)*	.41	**.00**	-2.34	-.65
	2,00	1,00	1,50*	.41	**.00**	.65	2.34
T15	1,00	2,00	5,18*	1.55	**.00**	2.01	8.36
	2,00	1,00	-5,18)*	1.55	**.00**	-8.36	-2.01

Legend: Mean - arithmetic mean, Std. Error - standard errors of the arithmetic means, Sig. significant level and Lower and upper bound - lower and upper bound of the confidence interval for the differences

CONCLUSION

Using the multivariate analysis of variance between groups, it can be seen that there is significant significance in all examined variables with the exception of two variables (L - social desire and P - psychoticism), i.e. with the multivariate comparisons of the variables of psychological characteristics between the groups of respondents and representatives, it was determined that in 11 out of a total of 13 examined variables, there are statistically significant differences at the level of $p<.05$. The two variables that are exceptions are the variables L=.60 (social desire) and P=.16 (psychoticism). If we take into account the previous experiences according to which psychoticism is more of a genetic predisposition and can be influenced very little, and social desire is more determined by attempts at emotional control, it can be concluded that the results obtained are logical and expected. Building on the above, Ikhram et al., (2020), in their research, highlighted that members of the national karate team exhibit higher levels of mental toughness, enabling them to more effectively manage pressure, setbacks, and intense competition. This includes resilience, focus, and unwavering belief in their abilities.

REFERENCES

1. Aleksovska, V., L. (2002). Determination and differences in the psychological structure of the personality among athletes from different sports disciplines and non-athletes in the Republic of Macedonia. Doctoral dissertation, Faculty of Physical Education, Skopje [Утврдување и разлики во психолошката структура на личноста кај спортисти од различни спортски дисциплини и неспортисти во Р. Македонија. Докторска дисертација, Факултет за физичка култура, Скопје]
2. Ayyildiz, T., Gökyürek, B. (2017). Investigation of mental well-being and aggression level of karate-do athletes, The Online Journal of Recreation and Sport, Vol. 6, Issue 2 DOI:10.22282/ojrs.2017.10
3. Ikhram, A., Muh. Jufri, Ahmad R. (2020). Mental Toughness dan Competitive Anxiety Pada Atlet Karate UNM, Jurnal Psikologi Pers... 5(2), DOI: 10.24176/perseptual.v5i2.5206, http://jurnal.umk.ac.id/index.php/perseptual
4. Macovei S., Lambu I.S., Lambu E.A, Predoiu R. (2014). Procedia - Social and Behavioral Sciences, Vol. 117, Pp.269-274, doi.org/10.1016/j.sbspro.2014.02.212
5. Piepiora P, Witkowski K, Piepiora Z. (2018). Personality profiles of karate masters practicing different kumite styles. Arch Budo 2018; 14: 247-257
6. Piepiora, P., Kindzer, B., Bagińska, J., & Cynarski, W. J. (2022). Personality and Age of Male National Team of Ukraine in Kyokushin Karate—Pilot Study. International Journal of Environmental Research and Public Health, 19 (12), 7225. https://doi.org/10.3390/ijerph19127225
7. Soklevska, I., E. (2018). Structure and differences of situational motor stereotypes and psychological traits in karate national team members and competitors, Doctoral dissertation, Faculty of Physical Education, Sport and Health, Skopje [Структура и разлики на ситуационо моторичките стереотипи и психолошките особини кај карате репрезентативци и натпреварувачи, Докторска дисертација, Факултет за физичко образование, спорт, и здравје, Скопје]
8. Soltani, H., and Reddy.,K S. (2013). Comparative analysis of competitive state anxiety among elite and non-elite Karate athletes in Iran. Advances in Environmental Biology, 7(7): 1244-1248, ISSN 1995-0756

MULTIVARIJATNA ANALIZA VARIJANCIJE PSIHOLOŠKIH KARAKTERISTIKA KARATE TAKMIČARA I KARATE REPREZENTATIVACA

Soklevska Ilievski Elena, Kostovski Žarko

Sažetak: *Ovo istraživanje je sprovedeno na namernom uzorku od 32 ispitanika, 16 karatista takmičarai 16 karatista reprezentativaca, muškaraca, seniora (prema VKF) iz Republike Severne Makedonije. Osnovni cilj istraživanja bio je da se analiziraju višedimenzionalne manifestacije ili latentni prostori psiholoških karakteristika u obe grupe ispitanika. U istraživanju je korišćeno ukupno 13 varijabli psiholoških karakteristika: jedna varijabla za procenu opštih intelektualnih sposobnosti, tri varijable za procenu specifičnih intelektualnih sposobnosti, šest varijabli za procenu emocionalnih karakteristika i tri varijable za procenu motivacionih dispozicija. Za određivanje osnovnih statističkih parametara odvojeno je primenjena osnovna deskriptivna statistika za dve grupe ispitanika. Budući da je većina kinezioloških informacija dobijenih ovim tipom istraživanja multivarijantna, to znači da je na niz faktora, bilo*

motoričkih, psiholoških ili sociolоških, utiče jedna antropološka karakteristika. Zbog toga je za ovu svrhu korišćena multivarijantna analiza varijanse MANOVA, koja u osnovi analizira samo jednu varijablu već vektorske varijable čiji su elementi varijable u oblasti istraživanja. Rezultati dobijeni u studiji pokazuju statistički značajne razlike u 11 od 13 ispitivanih varijabli.
Ključne reči: *psihološke karakteristike, karate takmičari i reprezentativci, MANOVA, deskriptivna statistika*

РАЗЛИКЕ У НИВОУ МОТОРИЧКИХ СПОСОБНОСТИ УЧЕНИКА КОЈИ ДОДАТНО ТРЕНИРАЈУ КОШАРКУ У СВРХУ РЕКРЕАЦИЈЕ

Коцић Јадранка[1], Петровић Лана[2], Алексић Драгана[1]
[1]Факултет за спорт и физичко васпитање, Лепосавић, Србија
[2]Факултет педагошких наука Јагодина, Србија

ORIGINAL SCIENTEFIC ARTICLE
DOI: 10.5937/ATAVPA25021J

Сажетак: *Организација спортско-рекреативног вежбања у школи има за циљ подстицање општег и правилног развоја тела, добијање што ширег моторичког искуства, стварање корисних навика које ће током целог живота остати и служити функцији развоја и очувања здравља, као и задовољења дечијих потреба за кретањем и игром. Истраживање у овом раду спроведено је са циљем да се прикажу ефекти утицаја рекреативног вежбања кошарке у оквиру додатне секције у школи ученика осмог разреда, у односу на ученике који нису укључени у исту. За потребе рада коришћена су три моторичка теста (експлозивна снага): скок у даљ из места, скок у вис (Сарџент тест) и бацање медицинке из стојећег положаја. Резултати истраживања су показали да се тренд развоја моторичких способности с обзиром на тренирање (рекреативце) и нетренирање ученике, одвија складно законитостима развоја моторичких способности. Тест скок у даљ, показује да такође постоји статистички значајна разлика у резултатима (на нивоу 0.95) између две групе испитаника, тако да се може закључити да активност на кошаркашкој секцији има утицаја на постигнуће на овом тесту. У погледу резултата теста скок у вис који износи 9.478, са вероватноћом грешке, одбацујући нулту хипотезу, ако је она тачна, која износи 0.004. добијени резултати указују да је активност у секцији имала утицаја. Када је у питању тест бацање медицинке, запажа се вредност Ф статистике од 24.61, што указује на исти закључак. Добијени подаци нам недвосмислено показују да се додатна активност чланова кошаркашке секције несумњиво позитивно одражава на резултате способности које мере тестови скок у вис, скок у даљ и бацање медицинке.*
Кључне речи: *моторичке способности, експлозивна снага, спортско-рекреативно вежбање*

УВОД

Развој моторике, као и организма у целини, не тече равномерно. Он скоковит, тј. да постоје периоди у развоју када се поједине моторичке способности убрзано развијају, да би затим наступили периоди успоренијег раста или стагнације. У стручној литератури, ти периоди називају се сензитивним. Сензитивни периоди су конкретне временске фазе у којима поједине димензије у оквиру моторичког простора појачано осећају дејство програмираних облика телесног вежбања (Трунић, 2007). Период средњег школског узраста је период у коме постоје оптимални услови за развој максималне брзине, брзине појединачних покрета, способности убрзања, експлозивне снаге, координационих способности и активне покретљивости. Такође, повољни су услови за развој издржљивости у снази, као и аеробне, а нешто касније и анаеробне издржљивости**.**

Специфичне моторичке способности кошаркаша су у ситуацији игре представљене могућностима играча да са актуелним моторичким потенцијалом решавају техничко-тактичке проблеме у игри. Суштина рада на развоју специфичних моторичких способности играча је у развоју техничко-тактичких способности на бази индивидуалних моторичких карактеристика играча. Развој специфичних моторичких способности или развој техничко-тактичких капацитета играча је сложен дидактички процес, који поред стручности тренера у преношење знања на играче има за циљ оспособљавање играча или подстицање његовог осећаја компететности, односно упознавање са методама којима играч може самостално усавршити властиту, индивидуалну и тимску игру. Основни аспекат обуке и усавршавања индивидуалне, групне и колективне технике и тактике у кошарци (као процес развоја специфичних моторичких способности кошаркаша) је пренети играчима знање и створити стабилну мотивациону структуру која ће игрчима омогућити потребу за самоусавршавањем током играчке каријере.

Моторичке способности према Блашковићу у одређеној мери представљају добар

предикторски систем за ситуационо-моторичке способности у кошарци. Матковић у раду са младим кошаркашима закључује да је за успешност специфичног кретања у кошарци, честе промене правца кретања са наглим убрзањем и скоковима приликом вођења лопте или у кретању без лопте, значајна пре свега агилност и координација, флексибилност, брзина фреквенције покрета и експлозивна снага. За активност типа скок шут битна је експлозивна снага руку, брзина фреквенције покрета руку, координација и издржљивост. Заједничка констатација већине аутора је да су ситуационо-моторичке способности условљене експлозивном снагом, брзином фреквенције покрета и тек секундарно, издржљивошћу.

ПРЕДМЕТ, ПРОБЛЕМ, ЦИЉ И ЗАДАЦИ ИСТРАЖИВАЊА

Предмет истраживања су ученици осмог разреда који похађају кошаркашку секцију у склопу додатних активности наставе физичког васпитања и ученици који не похађају секцију и не баве се другим спортским активностима.

Проблем истраживања је да се испита да ли постоје значајне разлике у моторичким способностима код ученика који похађају кошаркашку секцију и ученика који не похађају, конкретно у експлозивној снази која заједно са репетативном снагом и сегментарном брзином чини важну моторичку активност која је веома значајна за постизање врхунских спортских резултата (Благајац 2004, Пржуљ 2007).

На основу постављеног предмета и проблема истраживања, општи циљ истраживања је утврђивање релације између моторичких способности (експлозивне снаге) ученика осмог разреда основне школе који су чланови кошаркашке секције и оних који то нису.

Из свега горе наведеног, произилази да је један од основних задатака: утврђивање разлике нивоа моторичких способности између ове две групе ученика.

ХИПОТЕЗЕ ИСТРАЖИВАЊА

X0, Претпоставља се да не постоје значајне разлике у погледу моторичких способности код ученика осмог разреда који су чланови кошаркашке секције и оних који то нису

X1, Очекује се статистички значајна разлика у погледу моторичких способности које мери тест скок у даљ из места код испитаника који су чланови кошаркашке секције и оних који то нису

X2, Очекује се статистички значајна разлика у погледу моторичких способности које мери тест, скок у вис (Сарџент тест)

X3, Очекује се статистички значајна разлика у погледу моторичких способности које мери тест, бацање медицинке из стојећег положаја.

МЕТОДЕ ИСТРАЖИВАЊА

Узорак испитаника

Узорак од 40 испитаника чинили су ученици осмог разреда ОШ „Ратко Вукићевић“ из Ниша. Узорак је био подељен у две групе:

- Прву групу су чинили ученици који су били укључени у кошаркашку секцију која се спроводила три пута недељно у склопу додатних активности наставе физичког васпитања
- Другу групу су чинили ученици који нису били чланови кошаркашке секције и који се нису бавили никаквим физичким активностима

Основни услов који су испитаници обје групе испунили да би учествовали у истраживању је да су здрави. Сви испитаници су добровољно дали пристанак за тестирање и учествовање у истраживању.

Узорак варијабли

Варијабле за ово истраживање одабране су тако да процењују моторичку способност, експлозивну снагу, која је веома важна у игрању кошарке. На основу досадашњих истраживања за ово истраживање израђени су хипотетски модели моторичких способности и одабране су одговарајуће мере и моторички тестови.

Зависне варијабле:
- Резултати на тесту, скок у даљ из места, који мери моторичку способност-експлозивну снагу
- Резултати на тесту, скок у вис (Сарџент тест) који мери моторичку способност-експлозивну снагу
- Резултати на тесту, бацање медицинке из стојећег положаја, који мери моторичку способност-експлозивну снагу

Независне варијабле:
- Ученици који су чланови кошаркашке секције
- Ученици који нису чланови кошаркашке секције.

Мерни инструменти за процену моторичких способности

За правилан раст и развој младог организма, као и играње кошарке или бављење неком другом спортском активношћу, од великог је значаја да вежбач поседује опште и специфичне моторичке способности. На основу тога, постављен је и хипотетски модел моторичких способности, који између осталих фактора (брзине трчања, ситуационо-кошаркашке елементе, репетативне снаге...) садржи и експлозивну снагу у чијој су процени била постављена по три теста:

Скок удаљ из места (MSDM)
Сарџент тест - Sardžent test (MSARDŽ)
Бацање медицинке с груди (MBAM)

Методе обраде података

Примењена је дескриптивана статистика (аритметичка средина, стандардна девијација, минимум и максимум), једнофакторска мултиваријантна анализа варијансе за тестирање постојања разлика аритметичких средина испитаника две групе (они који су чланови кошаркашке секције и они који то нису) у односу на постигнућа на тестовима моторичких способности (бацање медицинке, скок у даљ, скок у вис).

РЕЗУЛТАТИ ИСТРАЖИВАЊА СА ДИСКУСИЈОМ

Табела бр. 1 приказује боља просечна постигнућа испитаника који су чланови кошаркашке секције (прва група), осим када је у питању тест скок у даљ, где су просечни резултати изједначени.

Табела 1.

		Број испитаника	Аритметичка средина	Стандардна девијација
Скок у вис	Прва група	20	236.50	11.24
	Друга група	20	248.75	13.80
	Укупно	40	242.63	13.88
Скок у даљ	Прва група	20	183.30	11.24
	Друга група	20	183.30	13.80
	Укупно	40	194.28	13.88
Бацање медицинке	Прва група	20	511.40	54.91
	Друга група	20	598.00	55.47
	Укупно	40	554.70	69.94

Из табеле бр. 2 се уочава да су разлике од најлошијих до најбољих резултата највећи када је у питању тест бацање медицинке, и то код обе групе испитаника. Тест скок у даљ прави исту разлику од најлошијег до најбољег резултата и код прве (чланови кошаркашке секције) и друге групе (они који нису чланови кошаркашке секције) испитаника.

Табела 2.

		Minimum	Maksimum
Скок у вис	Прва група	222	252
	Друга група	223	275
	Укупно	222	275
Скок у даљ	Прва група	165	215
	Друга група	170	220
	Укупно	165	220
Бацање медицинке	Прва група	438	655
	Друга група	520	750
	Укупно	438	750

Табела бр. 3 нам указује да вредност Ф статистика за тестирање нулте хипотезе о једнакости аритметичких средина две групе ученика (оних који су чланови кошаркашке секције и оних који то нису) у погледу резултата теста скок у вис износи 9.478, а вероватноћа да погрешимо одбацујући ову нулту хипотезу, ако је она тачна, износи 0.004. Стога закључујемо да нулту хипотезу има смисла одбацити те можемо рећи да постоји статистички значајна разлика по питању постизања резултата на тесту скок у вис код ученика који похађају и не похађају кошаркашку секцију. Када је у питању тест скок у даљ, увиђамо да такође постоји статистички значајна разлика у резултатима (на нивоу 0.95) између две групе испитаника, тако да можемо закључити да активност на кошаркашкој секцији има утицаја на постигнуће на овом тесту. Добијени подаци нам дају основу да донесемо исти закључак и када је у питању тест бацање медицинке. Са вредношћу Ф статистика од 24.61, вероватноћа да погрешимо одбацујући хипотезу о непостојању разлике аритметичких средина код испитаника ове две групе ученика, ако је она тачна, је 0.000.

Табела 3.

		Сума квадрата	df	Варијанса између/унутар група	F	p
Скок у вис	Између група	1500.625	1	1500.625	9.478	.004
	Унутар група	6016.750	38	158.336		
	Укупно	7517.375	39			
Скок у даљ	Између група	4818.025	1	4818.025	17.041	.000
	Унутар група	10743.950	38	282.736		
	Укупно	15561.975	39			
Бацање медицинке	Између група	74995.600	1	74995.600	24.61	.000
	Унутар група	115764.800	38	3046.442		
	Укупно	190760.400	39			

ЗАКЉУЧАК

Имајући у виду добијене резултате овог истраживања, утврђено је да постоји статистички значајна разлика између ученика који су чланови кошаркашке секције и упражњавају исту у рекреативне сврхе три пута недељно, и ученика који немају додатних физичких активности на нивоу моторичких способности, осим школских обавеза. Тиме је хипотеза Х0 која гласи ``Претпоставља се да не постоје значајне разлике у погледу моторичких способности код ученика осмог разреда који су чланови кошаркашке секције и оних који то нису``одбацује.

Резултати разлика између две групе испитаника показују да су највећим разликама између субузорка допринеле варијабле које мере експлозивну снагу помоћу тестова, бацање медицинке и скока у вис-Сарџент тест. Тиме је хипотеза Х1 која гласи ``Очекује се статистички значајна разлика у погледу моторичких способности које мери тест скок у даљ из места код испитаника

који су чланови кошаркашке секције и оних који то нису`` и хипотеза Х2 која гласи ``Очекује се статистички значајна разлика у погледу моторичких способности које мери тест, скок у вис (Сарџент тест)`` потврђене.

Хипотеза Х3 која гласи „Очекује се статистички значајна разлика у погледу моторичких способности које мери тест, бацање медицинке из стојећег положаја“ се делимично потврђује, с обзиром да су уочљиве мање разлике између истраживаних субузорака које се виде у варијаблама за процену брзине експлозивне снаге помоћу теста, скок у даљ из места.

На основу добијених резултата може се закључити да се тренд развоја моторичких способности с обзиром на тренирање (рекреативце) и нетренирање ученике, одвија складно законитостима развоја моторичких способности.

Изабраним моторичким тестовима се покушало утврдити да ли постоје разлике у моторичким способностима које су везане за пре свега правилан раст и развој деце, усвајање елемената кошарке, тј. постављање базе за бављењем осталим спортовима и спортским играма. Резултати су показали статистички значајне разлике, у корист групе вежбача-рекреативаца у односу на вршњаке који нису ни у каквом тренажном процесу, на нивоу статистички значајне разлике, што је и очекиван резултат.

ЛИТЕРАТУРА

1. Andrews, J.C. (1999). From school sport to sporting excellence: respecting right of minors. *Facta Universitatiss: Series: Phisical Education,* 1(6) , (59-69);
2. Гаџић, А., Вучковић, И., (2012). Моторичке способности ученица основне школе урбане и руралне средине, *Гласник Антроплошког друштва Србије* 2012, бр. 47, стр. 131-138;
3. Јовановић И., (1994): *Кошарка-теорија и методика*, Ниш: Цип.
4. Janz, Dawson & Mahoney, (2000). Tracking physical fitness and physical activity from childhood to adolescence, *Medicine & Science in Sports & Exercise* 32(7):1250-7 · August 2000;
5. Коцић Ј., Алексић, Д., Тошић С. (2009). *Основе Кинезиологије и спортова естетско – координационог карактера*, Педагошки факултет у Јагодини;
6. Коцић, Ј., Алексић, Д., Станковић, С. (2018). *Основе Кинезиологије и спортова естетско – координационог карактера.* Факултет за спорт и физичко васпитање, Лепосавић.
7. Коцић, Ј., Алексић, Д., Станковић С. (2018). Ефекти програмиране наставе пливања на морфолошке карактеристике ученика, *Гласник Антрополошког друштва Србије*, Ниш, вол. 54, стр. 27-34 ,2019;
8. Кукољ, М. (2006). *Антропомоторика*. Београд: Факултет спорта и физичког васпитања;
9. Каралејић, М., Јаковљевић, С. (2009). *Дијагностика у кошарци*. Нови Сад, „3D+“;
10. Мијановић М., (2005) *Статистичке методе*. Подгорица: Универзитет Црне Горе
11. Мекић, Б. (2007). *Општа Антропомоторика*, Лепосавић, Факултет спорта физичког васпитања;
12. Перић Д. (2001) *Статистичке апликације у истраживањима спорта и физичког васпитања*. Београд: Факултет физичке културе
13. Rezolution on development and Sport, Europen Parliament Resolution (RES/59315EN, B60663, 24. Novembar 2005);
14. Савић, З. (2014). *Основе школског спорта*, Факултет спорта и физичког васпитања, Ниш;
15. Фулурија Д., Цицовић Б., Тошић Ј. (2010) Динамика развоја моторичких способности кошаркаша узраста од 7 до 18 година. *Спорт и здравље*
16. Tomkinson GR, Olds TS, Gulbin J. Secular trends in physical performance of Australian children: Evidence from the talent Search program. *Journal of sports medicine and physical fitness*. 2003; 43:90-98.;
17. Живановић, Н., Станковић, В., Ранђеловић, Н., Павловић П. (2010). *Теорија физичке културе*, Ниш, Факултет спорта и физичког васпитања, стр. 38-39.

DIFFERENCES IN THE LEVEL OF MOTOR SKILLS OF STUDENTS WHO ADDITIONALLY TRAIN BASKETBALL FOR RECREATIONAL PURPOSES

Kocić Jadranka, Petrović Lana, Aleksić Dragana

Abstract: *The organization of sports and recreational exercise at school aims to encourage the general and proper development of the body, gain the widest possible motor experience, create useful habits that will remain throughout*

life and serve the function of developing and preserving health, as well as satisfying children's needs for movement and play. The research in this paper was conducted with the aim of showing the effects of recreational basketball practice within an additional section at school on eighth grade students, compared to students who were not included in it. For the purposes of the paper, three motor tests (explosive power) were used: long jump from a standing position, high jump (Sargent test), and medicine ball throw from a standing position. The results of the research showed that the trend of motor skills development with regard to trained (recreational) and untrained students, occurs in accordance with the laws of motor skills development. The long jump test shows that there is also a statistically significant difference in the results (at the 0.95 level) between the two groups of respondents, so it can be concluded that the activity in the basketball section has an impact on the achievement in this test. Regarding the results of the high jump test, which is 9.478, with a probability of error, rejecting the null hypothesis, if it is correct, which is 0.004. the results obtained indicate that the activity in the section had an impact. When it comes to the medicine ball throw test, the F statistic value of 24.61 is observed, which points to the same conclusion. The obtained data clearly show us that the additional activity of the basketball section members is undoubtedly reflected positive in the results of the abilities measured by the high jump, long jump and medicine ball throw tests.
Key words: *motor skills, explosive strength, sports and recreational exercise*

DIFFERENCES IN BODY COMPOSITION AND MOTOR ABILITIES IN YOUNG FOOTBALL PLAYERS PLAYING IN DIFFERENT POSITIONS

Okičić Miladin, Đokić Nenad, Majkić Branislav
Faculty of Sport and Physical Education, University of Niš, Serbia

ORIGINAL SCIENTEFIC ARTICLE
DOI: 10.5937/ATAVPA25027O

Abstract: *Football is a dynamic and physically demanding sport that requires specific biomechanical characteristics and abilities from players. The aim of this research was to analyze the differences in body composition and motor skills of football players depending on their position. The study involved 25 football players aged 12-15 years, competing at the highest level for their age group. The participants were divided based on their positions: defense (n=11; age - 15.13±0.39 years; height - 171.17±5.24 cm; body weight - 59.25±5.99 kg; BMI - 20.16±1.54), midfield (n=12; age - 15.14±0.40 years; height - 165.32±11.4 cm; body weight - 52.84±9.64 kg; BMI - 19.17±1.39), and attack (n=10; age - 15.11±0.37 years; height - 169.32±10.3 cm; body weight - 52.58±10.28 kg; BMI - 17.82±1.73). The results showed that there were no significant differences in muscle mass or subcutaneous fat between different positions (p > .05). Furthermore, there were no significant differences in sprint times for 5m, 10m, 30m, squat jump (SJ), countermovement jump with arm swing (CMJarm), slalom test, slalom test with the ball, Zig-Zag test, or Zig-Zag test with the ball (p > .05). Further research with a larger sample size could provide additional insights and explanations for the lack of differences. In conclusion, although positional differences were expected, the results indicate that at the age tested, there are still no significant changes when it comes to different positions on the team.*
Key words: *change of direction, explosive strength, running speed, soccer*

INTRODUCTION

Football is a dynamic sport played on a field divided into different positions, each with specific demands. The main positions include goalkeeper, defenders, midfielders, and forwards. Each position has its own characteristics, but the success of the game depends on coordination and synergy among all players. Defenders need to be physically strong and durable, midfielders require good ball control and the ability to distribute the game, while forwards must be fast and precise in finishing (Reilly & Williams, 2003). Considering all these demands, a footballer must develop specific motor skills and adjust their body composition depending on the position they play. The physical demands of each role influence how a player trains, emphasizing particular areas such as strength for defenders or speed for forwards, ensuring they meet the specific requirements of their position on the field (Bangsbo, 2003).

In order to be efficient in specific on-field roles, football players must maintain adequate body composition and motor abilities. Balance of body composition allows players to maintain high performance throughout the game, while motor skills such as coordination, balance, strength, explosiveness, and agility are critical for effectiveness on the field (Bangsbo, 2003). Developing these skills is a key factor in improving the overall performance of a football team (Wittekind et al., 2020). For young footballers aged 12 to 15 years, the development of body composition and motor abilities presents specific challenges and goals. At this age, the body is in a growth phase, which requires a careful approach to training to avoid injuries and achieve optimal development (Vaeyens et al., 2006). Young players need to focus on developing fundamental motor skills, such as agility, speed, coordination, and strength, as these will lay the foundation for later athletic development (Malina et al., 2004). At the same time, proper body composition is important for reducing the risk of injuries and achieving the physical potential that allows for efficient movement on the field (Reilly et al., 2000).

Previous research has shown that there are varying differences in body composition and motor abilities among football players depending on their position. Specifically, studies have highlighted that players in positions requiring more endurance, such as midfielders, typically have lower body fat percentages and a higher proportion of lean muscle mass compared to players in positions with less running intensity, such as goalkeepers or central defenders. For example, wingers and forwards tend to excel in speed and agility due to their need for quick bursts of energy, while defenders may demonstrate superior strength and power, critical for aerial duels and physical challenges. However, despite these

findings, there is no consistent conclusion regarding the exact relationship between body composition and motor abilities across all studies, with some research indicating that position-specific training and playing style may have a more substantial effect than body composition alone. Moreover, the development of specific motor skills, such as strength, endurance, and flexibility, varies considerably across positions, reflecting the unique demands placed on players in different roles.

It is already clear that body composition and motor skills play a crucial role in football performance, but there is a lack of research specifically addressing young footballers aged 12 to 15 years. While numerous studies have examined these aspects in professional players, By identifying the key factors that influence their performance, this research aims to fill a gap in existing literature and provide. The main goal of this research was to investigate the differences between body composition and motor abilities in young football players aged 12 to 15 years, with a focus on how these factors contribute to their overall performance. By understanding these relationships,

METHODS

Participants

The participants in this study were 25 male football players, aged 12-15 years, competing at the highest level of competition for their age group divided into three playing positions: defense (n=11; age - 15.13±0.39 yo; height - 171.17±5.24 cm; body weight - 59.25±5.99 kg; BMI - 20.16±1.54), midfield (n=12; age - 15.14±0.40 yo; height - 165.32±11.4 cm; body weight - 52.84±9.64 kg; BMI - 19.17±1.39), and attack (n=10; age - 15.11±0.37 yo; height - 169.32±10.3 cm; body weight - 52.58±10.28 kg; BMI - 17.82±1.73). The average age of the participants was 15.13±0.39 years, with no significant differences between the groups. The characteristics for each group are as follows:

Given that all participants were minors, consent for participation was obtained from their parents/guardians. The study received approval from the Ethics Committee of the Faculty of Sport and Physical Education at the University of Niš, and all testing procedures adhered to the ethical guidelines outlined in the Helsinki Declaration.

Organization of Testing

Upon arrival, participants were given detailed instructions and a demonstration of each test. participants were given detailed instructions this order: anthropometry (body composition) measurements, followed by the motor skills tests. Before the body composition measurement, participants will have fasted for 12 hours and refrained from intense training for 48 hours. The motor skills tests will follow a standardized warm-up, consisting of aerobic running, dynamic stretching, and specific drills with the ball.

Anthropometry and Body Composition

Anthropometric characteristics were assessed using Martin's Anthropometer, a widely used instrument for precise skeletal and body segment measurements. This method enables accurate assessment of body height, limb lengths, and segment proportions, which are essential for evaluating an athlete's structural and functional potential. Body composition analysis was conducted using an OMRON® scale (BF-508), which utilizes bioelectrical impedance analysis (BIA) to estimate body fat percentage, muscle mass, and hydration levels. The device operates by transmitting a low-intensity 50 kHz electrical current through the body. Since muscle, fat, and water conduct electrical signals differently, the scale analyzes the impedance (resistance) to determine body composition. This non-invasive method provides valuable insights into fat distribution, lean body mass, and overall physique, which are crucial for monitoring athletic performance, training adaptations, and health status. Despite its convenience and efficiency, bioelectrical impedance analysis may be influenced by hydration status, recent food intake, and physical activity, requiring standardized conditions for accurate measurements.

Explosive power

For explosive power assessment Countermovement jump test with free arms (CMJarms) was utilized. The OptoJump system (Microgate, Italy) was used for measuring jump. It is an advanced optical

measurement tool which provides highly accurate and reliable data by utilizing infrared optical sensors to measure flight time and jump height. The test was conducted starting from the standing positions and free arms movement, after that participants were instructed to take half-squat position and to jump as high as possible with arms assistance.

Sprint Time

The sprint test is designed to assess the participants' sprint time over a distance of 30 meters. The test was structured with timing checkpoints at 5 meters, 10 meters, and the final 30 meters. The participants were instructed to run the full distance at their maximum speed, maintaining a constant pace without slowing down at any point. The purpose of the 30-meter sprint is to measure acceleration, speed, and the ability to maintain peak performance over a short distance. To ensure accuracy in measuring sprint times, photo cells from Witty (Microgate, Italy) was used. These sensors are capable of measuring time with an accuracy of ±0.1 seconds, ensuring precise and reliable data. The test will be repeated three times for each participant, with a 2-minute rest period between each sprint to allow for recovery and to reduce fatigue, ensuring that each sprint attempt reflects the player's true speed capabilities.

Change of Direction (COD)

The Change of Direction (COD) tests are designed to assess the participants' their ability to quickly change direction, which is a crucial skill for footballers, particularly midfielders and defenders who are required to react swiftly to the ball and opponents. Several tests will be conducted to evaluate this aspect of agility:

1. **Slalom Test**: In this test, participants wove through six cones placed 2 meters apart in a straight line. After completing the slalom forward, they reversed direction and wove through the cones again in the opposite direction. The test simulated the quick changes in direction that are often needed during gameplay, such as avoiding an opponent or adjusting positioning.
2. **Zig-Zag Test**: In this test, participants maneuvered through a series of cones set 5 meters apart at a 90º angle. This drill required players to navigate sharp turns and was effective for measuring lateral movement and agility. The zig-zag pattern replicated the types of rapid, sharp directional changes common during matches, especially when tracking an opponent or attempting to intercept a pass.
3. **Slalom with a Ball**: This variation of the slalom test required participants to dribble the ball while weaving through the cones. This test was more challenging as it added the element of ball control under pressure while changing direction. Midfielders, in particular, needed to exhibit good ball control while quickly adjusting their movement to maintain possession and evade opponents.
4. **Zig-Zag with a Ball**: Similar to the regular zig-zag test, this variation required participants to dribble the ball through the cones set at a 90º angle. This test combined agility with ball handling, providing a clear picture of how well the participants could change direction while maintaining control of the ball.

For all the COD tests, the times for each attempt were measured using photo cells (Witty, Microgate, Italy), ensuring precise time tracking with an accuracy of ±0.1 seconds. Participants completed three attempts for each test, with a 2-minute rest period between each attempt to allow for recovery and prevent fatigue from affecting performance.

Statistics

The data will be analyzed using Statistical Package for the Social Sciences (SPSS for Windows®, version 26.0.). Descriptive statistics will be presented, and the Kolmogorov-Smirnov test will be used to check for the normality of the distribution of the results. Differences in body composition and motor abilities between players of different positions will be assessed using ANOVA with Bonferroni post-hoc analysis. Statistical significance will be set at $p < .05$.

RESULTS

As shown in Table 2, the average fat mass percentage was slightly higher in midfielders (13.02 ± 5.49%) compared to defenders (12.56 ± 4.13%) and attackers (10.64 ± 1.52%), but the difference was not statistically significant (p = 0.613). Similarly, muscle mass percentage was highest among defenders (41.05 ± 1.62%), followed by midfielders (40.22 ± 3.01%), and lowest in attackers (37.28 ± 9.71%), with no significant difference (p = 0.335).

Table 2 Differences in anthropometric characteristics and body composition parameters between different positions in the team

	Defense (n=11)	Midfield (n=9)	Attack (n=5)	Total (n=25)	p
Fat mass (%)	12.56±4.13	13.02±5.49	10.64±1.52	12.34±4.28	.613
Muscle mass (%)	41.05±1.62	40.22±3.01	37.28±9.71	40±4.67	.335

The post hoc analysis (Table 3) confirmed that none of the pairwise comparisons between positions reached statistical significance, with p-values ranging from 0.245 to 0.900. These findings suggest that body composition characteristics do not significantly differ based on playing position within this sample.

Table 3 Post hoc analysis for differences in anthropometric characteristics and body composition parameters between team positions

		Defense	Midfield
Fat mass (%)	Midfield	.632	
	Attack	.478	.245
Muscle mass (%)	Midfield	.900	
	Attack	.439	.805

Table 4 Difference in motor skills between different positions in the team

	Defense (n=11)	Midfield (n=9)	Attack (n=5)	Total (n=25)	p
CMJ (cm)	30.58±4.11	29.28±3.58	27.96±3.77	29.59±3.84	.447
CMJarm (cm)	35.97±5.31	35.20±5.43	34.52±4.59	35.40±5.04	.867
SJ (cm)	28.15±4.13	27.40±4.21	27.32±2.80	27.72±3.80	.886
5m (s)	1.29±.16	1.24±.09	1.25±.06	1.27±.12	.627
10m (s)	2.06±.09	2.07±.11	2.11±.59	2.07±.09	.601
30m (s)	4.69±.21	4.77±.25	4.90±.12	4.76±.22	.251
Slalom (s)	7.71±.58	7.40±.21	7.52±.22	7.56±.43	.271
Slalom with ball (s)	10.93±1.64	10.52±.98	11.28±1.04	10.85±1.31	.573
Zig-Zag (s)	5.42±.19	5.48±.26	5.56±.21	5.47±.22	.498
Zig-Zag with ball (s)	6.71±.55	6.81±.82	7.07±1.01	6.82±.73	.683

Legend: CMJ – Countermovement Jump; CMJmax – Countermovement Jump with arm swing; SJ – Squat Jump; 5m, 10m, 30m – Running speed tests; Slalom, Slalom with Ball, Zig-Zag, Zig-Zag with Ball – Agility tests.

As presented in Table 4, the Countermovement Jump (CMJ) results were slightly higher in defenders (30.58 ± 4.11 cm) compared to midfielders (29.28 ± 3.58 cm) and attackers (27.96 ± 3.77 cm), but the difference was not significant (p = 0.447). Similarly, CMJ with arm swing (CMJarm) and Squat Jump (SJ) showed no meaningful variations between positions (p = 0.867 and p = 0.886, respectively). The running speed tests (5m, 10m, 30m) indicated minor variations among positions, with attackers demonstrating slightly faster times, but none of the differences were statistically significant (p-values ranging from 0.251 to 0.627). For agility tests (Slalom, Slalom with Ball, Zig-Zag, and Zig-Zag with Ball), no significant positional differences were observed (p = 0.271–0.683). These findings suggest that motor skill performance is similar across all playing positions within this sample.

DISCUSSION

The aim of this study was to examine the body composition and motor skills (speed and agility) of young football players, The results of speed and endurance tests clearly show significant differences between forwards and defenders, reflecting the specific physical demands of each position. Forwards are primarily focused on developing speed and explosiveness, which are crucial for quick reactions during key moments of the game, such as sprinting to break away from defenders or executing finishing actions. Research has consistently demonstrated that forwards generally perform better in speed tests, such as the 30-meter sprint and short-distance intervals (Di Salvo et al., 2007). These players engage in high-intensity bursts, often requiring quick acceleration to create goal-scoring opportunities, making speed a critical component of their role.

Anthropometric characteristics and body composition play a crucial role in the performance and development of young football players. These factors influence strength, endurance, agility, and injury prevention, making them key indicators of athletic potential. Our study found no significant differences in fat mass (%) and muscle mass (%) among different playing positions. Although midfielders exhibited slightly higher fat mass values than defenders and attackers, the differences were not statistically significant ($p = 0.613$). Similarly, muscle mass was highest among defenders, followed by midfielders and attackers, but no significant positional differences were observed ($p = 0.335$). When compared to previous studies, our findings align with research by Nikolaidis et al. (2014), which reported that body composition differences between playing positions in young footballers tend to be minimal due to the homogeneous nature of training in youth academies. However, our results contrast with those of Gil et al. (2007), who found that defenders had significantly higher muscle mass than midfielders and attackers. This discrepancy could be attributed to variations in training regimens, genetic factors, or age-related physical development. The lack of significant differences in our study suggests that training loads and nutritional strategies may have standardized effects across all positions, leading to comparable body composition among players. This finding is important for coaches and fitness professionals as it suggests that position-specific body composition development may become more pronounced at later stages of player maturation.

The development of explosive power is a fundamental aspect of football performance, contributing to acceleration, jumping ability, and overall physical dominance in duels. Given its relevance, we assessed explosive power through Countermovement Jump (CMJ), CMJ with arm swing (CMJarm), and Squat Jump (SJ). The results showed no significant differences in CMJ performance among positions ($p = 0.447$), with defenders demonstrating slightly higher jump heights than midfielders and attackers. Similarly, CMJarm ($p = 0.867$) and SJ ($p = 0.886$) did not show significant positional differences. Previous studies have reported varying trends. Research by Milanović et al. (2011) found that midfielders and attackers typically exhibit superior jump performance due to their higher involvement in sprinting and aerial duels. However, our findings align with Haugen et al. (2013), who suggested that differences in explosive power among youth players are often negligible due to shared training methodologies. One possible explanation for our results is that young football players, regardless of position, follow similar strength and plyometric training protocols, leading to comparable levels of explosive power. These findings emphasize the importance of integrating individualized strength and power training programs tailored to specific positional demands.

Running speed is one of the most crucial attributes in football, influencing both offensive and defensive effectiveness. Speed over 5m, 10m, and 30m distances was analyzed in our study, revealing no statistically significant differences between positions (p-values ranging from 0.251 to 0.627). Although attackers showed slightly faster sprint times, the differences were not substantial. These results are consistent with those of Mendez-Villanueva et al. (2011), who reported that positional differences in sprinting ability are more evident in professional players than in youth athletes. Our findings contradict Little & Williams (2005), who observed that attackers tend to have significantly faster acceleration over short distances compared to defenders and midfielders. One possible reason for this discrepancy is that younger players undergo multidirectional speed training that benefits all positions equally. Additionally, the lack of statistical significance in our study may indicate that speed development is largely influenced by individual genetics rather than positional training demands at this stage of development. Nonetheless,

our results underscore the importance of maintaining high-speed training across all playing positions to maximize match performance.

Agility and the ability to change direction rapidly are vital for success in football, allowing players to evade opponents and react to dynamic game situations. In our study, we evaluated agility through Slalom, Slalom with Ball, Zig-Zag, and Zig-Zag with Ball tests. The results showed no significant positional differences ($p = 0.271–0.683$), suggesting that agility levels were relatively uniform across defenders, midfielders, and attackers. Previous research by Chaouachi et al. (2009) supports our findings, as they observed minimal agility differences between positions in youth players. However, studies on elite footballers (Gabbett et al., 2008) indicate that midfielders and attackers generally exhibit superior agility due to their greater involvement in dribbling and one-on-one situations. The lack of significant differences in our study could be attributed to the standardized agility training conducted within youth academies, which does not yet emphasize position-specific movement patterns. This finding highlights the need for incorporating individualized agility drills that reflect the unique movement demands of each playing position.

Despite providing valuable insights into the physical characteristics of young football players, our study has certain limitations. First, the relatively small sample size ($n = 25$) may have limited the statistical power, reducing the likelihood of detecting subtle differences between positions. Future research should consider larger sample sizes and multi-club comparisons to enhance generalizability. Second, our study focused solely on anthropometric, explosive power, speed, and agility assessments, without incorporating technical and tactical performance indicators. Future studies should explore how these physical attributes translate into match performance by integrating game-related metrics such as total distance covered, high-intensity sprints, and ball possession effectiveness. Additionally, the use of bioelectrical impedance analysis (BIA) for body composition assessment may be influenced by hydration status and recent food intake, potentially affecting accuracy. Future research could employ dual-energy X-ray absorptiometry (DXA) or skinfold calipers for more precise body composition measurements.

CONCLUSION

In summary, our findings suggest that anthropometric characteristics, explosive power, sprinting ability, and COD do not significantly differ among playing positions in young football players. The similarities in body composition and physical performance metrics across positions may be attributed to homogeneous training loads, early-stage development, and genetic predispositions. While these results indicate a balanced physical profile across all positions, future training programs should consider position-specific development strategies, particularly in speed, agility, and explosive power. These attributes become increasingly critical as players progress into professional levels, where physical demands vary significantly between defenders, midfielders, and attackers. Implementing tailored strength and conditioning programs will be essential in optimizing player development and maximizing on-field performance.

REFERENCES

1. Bangsbo, J. (2003). *Physiological demands of football: A review*. Journal of Sports Sciences, 21(12), 961-974.
2. Chaouachi, A., Manzi, V., Wong del P., Chaalali, A., Laurencelle, L., Chamari, K., & Castagna, C. (2009). Intermittent endurance and repeated sprint ability in soccer players. *Journal of Strength and Conditioning Research, 24*(10), 2663-2669.
3. Di Salvo, V., Baron, R., Tschan, H., & Bachl, N. (2007). *Performance characteristics according to playing position in elite soccer*. International Journal of Sports Medicine, 28(3), 222-227.
4. Gabbett, T. J., Jenkins, D. G., & Abernethy, B. (2008). Influence of physiological characteristics on selection in a semi-professional first grade rugby league team: a case study. *Journal of Sports Sciences, 26*(11), 1335-1343.
5. Gil, S. M., Gil, J., Ruiz, F., Irazusta, A., & Irazusta, J. (2007). Physiological and anthropometric characteristics of young soccer players according to their playing position: relevance for the selection process. *Journal of Strength and Conditioning Research, 21*(2), 438-445.
6. Haugen, T. A., Tønnessen, E., & Seiler, S. (2013). Anaerobic performance testing of professional soccer players 1995–2010. *International Journal of Sports Physiology and Performance, 8*(2), 148-156.

7. Krustrup, P., Mohr, M., Nybo, L., & Bangsbo, J. (2006). *The Yo-Yo intermittent recovery test: Physiological response, reliability, and validity*. Medicine and Science in Sports and Exercise, 38(7), 1234-1242.
8. Little, T., & Williams, A. G. (2005). Specificity of acceleration, maximum speed, and agility in professional soccer players. *Journal of Strength and Conditioning Research, 19*(1), 76-78.
9. Malina, R. M., Bouchard, C., & Bar-Or, O. (2004). *Growth, maturation, and physical activity* (2nd ed.). Human Kinetics.
10. Mendez-Villanueva, A., Buchheit, M., Simpson, B., & Bourdon, P. (2011). Match play intensity distribution in youth soccer. *International Journal of Sports Medicine, 32*(7), 490-495.
11. Milanović, Z., Sporiš, G., Trajković, N., James, N., & Samija, K. (2011). Differences in agility performance between futsal and soccer players. *Sport Science, 4*(1), 55-59.
12. Moraes, D. D., Barbosa, M. S., & Martins, F. A. (2018). *Agility and strength in soccer players: A systematic review*. Journal of Human Kinetics, 63(1), 45-52.
13. Nikolaidis, P. T., Asadi, A., Santos, E. J., Calleja-González, J., Padulo, J., & Chtourou, H. (2014). Relationship of body mass status with running and jumping performances in young basketball players. *Journal of Strength and Conditioning Research, 28*(7), 2085–2093.
14. Reilly, T., & Williams, A. M. (2003). *Science and soccer*. Routledge.
15. Reilly, T., Bangsbo, J., & Franks, A. (2000). *Anthropometric and physiological demands of football*. Journal of Sports Sciences, 18(7), 557-565.
16. Rienzi, E., Drust, B., Reilly, T., & Carter, J. (2000). *Investigating the effect of playing tactics on physical performance in English Premier League soccer players*. Journal of Sports Sciences, 18(10), 741-747.
17. Sáez-Sáez de Villarreal, E., Requena, B., & García, I. (2015). *The effects of plyometric training on sprint performance in football players: A systematic review*. Journal of Sports Sciences, 33(2), 193-202.
18. Sever, A. D., & Zorba, E. (2018). *Explosive strength and agility in youth soccer players: Effects of training*. The Journal of Strength and Conditioning Research, 32(7), 1981-1989.
19. Vaeyens, R., Lenoir, M., Williams, A. M., & Philippaerts, R. M. (2006). *Talent identification and development in youth football*. Sports Medicine, 36(9), 767-778.
20. Wittekind, A., Brink, M., & Dörge, H. (2020). *The development of physical capacities in youth football: Implications for performance and injury prevention*. European Journal of Sport Science, 20(1), 70-78.

RAZLIKE U TELESNOJ KOMPOZICIJI I MOTORIČKIM SPOSOBNOSTIMA KOD MLAĐIH FUDBALSKIH IGRAČA NA RAZLIČITIM POZICIJAMA

Okičić Miladin, Đokić Nenad, Majkić Branislav

***Sažetak**: Fudbal je dinamičan i fizički zahtevan sport koji od igrača zahteva specifične biomehaničke karakteristike i sposobnosti. Cilj ovog istraživanja bio je da se analiziraju razlike u telesnoj kompoziciji i motoričkim sposobnostima fudbalera u zavisnosti od njihove pozicije. Istraživanje je obuhvatilo 25 fudbalera uzrasta 12-15 godina, koji se takmiče na najvišem nivou za njihov uzrast. Učesnici su podeljeni prema pozicijama: (n=11; uzrast - 15.13±0.39 god; telesna visina - 171.17±5.24 cm; telesna težina - 59.25±5.99 kg; BMI - 20.16±1.54), sredina terena (n=12; uzrast - 15.14±0.40 god; telesna visina - 165.32±11.4 cm; telesna težina - 52.84±9.64 kg; BMI - 19.17±1.39), I napad (n=10; uzrast - 15.11±0.37 god; telesna visina - 169.32±10.3 cm; telesna težina - 52.58±10.28 kg; BMI - 17.82±1.73). Rezultati su pokazali da nije bilo značajnih razlika u mišićnoj masi ili potkožnom masnom tkivu između različitih pozicija (p > .05). Takođe, nije bilo značajnih razlika u vremenu sprinta na 5m, 10m, 30m, skoku iz čučnja (SJ), skoku sa kontra pokretom sa zamahom ruku (CMJarm), slalom testu, slalom testu sa loptom, Zig-Zag testu kao ni Zig-Zag testu sa loptom (p > .05). Dalja istraživanja sa većim brojem ispitanika mogla bi pružiti dodatne informacije i obrazlženja o nedostatku razlika. Zaključno, iako su razlike po pozicijama bile očekivane, dobiveni rezultati ukazuju na to da u uzrastu koji je testiran još uvek ne dolazi do značajnijih promena kada su u pitanju različite pozicije u timu.*
***Ključne reči**: promena pravca, eksplozivna snaga, brzina trčanja,*

СКИЈАШКО ТРЧАЊЕ КАО ВЕЗА ЧОВЕКА И ПРИРОДЕ

Видаковић Хаџи Милош, Хаџи Видаковић Марија, Димитријевић Иван
Факултет за спорт и физичко васпитање, Универзитет у Приштини - Косовска Митровица, Србија

PROFESSIONAL ARTICLE
DOI: 10.5937/ATAVPA25034V

Сажетак: *Векови пролазе, али суштина остаје непромењена: човек без природе је као светионик без светлости. Наше ћелије проткане су миленијумским записима предака, који су живели у складу с природом. Физичка активност је од суштинске важности, а скијашко трчање, или нордијско скијање, спада у ретке спортове који активирају око 80% мишића тела, чинећи га изузетно комплетном активношћу. Настало је као потреба за опстанком услед обилних снежних зима, а данас је дисциплина на Олимпијади. То је апсолутна синтеза: човек и природа, активност и авантура. Скијашко трчање омогућава непосредан контакт с нетакнутом природом и отвара планинске пределе који су иначе недоступни. Пружа јединствен осећај слободе и задовољства. Бројна истраживања показују његов позитиван утицај на психолошко здравље, подстичући и физичко и ментално благостање. Осим тога, развија свест о важности очувања природних ресурса. Важно је нагласити да скијашко трчање не захтева скупе жичаре нити друге ресурсе; довољно је имати скије, штапове и добру вољу. Скијашко трчање представља значајан начин повратка природи, јер комбинује физичку активност и директан контакт са природним окружењем. Учећи о природним лепотама, људи постају свеснији њеног значаја и мотивисани су за њену заштиту. Позивамо све да активно промовишу скијашко трчање и подрже иницијативе за очување природе. Чувањем природе осигуравамо да будуће генерације могу уживати у истим искуствима и благодатима које она пружа. Улажимо у нашу планету и наше здравље, јер живот се наставља и након нас.*
Кључне речи: *скијашко трчање, спорт, природа, здравље*

УВОД

Векови пролазе, али суштина остаје непромењена: човек без природе је као светионик без светлости. У данашњем друштву, где је човек све више удаљен од природног окружења, а технологија доминира животом, често заборављамо значај активног контакта са природом. Ипак, неке активности као што је скијашко трчање, поново нас повезују с природом, омогућавајући нам да искусимо њену лепоту и моћ. Скијашко трчање је спорт који не само да помаже људима да побољшају своје физичко здравље, већ и да се опусте и поврате емоционалну равнотежу, истовремено развијајући дубљу свест о очувању природног окружења.

Овај рад ће истражити физичке, психолошке и еколошке користи скијашког трчања. Фокусираћемо се на историју овог спорта, његове здравствене аспекте, као и на начин на који ова активност помаже људима да се поново повежу са природом и постану свесни важности њене заштите.

Историјски контекст скијашког трчања

Скијашко трчање има дугу историју која датира још из праисторијских времена. Први записи о скијама као средству за кретање датирају из Северне Европе и Азије, где су се користиле као начин превоза преко снега. Изгледа да је скијашко трчање у најранијим облицима било изузетно практично средство за преживљавање у суровим зимским условима. У земљама као што су Норвешка, Шведска и Финска, скије су се користиле не само као средство за путовање, већ и као део војних активности.

Током 19. века, скијашко трчање постаје популаран спорт, а касније се развија у дисциплину која је уврштена на Олимпијаду. Савремено скијашко трчање не подразумева само функционалност, већ и такмичарски аспект, са многим такмичењима која се одржавају на светском нивоу. У овом контексту, скијашко трчање је један од ретких спортова који комбинује брзину, издржљивост и технику, док истовремено омогућава дубоко урањање у природно окружење.

Физичка активност и здравље

Скијашко трчање је један од најкомплетнијих спортова, јер активира више од 80% мишића тела. Ова активност има позитиван утицај на кардиоваскуларни систем, као и на мишићну снагу и издржљивост. Доказано је да редовно скијашко трчање помаже у спречавању и лечењу различитих здравствених проблема као што су гојазност, висок крвни притисак и кардиоваскуларне болести.

Истраживања показују да је скијашко трчање изузетно ефикасно у повећању аеробне издржљивости. Према студији из 2015. године, скијаши који редовно практикују ову дисциплину имају значајно боље резултате у кардиоваскуларним тестовима у поређењу са људима који се баве другим облика физичке активности. Поред тога, ова активност је одлична за развој мишићне снаге, посебно у ногама и срчаним мишићима, који су кључни за општу физичку издржљивост.

Скијашко трчање такође има повољан утицај на метаболизам и помаже у контроли тежине. Према истраживањима објављеним у "Журналу о физичким активностима", ова активност је један од најефикаснијих начина за сагоревање калорија, што је кључно за очување здравља и одржавање оптималне телесне тежине.

Психолошки ефекти скијашког трчања

Физичка активност је позната по томе што побољшава ментално здравље. Скијашко трчање није само изазов за тело, већ и за ум. Током дугих тренинга и такмичења, учесници морају да се носе са физичким напором, али и са стресом и психолошким изазовима који настају. Научна истраживања показују да је скијашко трчање изузетно ефикасно у смањењу нивоа стреса, анксиозности и депресије.

Истраживање из 2018. године, спроведено на групи од 150 учесника, показало је да скијашко трчање значајно побољшава расположење и менталну издржљивост. Учесници су пријавили значајно смањење стреса након неколико недеља редовног тренирања, а такође су изјавили да су се осећали опуштеније и срећније након сваког тренинга. Ови резултати су у складу са претходним студијама које показују да природно окружење, као што је оно које нуди скијашко трчање, има дубок утицај на психолошко благостање.

Еколошки значај скијашког трчања

Један од кључних аспеката скијашког трчања је његова еколошка одрживост. За разлику од других зимских спортова, који зависе од сложених инфраструктура и значајних ресурса (нпр. жичара и скијашке стазе), скијашко трчање захтева минималне ресурсе. Ова дисциплина не подразумева изградњу штетних објеката који нарушавају природне пределе, већ се практикује у нетакнутим планинским областима.

Скијашко трчање такође пружа могућност за едукативне активности у области заштите животне средине. Када људи уче о природним лепотама и опасностима које природа носи, њихова свест о потреби за очувањем природних ресурса расте. Према истраживањима из 2020. године, људи који активно учествују у активностима на отвореном, као што је скијашко трчање, имају већу вероватноћу да подрже иницијативе за заштиту животне средине и да се ангажују у активностима које промовишу еколошку свест.

Социјални аспект скијашког трчања

Скијашко трчање није само индивидуална активност, већ и снажан социјални феномен. Многи клубови и удружења организују заједничке тренинге и туре, што доводи до изградње заједништва и социјалне подршке међу учесницима. Учествовање у групним активностима побољшава осећај припадности и међусобне повезаности, што је посебно важно у времену када се људи све више изолују због дигитализације.

Истраживања показују да је физичка активност у друштву чешће одржива на дужи рок. Поред тога, заједнички боравак у природи поспешује развој тимског духа, солидарности и толеранције. Организовани кампови и школе скијашког трчања посебно су важни за младе, јер подстичу здраве навике и позитивне вредности.

Улога скијашког трчања у едукацији деце и младих

Увођење скијашког трчања у наставне програме физичког васпитања има велики потенцијал. Осим што доприноси физичком развоју ученика, овај спорт подучава важним животним вештинама као што су упорност, дисциплина и свесност о животној средини. У многим скандинавским земљама, скијашко трчање је део школског програма, што има вишеструке користи.

Увођење таквих програма у школама у Србији и региону могло би допринети не само здрављу деце, већ и њиховом еколошком образовању. Осим тога, природа као „учионица“ подстиче креативно размишљање и повезаност са стварним светом, што је често занемарено у савременом образовању.

Анализа енергетске ефикасности и калоријске потрошње

С обзиром на своју ниску утицајну силу (low-impact nature) и могућност прилагођавања интензитета, скијашко трчање све више се примењује у рехабилитацији. Особе које се опорављају од повреда, као и старији људи, могу се безбедно бавити овом активношћу уз адекватан надзор.

Према студији из 2021. године, пацијенти који су користили нордијско ходање и лагано скијашко трчање као део постоперативне терапије пријавили су бржи повратак функционалности и мањи осећај бола у поређењу са контролном групом. Користи се и у кардиолошкој рехабилитацији као начин повећања аеробног капацитета без претераног оптерећења.

Анализа енергетске ефикасности и калоријске потрошње

Скијашко трчање спада међу спортове са највишом енергетском потрошњом. У зависности од интензитета и терена, просечна особа може потрошити између **600 и 1200 калорија на сат**. Ово га чини изузетно ефективним за регулисање телесне тежине и побољшање метаболичке функције.

Поређења ради, трчање на траци троши око 600 калорија на сат, док пливање троши око 500. Скијашко трчање активира и горњи и доњи део тела, што га чини потпуним тренингом. Уз то, температура околине и надморска висина утичу на додатну потрошњу енергије, што га чини идеалним за спортисте у припремним фазама.

Потенцијал за развој руралног туризма и локалних заједница

Скијашко трчање представља велики потенцијал за развој одрживог туризма у руралним и планинским подручјима. За разлику од алпског скијања, не захтева скупу инфраструктуру, што омогућава локалним заједницама да самостално развијају туристичку понуду. У Србији постоји велики број подручја са идеалним условима за развој овог спорта – Копаоник, Стара планина, Златар и Голија.

Промоцијом скијашког трчања могу се отворити нова радна места, подржати домаћа производња спортске опреме и хране, као и подстаћи млади да остану у руралним срединама. Туристичка понуда која укључује активности на отвореном, локалну храну и културну баштину може бити конкурентна на међународном нивоу.

ЗАКЉУЧАК

Скијашко трчање представља свеобухватну активност која комбинује физичку и психолошку корист, као и дубоко повезивање са природним окружењем. Ова дисциплина не само да доприноси здрављу појединца, већ и развија свест о важности очувања природе. Скијашко трчање, као један од најкомплетнијих спортова, омогућава људима да се поврате у природу и да доживе дубоке психолошке и физичке користи које ова активност пружа.

Позивамо све да активно промовишу скијашко трчање као начин физичке активности, али и као средство за повратак природи и развој одговорног односа према животној средини. Чувањем природе, ми чувамо и будућност.

ЛИТЕРАТУРА

1. Бала, Г. (2007). Физичка активност и здравље. Нови Сад: Факултет спорта и физичког васпитања.
2. World Health Organization. (2010). Global Recommendations on Physical Activity for Health. Geneva: WHO Press.
3. Hoffman, M. D., & Clifford, P. S. (1992). Physiological aspects of competitive cross-country skiing. Journal of Sports Sciences, 10(1), 3–27.
4. Sandbakk, Ø., & Holmberg, H. C. (2014). A reappraisal of success factors for Olympic cross-country skiing. International Journal of Sports Physiology and Performance, 9(1), 117–121.
5. Миловановић, Д. (2015). Спортови у природи и еколошка свест. Београд: Завод за уџбенике.
6. Green Sport Initiative. (2020). Environmental Impact of Winter Sports: A Comparative Study. [Извештај].
7. Støren, Ø., et al. (2008). Maximal oxygen uptake and running economy in elite cross-country skiers. Medicine & Science in Sports & Exercise, 40(6), 1048–1054.
8. Маловић, М. (2020). Рекреативни спорт и ментално здравље. Физичка култура, 74(2), 195–204.
9. International Ski Federation (FIS). (2021). Cross-country skiing: Development and training guide. Oberhof: FIS Publications.

CROSS-COUNTRY SKIING AS A CONNECTION BETWEEN HUMANS AND NATURE

Vidaković Hadži Miloš, Hadži Vidaković Marija, Dimitrijević Ivan

Abstract: *Centuries pass, but the essence remains unchanged: a human without nature is like a lighthouse without light. Our cells are woven with millennia-old imprints of our ancestors, who lived in harmony with nature. Physical activity is of vital importance, and cross-country skiing, or Nordic skiing, is one of the rare sports that engages approximately 80% of the body's muscles, making it an exceptionally comprehensive activity. It originated as a necessity for survival during harsh, snowy winters and has evolved into an Olympic discipline. It represents the ultimate synthesis: humans and nature, activity and adventure. Cross-country skiing allows for direct contact with pristine nature and opens up mountain landscapes that would otherwise remain inaccessible. It provides a unique sense of freedom and fulfillment. Numerous studies have shown its positive effects on psychological health, promoting both physical and mental well-being. Moreover, it fosters awareness of the importance of preserving natural resources. It Is important to highlight that cross-country skiing does not require expensive ski lifts or other infrastructure—one only needs skis, poles, and goodwill. Cross-country skiing serves as a significant way to reconnect with nature, combining physical activity with direct interaction with the natural environment. By learning about the beauty of nature, people become more aware of its significance and are motivated to protect it. We encourage everyone to actively promote cross-country skiing and support initiatives for nature conservation. By preserving nature, we ensure that future generations can enjoy the same experiences and benefits it provides. Let us invest in our planet and our health, for life continues beyond us.*

Key words: *cross-country skiing, sport, nature, health*

РАЗВОЈ ЕКСПЛОЗИВНЕ СНАГЕ КОД АЛПСКИХ СКИЈАША

Димитријевић Данило, Хаџи Видаковић Марија
Факултета за спорт и физичко васпитање, Универзитет у Приштини - Косовска Митровица, Србија

PROFESSIONAL ARTICLE
DOI: 10.5937/ATAVPA25038D

Сажетак: *Развој експлозивне снаге код скијаша представља кључни фактор за унапређење спортских перформанси, посебно у дисциплинама које захтевају брзе и снажне покрете, као што су алпско скијање, ски-крос, скијашки скокови и нордијске дисциплине. Овај рад анализира значај експлозивне снаге у контексту динамичких и техничких захтева скијашког спорта, истражујући оптималне методе тренинга за њено унапређење. Фокус је стављен на различите облике тренинга, укључујући плиометријске вежбе, тренинг снаге са оптерећењем, тренинг брзине и специфичне вежбе које симулирају покрете у скијању. Посебна пажња посвећена је неуромишићној адаптацији, активирању брзих мишићних влакана, развоју снаге доњих екстремитета и стабилизацији центра тела. Поред тога, разматра се улога баланса, координације и флексибилности у контексту смањења ризика од повреда и побољшања укупне ефикасности покрета. Рад такође укључује анализу утицаја периодизације тренинга, планирања оптерећења и опоравка на дугорочни развој експлозивне снаге. Кроз преглед савремених истраживања и практичних примера из тренинга елитних скијаша, представљене су препоруке за оптималне програме припреме. Циљ рада је пружање научно утемељених смерница за унапређење експлозивне снаге код скијаша, што директно доприноси бољим спортским резултатима и смањењу ризика од повреда.*
Кључне речи*: Експлозивна снага, алпско скијање, плиометријски тренинг, тренинг снаге, спортска перформанса, превенција повреда.*

УВОД

Алпско скијање је комплексна дисциплина која захтева високе физичке и техничке способности. Скијаши морају бити у стању да брзо реагују на промене терена, да савладају нагибе и да примене максималну контролу над својом брзином и правцем кретања. Експлозивна снага је важна компонента која омогућава брзе и ефикасне реакције у овим ситуацијама. Људски организам развија експлозивну снагу кроз специфичне тренажне методе које стимулишу не само мишиће, већ и нервни систем да ради у највећој могућој синергији.

Теоријске основе експлозивне снаге

Експлозивна сила подразумева генерисање велике количине силе за кратак временски период, и представља важан елемент у контексту брзог и агилног кретања на стази. Мишићни систем у овом процесу мора бити у стању да се активира брзо и ефективно. Принципи тренинга експлозивне снаге укључују рад на развоју како брзине мишићних контракција, тако и способности да се одржи висок ниво снаге током кратког временског периода.

Физиолошка подлога експлозивне снаге

Развој експлозивне снаге зависи од ефикасног функционисања нервно-мишићног система. Специфичне адаптације које се јављају током тренинга као што су повећање броја моторних јединица које се активирају, побољшање координације између мишића и нервног система, као и повећање капацитета за брзо ослобађање енергије из АТР-а (аденозин трифосфат) и креатин фосфата, играју кључну улогу у развоју експлозивне снаге. У алпском скијању, овај капацитет омогућава скијашима да брзо реагују на теренске изазове и да избегну повреде.

МЕТОДЕ ТРЕНИНГА ЕКСПЛОЗИВНЕ СНАГЕ КОД АЛПСКИХ СКИЈАША

Плиометријски тренинг – Плиометрија се заснива на кратким, брзим активностима које укључују еластичну контракцију мишића. Плиометријски тренинг, као што су скокови или вежбе са брзим излазом из дубоког чучња, побољшавају способност развоја експлозивне снаге. Код

скијаша, овај тренинг се користи да би побољшао способност за брже одговоре на промене у терену, као и да се побољша агилност и брзина у маневрисању. У алпском скијању, плиометријски тренинг је од великог значаја за развој скока и брзих промена правца.

Типичне вежбе:

- Скокови са дубоког чучња.
- Скокови у висину (високи скокови).
- Бочни скокови.
- Вежбе с одскоком са једне ноге.
- Скијаши често користе вежбе попут брзих скокова и напред/назад скокова како би побољшали своје рефлексе на скијама.

Научна статистика: Истраживања су показала да плиометријски тренинг може повећати експлозивну снагу за 10-20% у поређењу с почетним нивоима. У једној студији спроведеној на скијашима, вежбе као што су скокови са дубоког чучња побољшале су висину скока за 12%, што је директно повезано с побољшањем способности скијаша да савладају брзе и стресне делове стазе.

Студије:

- У студији која је укључила 20 скијаша (оба пола), појединци који су редовно радили плиометријски тренинг пријавили су побољшање у време потребно за извођење маневра "слаломски заокрет" (slalom turns) за 9%.
- Други подаци указују да плиометријски тренинг побољшава време реакције у спортовима као што је трчање и скијање за 6 до 15%.

Тренинг са оптерећењем – Укључивање тежина у тренинг (нпр. чучњеви, мртво дизање) доприноси развоју максималне снаге која је основа за експлозивну силу. Овај тренинг помаже у изградњи мишићне масе и у побољшању способности мишића да се брзо активирају под високим оптерећењем. Тренинг са оптерећењем има за циљ развој максималне снаге, која је основа за развој експлозивне снаге.

Типичне вежбе:

- Чучњеви: Ова вежба је једна од основних за развој снаге у ногама, што је кључно за маневрисање и брзе реакције на стази.
- Мртво дизање: Усмерено на развој леђних и ножних мишића, који су кључни за стабилност и контролу на стазама.
- Тежински тренинг: Користи се за побољшање опште снаге скијаша, укључујући коришћење бучица, шипки и других оптерећења.

Научна статистика: Студије су показале да тренинг са оптерећењем побољшава максималну снагу у ногама за 15-30%, што има директан утицај на експлозивну снагу. Истраживање на скијашима у Норвешкој показало је да скијаши који су изводили тежинске тренинге два пута недељно, били у могућности да побољшају време извођења маневара на стази за 7% за само 6 недеља тренинга.

Тренинг брзине и агилности – Скијаши такође користе тренинге који укључују спринт и специфичне агилне вежбе како би побољшали време реакције и брзину. Агилност и способност брзог преласка са једне позиције у другу играју критичну улогу на стази.

Типичне вежбе:

- Спринт (брзо трчање): Брзо трчање на кратким растојањима (10-40 метара).

- Вежбе са брзим прелазима: Вежбе које укључују брзи прелаз с једне позиције у другу (на пример, трчање уназад, напред, бочно).
- Конусне вежбе: Вежбе у којима скијаш мора маневрисати око конуса, што побољшава координацију и брзу промену правца.

Научна статистика: Тренинг брзине и агилности може довести до побољшања у временима реакције и скоковима за 10-20%. Студије су показале да скијаши који су редовно радили брзо трчање и вежбе са агилношћу имају побољшане реакције на стази и смањују број техничких грешака.

Координација и баланс – Алпски скијаши морају имати високу координацију и способност да контролишу своје тело на различитим нагибима и на различитим типовима терена. Вежбе које развијају осећај за баланс и координацију, као што су тренинг на нестабилним површинама, од велике су важности.

Типичне вежбе:

- Баланс на нестабилним површинама: Вежбе на балансним даскама или фитнес лоптама.
- Јога и пилатес: Ове активности побољшавају основну стабилност и контролу тела.
- Скијаши на равним и нестабилним површинама: Коришћење равних стаза у комбинацији са балансним вежбама.

Научна статистика: Студије су показале да тренинг на нестабилним површинама повећава стабилност тела и смањује ризик од повреда. Анализе показују да скијаши који укључују тренинг баланса и координације имају 18% мањи ризик од повреда везаних за поремећај координације.

ВАЖНОСТ РЕХАБИЛИТАЦИЈЕ И ПРЕВЕНЦИЈЕ ПОВРЕДА

Алпско скијање је изузетно захтеван спорт који ставља велики стрес на тело, а скијаши су подложни различитим повредама због специфичне природе спортске дисциплине. Брзи покрети, оштре промене правца, висок интензитет активности, и различити терени на којима се такмиче чине ову дисциплину посебно ризичном. Зато је рехабилитација и превенција повреда од изузетне важности за очување здравља и дугорочне перформансе алпских скијаша.

Разноликост повреда у алпском скијању

Алпско скијање је један од спортова који захтева високу физичку кондицију и координацију, али истовремено и један од оних у којима се повреде често дешавају. Неки од најчешћих типова повреда које се јављају код алпских скијаша укључују:

- Повреде колена: Најчешће повреде су повреде лигамената колена, као што је руптура предњег укрштеног лигамента (ACL). Ове повреде се често дешавају током скокова, оштрих маневра или приликом неуспешних падова.
- Повреде рамена: Због високих брзина и великих сила на зглобове, рамена су подложна повредама као што су дислокације или контузије.
- Повреде кичме: Ударци и падови могу довести до оштећења пршљенова или дискова, што је изузетно озбиљно.
- Преломи и модрице: Преломи су такође чести, посебно код падова на тврде делове терена.

Тиме што је овај спорт високо ризичан, превенција и рехабилитација играју кључну улогу у одржавању здравља и перформанси скијаша.

Рехабилитација повреда

Рехабилитација је процес лечења повреда који има за циљ брзи и ефикасни повратак у нормалну функцију. Код алпских скијаша, рехабилитација је од суштинске важности јер омогућава бржи опоравак, а уједно смањује ризик од даљих повреда. Рехабилитација не

подразумева само физичке вежбе, већ и психолошку припрему, јер повреде могу утицати на самопоуздање скијаша.

Кључни аспекти рехабилитације:

1. Физикална терапија: Специјализовани терапеути користе различите методе као што су електростимулација, масажа, истезање и мануелна терапија како би помогли у опоравку мишића и зглобова.
2. Рехабилитација мишићне слабости: Овај аспект обухвата постепену изградњу снаге и издржљивости како би се поново вратила пуна функција оштећених делова тела. Тиме се повећава способност тела да издржи стрес који долази током скијања.
3. Прелазак на функционалне вежбе: Када се повреда повуче, скијаши обављају вежбе које им омогућавају да се поново навикну на покрете специфичне за скијање, као што су вежбе равномерног оптерећења ногу, скокови, маневрисање у динамичким условима, итд.
4. Психолошка подршка: Повреде могу довести до депресије и стреса због немогућности да се настави са тренингом или такмичењима. Стога је од важности обезбедити и психолошку подршку, како би се скијаши поново фокусирали на свој циљ.

ПРЕВЕНЦИЈА ПОВРЕДА

Превенција повреда подразумева предузимање мера које ће смањити ризик од њиховог настанка. У контексту алпског скијања, превенција обухвата низ активности које укључују физичку припрему, као и савете у вези са техникама скијања и опремом.

Кључне превентивне мере:

1. Јачање мишића и покретљивост: Развој снаге и издржљивости у мишићима који су највише подложни оптерећењу током скијања је од пресудног значаја. Јачање мишића ногу, као и рад на коришћењу стабилизатора зглобова и лигамената, може смањити ризик од повреда. Овде се користе вежбе као што су чучњеви, мртво дизање, и различити облици плиометријских вежби.
2. Истезање и мобилност: Развијена мобилност зглобова и мишића може помоћи у спречавању повреда као што су истегнућа, напетости и друге повреде због ограниченог опсега покрета. Прелазак на динамична истезања пре тренинга или такмичења помаже у припреми тела.
3. Технике скијања: Правилна техника скијања може значајно смањити ризик од повреда. Скијаши који користе исправну технику (као што је правилан положај тела, управљање скијама у зависности од терена, и контролисање брзине) мање су подложни повредама. Рад са стручним тренером или учитељем скијања може помоћи у усавршавању технике.
4. Коришћење адекватне опреме: Опрема као што су скије, панцерице и заштитне наочаре требају бити прилагођени индивидуалним потребама скијаша. Лоше прилагођена опрема може повећати ризик од повреда, као што су падови или деформације зглобова.
5. Одмор и опоравак: Недостатак одмора и преоптерећење тела могу довести до исцрпљености и повећати ризик од повреда. Правилно планирање тренинга са довољним временом за одмор и рехабилитацију изузетно је важно како би се спречио прерани замор или прекомерно оптерећење.
6. Редовни медицински прегледи: Редовни медицински прегледи и процене стања мишићно-скелетног система помажу у раном откривању потенцијалних проблема који могу довести до повреда.

ВАЖНОСТ ПРЕВЕНЦИЈЕ ЗА ДУГОРОЧНЕ ПЕРФОРМАНСЕ

Превенција повреда не само да доприноси безбедности скијаша током тренинга и такмичења, већ и дугорочним перформансама. Алпски скијаши који редовно примењују стратегије превенције и рехабилитације имају веће шансе да остану здрави, избегну повреде које би могле угрозити њихову каријеру, и наставе да напредују као спортисти.

Стратегије као што су правилно извођење вежби, рад на равнотежи и координацији, као и редовно истезање и превенција истегнућа, омогућавају скијашима да остану у најбољој физичкој кондицији и да издрже велике физичке захтеве овог спорта.

Превенција повреда и рехабилитација су кључни аспекти успеха у алпском скијању. Ове активности не само да помажу у смањењу ризика од повреда, већ такође играју важну улогу у дугорочном одржавању високих перформанси скијаша. Кроз правилну физичку припрему, коришћење технике, адекватну опрему и редовне прегледе, скијаши могу значајно побољшати своје резултате и смањити ризик од повреда, што је од пресудне важности за њихову каријеру.

ЗАКЉУЧАК

Развој експлозивне снаге и превенција повреда у алпском скијању су кључни фактори који директно утичу на перформансе скијаша и њихово здравље. Експлозивна снага, као основа за брзо реаговање на промене терена, маневрисање и извођење скокова, може значајно побољшати технику и резултате скијаша. Плиометријски тренинг, тренинг са оптерећењем, као и рад на агилности и брзини, играју важну улогу у развоју ових способности.

Међутим, скијање као високо ризичан спорт подразумева и велики потенцијал за повреде. Правилно вођена рехабилитација и превентивне мере, као што су јачање мишића, истезање, техника скијања, као и коришћење адекватне опреме, могу значајно смањити ризик од повреда и убрзати опоравак након њих. Интеграцијом ових мера у тренажни процес, скијаши могу не само смањити шансе за повреде, већ и побољшати своје перформансе на стази.

Тиме што се унапређују физичке способности и минимизирају ризици од повреда, скијаши су у стању да издрже велики физички напор који овај спорт захтева, те да наставе са високим перформансама, како на тренинзима, тако и на такмичењима. Стога, истовремени рад на развоју експлозивне снаге и превенцији повреда чини основну стратегију за успешну и дугорочну скијашку каријеру.

ЛИТЕРАТУРА

1. Young, W. B., & Pryor, J. F. (2008). *Effect of plyometric training on strength, power, and sports performance*. Sports Medicine, 38(5), 353-366.
2. Behm, D. G., & Sale, D. G. (1993). *Velocity specificity of resistance training*. Sports Medicine, 15(6), 374-388.
3. Ebben, W. P., & Blackard, D. O. (2001). *Strength and conditioning practices of National Basketball Association strength and conditioning coaches*. Journal of Strength and Conditioning Research, 15(2), 214-222.
4. Fletcher, J., & Jones, B. (2004). *The role of stretching in injury prevention*. Journal of Sports Science and Medicine, 3(1), 26-31.
5. Krämer, J. F., & Elter, J. (2012). *The effect of strength training on the prevention of injuries in alpine skiers*. Scandinavian Journal of Medicine & Science in Sports, 22(6), 776-785.
6. Aasa, U., & Häkkinen, K. (2013). *Effects of strength training on muscle injuries and rehabilitation for athletes*. Journal of Sports Science and Medicine, 12(4), 710-719.
7. Smith, M. T., & Lloyd, R. S. (2009). *Prevention and management of sport injuries in elite athletes*. Sports Medicine, 39(3), 193-202.
8. Tucker, R., & Noakes, T. D. (2009). *The physiology of elite athletes: Insights into the impact of training and recovery on performance*. British Journal of Sports Medicine, 43(6), 473-477.

DEVELOPMENT OF EXPLOSIVE POWER IN ALPINE SKIERS

Dimitrijević Danilo, Hadži Vidaković Marija

Abstract: *The development of explosive strength in skiers is a key factor in enhancing sports performance, particularly in disciplines that require fast and powerful movements, such as alpine skiing, ski cross, ski jumping, and Nordic disciplines. This paper analyzes the importance of explosive strength in the context of the dynamic and technical demands of skiing, exploring optimal training methods for its improvement. The focus is placed on various forms of training, including plyometric exercises, strength training with resistance, speed training, and specific exercises that simulate skiing movements. Special attention is given to neuromuscular adaptation, the activation of fast-twitch muscle fibers, the development of lower-body strength, and core stabilization. Additionally, the role of balance,*

coordination, and flexibility is examined in the context of injury prevention and overall movement efficiency. The paper also includes an analysis of the impact of training periodization, load planning, and recovery on the long-term development of explosive strength. Through a review of contemporary research and practical examples from elite skiers' training, recommendations for optimal training programs are presented. The aim of this paper is to provide scientifically based guidelines for improving explosive strength in skiers, which directly contributes to better sports performance and a reduced risk of injury.
Key words: *Explosive power, alpine skiing, plyometric training, sports performance, injury prevention*

BILATERALNI TRANSFER U RAZVOJU MOTORIKE DECE PRIMENOM SPORTSKIH IGARA I FIZIČKE AKTIVNOSTI

Petrović Lana[1], Kocić Jadranka[2]
[1]Fakultet pedagoških nauka u Jagodini, Univerzitet u Kragujevcu, Srbija
[2]Fakultet za sport i fizičko vaspitanje, Univerzitet u Prištini – Kosovska Mitrovica, Srbija

REVIEW ARTICLE
DOI: 10.5937/ATAVPA25044P

Sažetak: *Redovno učestvovanje u fizičkim aktivnostima, poput sportskih igara i vežbi koje angažuju oba uda, igra ključnu ulogu u razvoju bilateralnog transfera kod dece. Kroz takve aktivnosti, deca stiču sposobnost da prenesu veštine i pokrete naučene i na jednu i na drugu stranu, ruku ili nogu, što može biti od vitalnog značaja za poboljšanje motoričke koordinacije i performanse u različitim aktivnostima. Cilj ovog sistematsko preglednog rada bio je da na osnovu dosadašnjih istraživanja utvrdi efekte primene sportskih igara i drugih vrsta fizičkih aktivnosti na bilaterlani transfer u razvoju motorike dece. Podaci istraživanja prikupljeni su uzimajući u obzir kriterijume za uključivanje i isključivanje na PubMed-u, Web of Science-u i Google Scholar-u. Kao rezultat evaluacije sprovedene u okviru kriterijuma uključenja i isključenja, dvanaest (N= 12) originalnih naučnih studija uključeno je u ovo istraživanje. Glavni nalazi istraživanja ukazuju da programi bilateralnog transfera, koji uključuju elementarne igre ili programirane sesije vežbanja, kao i programirane vežbe fudbala, pozitivno utiču na bilateralni transfer dece starosti 3-12 godina. Ovi nalazi su u skladu sa rezultatima prethodnih istraživanja, koja su takođe analizirana, a koja su rađena sa odraslima i sugerišu da se kratkoročni ili dugoročni transfer sa jedne na drugu stranu tela može postići kod širokog spektra uzrasnih grupa.*
Ključne reči*: bilateralni tranfer, poboljšanje, motoričke sposobnosti, motorički razvoj.*

UVOD

Sposobnost osobe da nauči ili izvede određenu veštinu sa jednim ekstremitetom koji je naučen sa suprotnim ekstremitetom uopšteno se naziva bilateralni transfer (BT) (Ammons, 1958). Deca pokazuju više ili manje izraženu motoričku lateralnost koja se odražava u preferiranom delu tela (dominantnom delu) (Bozkurt, Çoban, Demircan, 2020). Iako se sticanje motoričkih veština uglavnom obavlja dominantnom stranom tela, situaciona akcija ne samo dominantnom već i nedominantnom stranom tela od vitalnog je značaja za mnoge sportske igre (Bozkurt i sar., 2020). Sposobnost da se nauči određena veština lakše sa jednom rukom ili nogom nakon što je veština naučena sa suprotnom rukom ili nogom povezana je sa onim što se naziva BT (Magill, 1993), kao što je već spomenuto. Ovo je najrazumniji način za ubrzanje procesa individualnog uspeha u učenju. Činjenica da početna praksa motoričkog zadatka sa jednom stranom tela dovodi do kasnijeg izvođenja sa drugom stranom tela pokazana je u mnogim studijama koje su istraživale pokrete gornjih i donjih ekstremiteta (Teixeira, Silva, & Carvalho, 2008). Međutim, samo nekoliko studija istražilo je bilateralnu praksu sportskih veština za donje ekstremitete ili uključilo iskusne sportiste posebno u ekipnim sportovima, a malobrojne studije koje su pronađene ukazuju na nekonzistentne rezultate. Većina studija istražuje populaciju nesportista (Erdil i sar., 2016; Chen i sar., 2023; Hussain i sar., 2022; Byrd i sar., 2000; Liu i sar., 2005; Akbari i sar., 2009; Bellows i sar., 2013; Rajović i sar., 2016; Magallón i sar., 2016; Wang i sar., 2020; Bozkurt i sar., 2020; Ljubičić i sar., 2022). S tim u vezi, iako ove studije ne istažuju bilateralni transfer kod deca koja su već uključena u sport one mogu pružiti sliku o BT kod deca ukoliko žele da se kasnije uključe u sport, što može olakšati proces učenja određenih tehničkih elemenata.

Pomenute studije (Chen i sar., 2023; Hussain i sar., 2022; Byrd i sar., 2000; Liu i sar., 2005; Akbari i sar., 2009; Bellows i sar., 2013; Rajović i sar., 2016; Magallón i sar., 2016; Wang i sar., 2020; Bozkurt i sar., 2020; Ljubičić i sar., 2022) pokazale su da programi bilateralnog transfera, koji uključuju elementarne igre ili vežbe koje podstiču korišćenje dominatne i nedominatne strane, pozitivno utiču na bilateralni transfer dece uzrasta od 3-12 godina.

Uprkos očiglednom značaju bilateralnog transfera za izvođenje nekih vrsta sportskih veština, istraživači u sportskim naukama do sada su samo sporadično istraživali bilateralni transfer. Studije koje istražuju bilateralni transfer motoričkih veština uglavnom su uključivale unapred određeni, fiksni

kriterijum učenja za sve ispitaniek (Hicks, Gualtieri, & Schroeder, 1983). Većina ovih istraživanja koristila je perceptualno-motoričke zadatke, kao što su zadaci s ogledalima i rotaciono praćenje (Grignon, 1985). S tim u vezi, ovaj rad ima prednost u tome što sistematizuje liteaturu koja istražuje efekte igara i drugih vrsta fizičkih aktivnost na bilateralni tranfer u razvoju dece. Povodom toga, cilj ovog rada bio je da, na osnovu dosadašnjih istraživanja, utvrdi efekte primene igara i drugih vrsta fizičkih aktivnosti na bilaterlani transfer u razvoju motorike dece.

METODE

Ovo istraživanje je dizajnirano korišćenjem tehnike sistematskog pregleda literature. Podaci istraživanja prikupljeni su uzimajući u obzir kriterijume uključenja i isključenja istraživanja objavljenih kao rezultat pretrage sprovedene korišćenjem ključnih reči "bilateralni tranfer, razvoj, motorika, deca" na sprskom i engleskom jeziku. Pretraga je izvršena na *Web of Science, Google Scholar* i *PubMed* bazama podataka u elektronskom okruženju između 01.04. 2024. i 10.05.2024. U skladu sa smernicama Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) (Moher, Liberati, Tetzlaff, Altman, 2009) (Figura 1.).

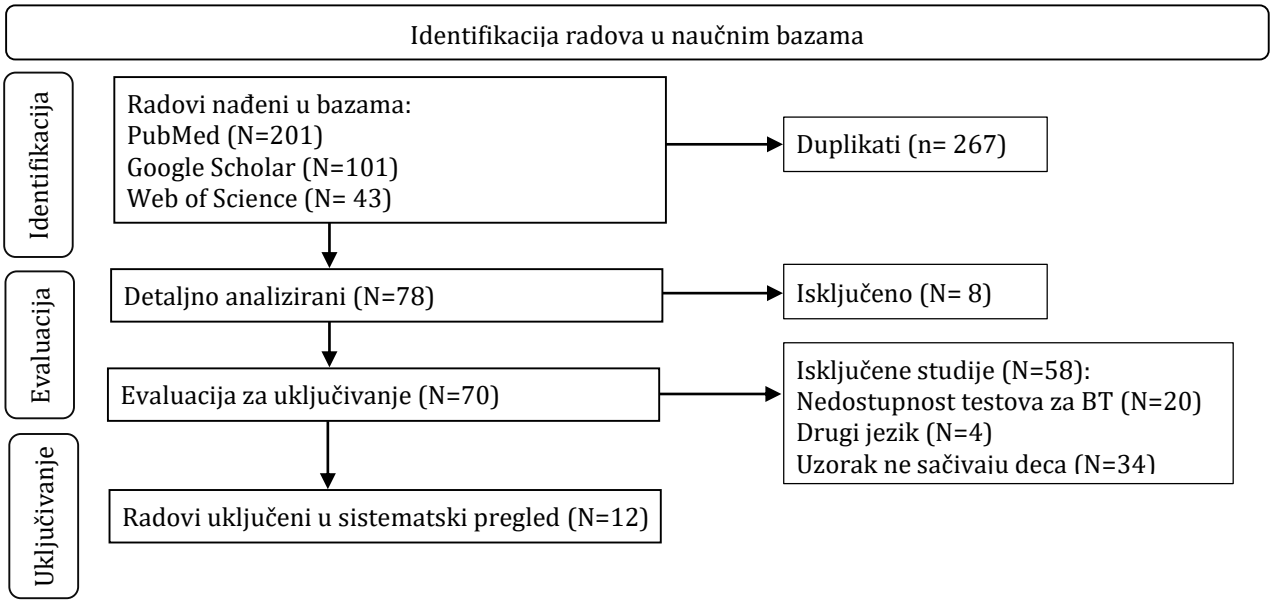
Kriterijumi uključivanja:

- Uzorak ispitanika treba da se sastoji od dece;
- Istraživanje mora primenjivati program fizičkog vežbanja ili elementarnih igara;
- U istraživanju moraju biti prikazani testovi koji procenjuju bilateralni transfer kod dece;
- Istraživanje treba da bude objavljeno kao članak na engleskom jeziku ili srpskom jeziku u periodu između 2013. i 2024. godine;
- Istraživanje treba da bude objavljeno kao originalni članak u celosti na engleskom ili srpskom jeziku.

Kriterijumi za isključivanje:

- Uzorak starijih adolescenata ili odraslih;
- Istraživanje ne sadrži nikakav oblik fizičke aktivnosti/pokreta;
- Istraživanje ne sadrži testove za bilateralni transfer;
- Objavljeno pre 2013. godine;
- Članci u kojima je dostupan samo apstrakt ili sistematski pregledi nisu uključeni u istraživanje.

Figura 1. Tok pretraživanja baza podataka



Na osnovu ključnih reči identifikovano je 345 radova. Čitanjem sažetaka izdvojenih radova isključeno je 78 radova (provere naslova, duplikati, sistematska istraživanja). U dalju analizu ušlo je 70 radova gde je 20 rada isključeno zbog nedostupnosti testova, 4 rada zbog stranog jezika i 34 radova zbog uključujućih kriterijuma vezanih za uzrast.U konačnu analizu ušlo je 12 radova u kojima su se utvrđivali efekte primene igara i drugih vrsta fizičkih aktivnosti na bilaterlani transfer u razvoju motorike dece.

REZULTATI ISTRAŽIVANjA

U ovom delu su prikazani rezultati dosadašnjih istraživanja na datu temu. Istraživanja su detaljno analizirana i prikazana na sledeći način: prvi autor na radu i godina publikovanja rada; uzorak, ond. osnovni parametri ispitanika koji učestvuju u istraživanju; eksperimentalni program (trajanje programa i vežbe koje su bile primenjivane tokom istog); rezultati do kojih su istraživači došli tokom istraživanja.

Tabela 1 Rezultati dosadašnjih istraživanja

Autor i god.	Uzorak	Eksperimentalni program	Rezultati istraživanja
Bellows i sar. (2013)	N= 201 3-5 god. EG= 103 KG= 98	18 nedelja, 4 puta nedeljno, 15-20 min, 72 sesija ukupno. Trčanje, skokovi, manipulativni zadaci, vežbe stabilizacije, vežbe sa loptom	Intervencija je dovela do značajni promena u BT kod dece u EG (p= .001) i bila je jak prediktor za dobar motorički razvoj
Rajović i sar. (2016)	N= 45 4-6 god. EG= 23 KG= 22	6 meseci, 2 puta nedeljno (Elementarne igre koje su se primenjivale u vrtiću)	Deca iz EG su imala bolji BT, (p= .004), dok nisu postojale razlike u drugim MS na IT i FT (KG regularna FA)
Erdil i sar. (2016)	N= 80 11-12 god. EG= 80	8 nedelja. Elementi u fudbalu (dribilnig, žogliranje, dodavanje, šutiranje, šutiranje preko živog zida)	Nisu postojale značajne razlike na IT i FT kod ispitanika. Autori pretpostavljaju da je prethodno učešće u treningu fudbala dovelo do dobrog razvoja BT-a
Magallón i sar. (2016)	N=90 6-12 god. EG= 45 KG= 45	20 sesija motoričkih zadataka koordinacije (10 dominatnom 10 nedominatnom rukom)	Postojale su značajne razlike na testu BT-a kod EG, što ukazuje da bilaterlne vežbe imaju pozitivan akutni efekat na koordinaciju (p= .01)
Stanley i sar. (2016)	N= 62 3-5 god EG= 32 KG= 32	6-nedelja, 2 puta nedeljno po 20 min u vrtićima Vežbe skokova (6 vrsta skokova)	Deca iz eksperimentalne grupe su imala značajan BT nakon 6 nedelja vežbanja uz pomoć vežbi koje se sastoje od skokova
Bellows i sar (2017)	N=51 3-5 god. EG= 26 KG 25	25 sesija vežbi motoričke koordinacije, trčanja, vežbe snage, ravnoteže Kontolisanje predmeta	Nakon 25 sesija postojale su značajne razlike u testiranim varijablama BT (ravnoteža, koordinacija) kod EG (p= .05)
Bonney i sar. (2017)	N=111 6-10 god. EG= 56 KG= 55	5 nedelja, 2 puta nedeljno po 20 minuta. Vežbe slaloma, skokova, ravnoteže, trčanje s promenom pravca ili smera	Nakon 5 nedelja deca iz EG su imala značajno poboljšanje BT u odnosu na decu iz KG (p= 0.05)
Wang i sar. (2020)	N= 268 3-6 god. EG= 134 KG= 134	Elementarne igre sa loptom (različite sportske igre sa ciljem razvoja motorike. EP – 4 nedelja, 2 puta po 30 min.	Postojale su značajne razlike na FT kod dece iz EG u BT (koordinacija, spretnost)
Bozkurt i sar. (2020)	N= 24 9-10 god. EG= 12 KG= 12	16 nedelja. Elementi u fudbalu (dribilnig, žogliranje, dodavanje, šutiranje)	BT kod dece iz EG su bili značajno veći u odnosu na decu iz KG što je veoma korisno u fudbalu (pogotovo pri pomenutim tehničkim elementima)

Hussain i sar. (2022)	N= 103 7-10 god. EG1= 26 EG2= 26 EG3= 26 KG= 25	3 EG (lopta - bacanje iznad glave, bacanje ispod ruke, hvatanje i bacanje iznad glave ili ispod ruke). Svi učesnici su radili (4 × 20 = 80 po sesiji). EG1: 10; EG2 – 15; EG3- 20 sesija	Grupa EG3 pokazala je najbolje rezultate na FT BT-a, što ukazuje da je učestalost vežbanja u razvojom periodu bitan faktor za poboljšanje BT
Ljubičić i sar. (2022)	N= 74 7-12 god. EG= 37 KG= 37	2h nedeljno, 12 nedelja (jednonožni skokovi, bočni skokovi, prepone, naskoci na platforme, doskoci na strunjače, skok uvis, skok udalj...)	Deca koja su bila u EG imala su bolje rezultate na testovima BT (bilateralne koordinacije) (p= .05) . Autori ukazuju da je primena ova vežbi bitna za simetrične neuromuskularne benefite kod dece
Chen i sar. (2023)	N= 174 3-6 god. EG= 174	Pratili su povezanost između primene igara sa loptom i bilaterlanog transfera kod dece iz Kine tokom perioda od 6 meseci	Deca koja su češće učestovala u igrama (sa ili bez lopte) imali su veći stepen BT u odnosu na decu koja nisu bila uključena u igre (p= .05)

Legenda: N – broj ispitanika; EG – eksperimentalna grupa; KG – kontrolna grupa; IT – incijalno testiranje; FT – finalno testiranje; BT – bilateralni transfer; EP – eksperimentalni program; MS – motoričke sposobnosti, FA – fizička aktivnost, EI - elementarne igre.

Sagledavajući pregledane i analizirane radove u tabeli 1, može se zaključiti da broj ispitanika nije varirao u velikim vrednostima od istraživanja do istraživanja. Najmanji broj od 24 ispitanika bio je u studiji Bozkurt i sar. (2020), dok je najveći broj ispitanika bio u istraživanju Bellows i sar. (2013), 201 ispitanik. Kada sagledamo uzrastne karateristike ispitanika, tj. starost, može se uvideti da su u analiziranim studijama bili prisutni ispitanici različitog uzrasta/starosti, u rasponu od 3-12 godina. Najmlađi uzorak bio je prisutan u radu Bellows i sar. (2013) sa samo 3 godina starosti, dok je starosna grupa od 12 godina primećena u radovima (Erdil i sar., 2016; Magallón i sar., 2016; Ljubičić i sar., 2022). U dve studija ispitanici su činili samo ekperimentalnu grupu (EG) (Erdil i sar., 2016; Chen i sar., 2023), dok je studija Hussain i sar. (2022) imala 3 EG i jednu kontrolnu grupu (KG). Preostalih 9 studija ispitanike su podelili u EG i KG (Stanley i sar., 2016; Bellows i sar., 2017; Bonney i sar., 2017; Bellows i sar., 2013; Rajović i sar., 2016; Magallón i sar., 2016; Wang i sar., 2020; Bozkurt i sar., 2020; Ljubičić i sar., 2022). Dakle, na osnovu cilja istraživanja ukupno je prikupljeno i analizirano 12 originalnih naučnih studija na datu temu. Na osnovu rezultata prikazanih u tabeli (Tabela 1) može se uvideti da programi bilateralnog transfera, koji uključuju elementarne igre ili vežbe koje podstiču korišćenje dominatne i nedominatne strane, pozitivno utiču na bilateralni transfer dece uzrasta od 3-12 godina.

DISKUSIJA

Cilj ovog rada bio je da pregleda literaturu koja istražuje bilaterlani transfer u razvoju motorike dece primenom igara i drugih vrsta fizičkih aktivnosti. Na osnovu toga nađeno je, i detaljno analizirano, 12 originalnih naučnih studija usko vezanih za datu tematiku. Glavni nalazi ove studije sugerišu da programi bilateralnog transfera, koji uključuju elementarne igre ili vežbe koje podstiču korišćenje dominatne i nedominatne strane, pozitivno utiču na bilateralni transfer dece uzrasta od 3-12 godina. „Beleženje" trenutnog BT u skladu je sa rezultatima prethodnih studija sa odraslima (Chavez & Coker, 2000) i sugeriše da se kratkoročni transfer sa jednog na drugi ekstremitet može postići kod širokog spektra uzrasnih grupa.

Redovno učestvovanje u fizičkim aktivnostima, poput sportskih igara i vežbi koje angažuju oba uda, igra ključnu ulogu u razvoju bilateralnog transfera kod dece. Kroz takve aktivnosti, deca stiču sposobnost da prenesu veštine i pokrete naučene na jednom udu na drugi, što može biti od vitalnog značaja za njihovu motoričku koordinaciju i performanse u različitim aktivnostima (Kohl & Roenker, 1980; Rouissi i sar., 2016). S tim u vezi, svi radovi prikazani u tabeli (Tabela 1.) istražuju upravo bilateralni transfer u razvoju motorike dece usled primene fizičkih aktivnosti, programa fizičkog vežbanja ili dečije igre u cilju

poboljšanja motorike kod dece uzrasta 3-12 godina. Stanley i sar. (2016) su primenjivali 6-nedeljni program vežbi skokova u vrtićima i otkrili da je EG imala značajan BT nakon 6 nedelja. Bonney i sar. (2017) su nakon 5 nedelja vežbanja slaloma, skokova, vežbi ravnoteže i trčanja s promenom smera i pravca utvrdili da su deca starosti 6-10 godina poboljšala BT. Bellows i sar. (2017) su utvrdili da nakon 25 sesija kombinovanih vežbi (motorička koordinacija, snaga, ravnoteža, trčanje i kontrolisanje predmeta) deca imala značajan BT. Ljubičić i sar. (2022) su na uzorku starosti od 7-12 god., primenom dvanaesto-nedeljnog programa koji uključuje: jednonožni skokovi, bočni skokovi, prepone, naskoci na platforme, doskoci na strunjače, skok uvis i skok udalj, utvrdili da dolazi do poboljšanja bilateralne koordinacije. S druge strane, Magallón i sar. (2016) su primenili 20 sesija motoričkih zadataka koordinacije na istom uzrastu i utvrdili isto što i Ljubičić i sar. (2022). Hussain i sar. (2022) su primenili: bacanje iznad glave, bacanje ispod ruke, hvatanje i bacanje iznad glave ili ispod ruke kod 3 EG i utvrdili da je BT značajan, nezavisno od broja sesija u rasponu od 10-20 sesija, što ukazuje na akutni efekat ovih vežbi na BT.

Redovno učestvovanje u elementarnim igrama, kao što su trčanje, skakanje, igre sa loptom i druge aktivnosti koje zahtevaju angažovanje oba uda, igra važnu ulogu u razvoju bilateralnog transfera kod dece (Wang i sar., 2020). Kroz ove igre, deca stiču sposobnost da prenesu veštine i pokrete naučene na jednom udu na drugi, što doprinosi razvoju motoričke koordinacije i spretnosti. Stoga je podržavanje učešća dece u elementarnim igrama ključno za njihov celokupni razvoj motoričkih veština (Tousi, Emami, Hoseini, 2012). Nekoliko radova su anazalirala efekte elementarnih igara na BT (Wang i sar., 2020; Rajović i sar.,2016) na uzorku dece starosti od 4-6 godina. Bellows i sar. (2013) su, na mladom uzorku od 3-5 godina, primenili program od 18 nedelja, 4 puta nedeljno, 15-20 min (trčanje, skokovi, manipulativni zadaci, vežbe stabilizacije, vežbe sa loptom, što je dovelo do značajnog BT kod dece iz EG. Wang i sar. (2020) su na uzorku starosti 3-6 godina ukazali da elementarne igre sa loptom značajno utiču na BT kod ove dece na akutnom nivou.

Učešće u programima fudbala može značajno doprineti razvoju bilateralnog transfera kod dece, budući da ovaj sport zahteva korišćenje obe noge u različitim situacijama tokom igre. Kroz vežbanje osnovnih fudbalskih veština poput driblanja, dodavanja i šutiranja lopte, deca mogu poboljšati koordinaciju i spretnost obe strane svog tela (Witkowski i sar., 2011). Nekolicina studija u ovom preglednom radu bavilo se efektima programa fudbala na BT kod dece uzrasta 9-12 godina (Bozkurt i sar., 2020; Erdil i sar., 2016). Naime, Bozkurt i sar. (2020) utvrdili su da je program fudbala u trajanju od 16 nedelja (dribilnig, žogliranje, dodavanje, šutiranje) doveo do značajnog BT kod dece uzrasta 9-10 godina. S druge strane, Erdil i sar. (2016) utvrdili su, na uzorku starosti 11-12 godina da je osmonedeljni program fudbala sa sličnim elementima doveo do poboljšanja BT, što znači da su rezultati studija rađenih na ovu konkretnu temu saglasni, kao što je slučaj i sa populacijom adolescenata (Witkowski i sar., 2011). Na kraju, Chen i sar. (2023) pratili su povezanost između primene igara sa loptom i bilaterlanog transfera kod dece iz Kine tokom perioda od 6 meseci i utvrdili da deca koja su češće učestovala u igrama (sa ili bez lopte) imali su veći stepen BT.

Ovo istraživanje ima nekoliko nedostataka koji su vredni pomena. Prvo, postoji mali broj studija koji ispituje bilateralni transfer prilikom korišćenja različitih programa, prema našem saznanju. Drugo, nehomogenost programa koji su korišćeni ne dozvoljavaju nam da izvršimo meta-analizu i utvrdimo veličine efekata za određeni program.

ZAKLJUČAK

Cilj ovog istraživanja je bio da pregleda relevantnu literaturu koja se bavi istraživanjem bilateralnog transfera u razvoju motorike dece kroz primenu igara i drugih fizičkih aktivnosti. Na osnovu pregleda literature, analizirano je 12 originalnih naučnih studija koje se usko tiču ovog konkretnog područja istraživanja. Glavni zaključci ovog istraživanja ukazuju da programi bilateralnog transfera, koji uključuju osnovne igre ili vežbe koje podstiču korišćenje obe strane tela, pozitivno utiču na bilateralni transfer kod dece u dobi od 3 do 12 godina. Ovi nalazi su u skladu sa rezultatima ranijih studija sa odraslima i sugerišu da se kratkoročni transfer sa jednog na drugi ekstremitet može postići kod različitih uzrasnih grupa.

LITERATURA

1. Akbari, H., Abdoli, B., Shafizadeh, M., & Ziaee, V. (2009). The effect of traditional games in fundamental motor skill development in 7-9 year-old boys. *Iranian Journal of Pediatrics, 19*(2), 1-7.
2. Ammons, R. B. (1958). *Cussent psychological issues*. Champaign, IL: Human Kinetics.
3. Bardid, F., Deconinck, F. J., Descamps, S., Verhoeven, L., De Pooter, G., Lenoir, M., & D'Hondt, E. (2013). The effectiveness of a fundamental motor skill intervention in preschoolers with motor problems depends on gender but not environmental context. *Research in Developmental Disabilities, 34*(12), 4571–4581.
4. Bellows, L. L., Davies, P. L., Anderson, J., & Kennedy, C. (2013). Effectiveness of a physical activity intervention for Head Start preschoolers: A randomized intervention study. *American Journal of Occupational Therapy, 67*(1), 28-36.
5. Bellows, L. L., Davies, P. L., Courtney, J. B., Gavin, W. J., Johnson, S. L., & Boles, R. E. (2017). Motor skill development in low-income, at-risk preschoolers: A community-based longitudinal intervention study. *Journal of Science and Medicine in Sport, 20*(11), 997-1002.
6. Bonney, E., Jelsma, L. D., Ferguson, G. D., & Smits-Engelsman, B. C. (2017). Learning better by repetition or variation? Is transfer at odds with task specific training? *PLoS One, 12*(3), e0174214.
7. Bozkurt, S., Çoban, M., & Demircan, U. (2020). The effect of football basic technical training using unilateral leg on bilateral leg transfer in male children. *Journal of Physical Education, 31*, 1-10.
8. Byrd, R., Gibson, M., & Gleason, M. H. (2000). Bilateral transfer across ages 7 to 17 years. *Perceptual and Motor Skills, 62*(1), 87-90.
9. Chavez, J. N., & Coker, C. A. (2000). Effect of practice sequence on the bilateral acquisition of a novel motor skill. *Research Quarterly for Exercise and Sport, 71*(1), A-55.
10. Chen, J., Song, W., Zhao, X., Lou, H., & Luo, D. (2023). The relationship between fundamental motor skills and physical fitness in preschoolers: A short-term longitudinal study. *Frontiers in Psychology, 14*, 1270888.
11. Erdil, G., Yorulmaz, H., Olcucu. B., & Bülbül, A. (2016). Effect of 8 weeks bilateral football training program for 11-12 age group children over learning transfer and permanency of the learning transfer. *International Journal of Academic Research, 8*(5), 1-10.
12. Graham, G. (1992). Developmentally appropriate physical education for children. *Journal of Physical Education, Recreation & Dance, 63*(6), 29–30.
13. Hicks, R. E., Gualtieri, C. T., & Schroeder, S. R. (1983). Cognitive and motor components of bilateral transfer. American Journal of Psychology, 96, 223–228.
14. Hussain, B., & Cheong, J. P. G. (2022). Improving gross motor skills of children through traditional games skills practiced along the contextual interference continuum. *Frontiers in Psychology, 13*, 986403.
15. Kohl, R. M., & Roenker, D. L. (1980). Bilateral transfer as a function of mental imagery. *Journal of Motor Behavior, 12*, 197–206.
16. Liu, J., & Wrisberg, C. A. (2005). Immediate and delayed bilateral transfer of throwing accuracy in male and female children. *Research Quarterly for Exercise and Sport, 76*(1), 20-27.
17. Ljubičić, S., Antekolović, Lj., & Petrić, V. (2022). Integration of bilateral coordination in children's motor learning process. *Journal of Elementary Education, 15*(3), 285-299.
18. Magallón, S., Narbona, J., & Crespo-Eguílaz, N. (2016). Acquisition of motor and cognitive skills through repetition in typically developing children. *PLoS One, 11*(7), e0158684.
19. Magill, R. A. (1993). *In motor learning concepts and applications.* Indiana: Brown and Benchmark.
20. Malina, R., Bouchard, C., & Bar-Or, O. (2004). *Growth, maturation, and physical activity (2nd edition).* Champaign, IL: Human Kinetics.
21. Moher, D., Liberati, A., Tetzlaff, J., & Altman, D. G. (2009). The PRISMA Group. Reprint—Preferred reporting items for systematic reviews and meta analyses: The PRISMA statement. *Physical Therapy, 89*, 873–880.
22. Rajović, R., Berić, D., Bratić, M., Živković, M., & Stojiljković, N. (2016). Effects of an "NTC" exercise program on the development of motor skills in preschool children. *Facta Universitatis, Physical Education and Sport, 14*(3), 315-329.
23. Rouissi, M., Chtara, M., Owen, A., Chaalali, A., Chaouachi, A., Gabbett, T., et al. (2016). Effect of leg dominance on change of direction ability amongst young elite soccer players. *Journal of Sports Science, 34*(6), 542-548.
24. Shenouda, L., Gabel, L., & Timmons, B. W. (2011). Preschooler focus-physical activity and motor skill development. *Child Health & Exercise Medicine Program, 1*, 1–2.
25. Stanley, R. M., Jones, R. A., Cliff, D. P., Trost, S. G., Berthelsen, D., Salmon, J., ... Okely, A. D. (2016). Increasing physical activity among young children from disadvantaged communities: Study protocol of a group randomised controlled effectiveness trial. *BMC Public Health, 16*(1), 1095.
26. Teixeira, L. A., Silva, M. V., & Carvalho, M. A. (2003). Reduction of lateral asymmetries in dribbling: The role of bilateral practice. *Laterality, 8,* 53-65.

27. Tousi, M. M., Emami, T., & Hoseini, S. M. (2012). The effect of initial practice with dominant and non-dominant hand on acquisition, retention and transfer of a complex motor task. *Bioscience Biotechnology Research Asia, 14*(3), 1067-1074.
28. Wang, H., Chen, Y., Liu, J., Sun, H., & Gao, W. (2020). A follow-up study of motor skill development and its determinants in preschool children from middle-income family. *BioMed Research International, 2020*, 6639341.
29. Witkowski, Z., Lyakh, V., Gutnik, B., Lipecki, K., Rutowicz, B., & Penchev, B., et al. (2011). Corrective effects of different options on development and maturation of professional motor skills from dominant and non-dominant legs of young soccer players. *Journal of Physical Education and Sport Management, 11*(3), 291-299.

BILATERAL TRANSFER IN CHILDREN'S MOTOR DEVELOPMENT USING SPORTS GAMES AND PHYSICAL ACTIVITY

Petrović Lana, Kocić Jadranka

Abstract*: Regular participation in physical activities, such as sports games and exercises that engage both limbs, plays a key role in the development of bilateral transfer in children. Through such activities, children gain the ability to transfer the skills and movements learned to both sides, arms and legs, which can be vital for improving motor coordination and performance in various activities. The goal of this systematic review was to determine, based on previous research, the effects of the application of sports games and other types of physical activities on bilateral transfer in the development of children's motor skills. Research data were collected taking into account inclusion and exclusion criteria on PubMed, Web of Science and Google Scholar. As a result of the evaluation carried out within the inclusion and exclusion criteria, twelve (N= 12) original scientific studies were included in this research. The main findings of the research indicate that bilateral transfer programs, which include elementary games or programmed practice sessions, as well as programmed soccer exercises, have a positive effect on the bilateral transfer of children aged 3-12 years. These findings are consistent with the results of previous research, which was also analyzed, that was done with adults and suggests that short-term or long-term side-to-side transfer can be achieved in a wide range of age groups.*

Key words: *bilateral transfer, improvement, motor skills, motor development.*

THE IMPACT OF RECREATIONAL FOOTBALL ON BODY COMPOSITION, FUNCTIONAL AND MOTOR ABILITIES - SYSTEMATIC REVIEW

Filipović Žaklina, Volaš Dejan, Milošević Nikola, Stanković Nemanja, Stanisavljević Ivan
Faculty of Sport and Physical Education, University of Niš, Serbia

REVIEW ARTICLE
DOI: 10.5937/ATAVPA25051F

Abstract: *Recreational football is a versatile and intense form of physical activity that can be considered an excellent alternative to traditional continuous exercise forms such as running, cycling, and swimming. This type of exercise offers numerous health benefits, including improvements in body composition, functional abilities, and motor skills. The aim of this paper is to provide a systematic review of existing research on the impact of recreational football on body composition, functional, and motor abilities. By analyzing data from relevant scientific databases such as Google Scholar, SCOPUS, and the Serbian Citation Index, studies examining the effects of recreational football in different populations, including children, adults, and the elderly, were included. The results of numerous studies indicate that recreational football can lead to a reduction in body fat, an increase in muscle mass, and improvements in cardiorespiratory endurance. Additionally, this form of physical activity contributes to enhanced coordination, speed, agility, and explosive power. The conclusion of this research is that recreational football is a highly effective form of physical activity that can contribute to the improvement of health and physical abilities, regardless of age, gender, or fitness level. It's diversity makes it an attractive type of training that not only enhances physical parameters but also encourages social interaction and the long-term adoption of an active lifestyle.*
Key words: *football, recreation, motor abilities, functional abilities, body composition.*

INTRODUCTION

Structurally, football is a highly complex and intricate game. It belongs to the group of polystructural acyclic movements with a high level of complexity. It is a sport characterized by numerous complex movements, including both acyclic and cyclic movements of high volume and intensity. Since its inception, football has continuously evolved, both as a whole and in the transformation of individuals as integral and indivisible elements of the game (Joksimović, 2002). The current level of football development is marked by great dynamism and a high pace of play, which require players to have exceptional physical conditioning, a high level of movement technique, tactical maturity, and psychological stability. Alongside the development of football, the importance of conditioning training has increased, particularly concerning the pace, speed, and dynamism of the game, as well as its technical and tactical demands. Physical preparation in modern football is highly emphasized, especially at elite competitive levels. However, physical conditioning must always be considered within the context of football and not as a separate goal.

Recreational football is one of the most popular sports in the world, with over 200 million active participants. Therefore, it should be utilized to promote sports participation on a global scale, as a lack of time and motivation are key factors contributing to physical inactivity. As such, it fosters socialization and provides a motivational boost to participants (Elbe et al., 2010).

Recreational football serves as a suitable alternative to continuous exercises such as running, cycling, swimming, or other activities that improve the cardiorespiratory system (Castagna et al., 2007). In untrained men, it significantly improves maximal aerobic power, blood pressure, muscle capillarization, and intermittent exercise performance. These effects are similar to interval training and more pronounced than those of continuous moderate-intensity running and strength training. It effectively stimulates musculoskeletal, metabolic, and cardiovascular adaptations important for health, thereby reducing the risk of diseases associated with modern lifestyles (Krustrup et al., 2010). The structure of recreational football promotes socialization, and the nature of the game itself is motivating for participants. This form of training can help individuals stay motivated, persist in exercise, and improve their health (Elbe, Strahler, Krustrup, Wikman, & Stelter, 2010). This type of exercise is intense and versatile, involving multiple actions and significant, unexpected impacts. It is assumed that recreational

football is beneficial for bone health maintenance and modeling (Milanović et al., 2022). The primary goal of every football training session must be to enhance players' performance capacity. If a match is the best form of training, then conversely, a good training session should have the characteristics of a match (Joksimović, 2002).

Body composition and nutritional status are crucial factors for an athlete's health and performance. Body composition refers to the structure of the organism, represented by the grouping of measurable segments that make it up. While not every characteristic of body composition is expected to play a role in optimal professional and recreational football performance, lower levels of body fat and higher muscle mass are desirable for optimal sports results (Rienzi et al., 2000; Gil et al., 2007). It is known that morphological characteristics are determined by endogenous factors, while exogenous factors play a significant role in the expression of genetically defined ranges. It is important to note that physical activity is the most effective and popular external factor for inducing morphological adaptations in the body. In this context, the proper and adequate application of training, as well as the formation of recreational and sports training habits, is of great significance (Malacko et al., 2015).

RESEARCH METHOD

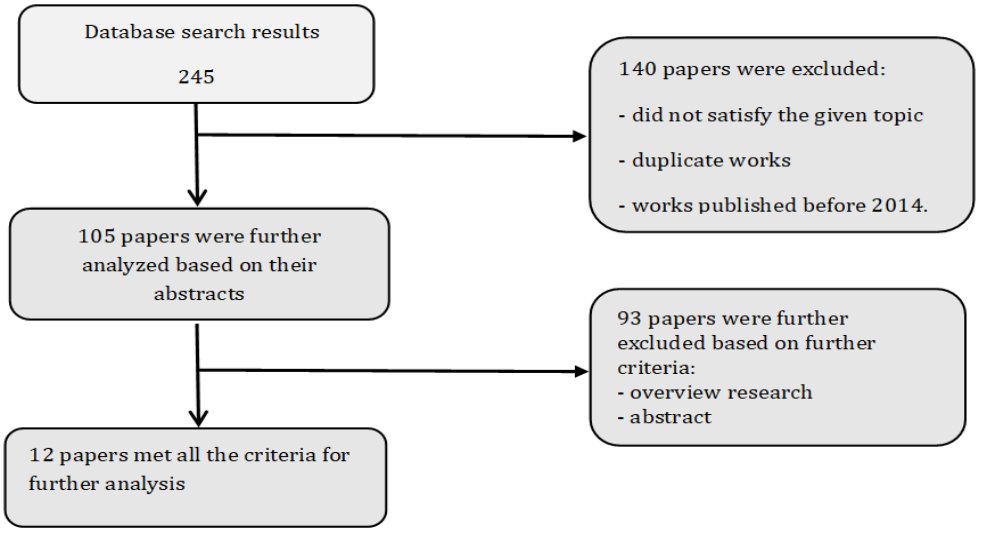
The following databases were used for literature collection: Google Scholar, PubMed, SCI Index, ResearchGate, as well as other relevant literature that could address the research question. The keywords used during the search included: football, recreation, motor skills, functional abilities, body composition, recreational football, amateur soccer, body composition, fat percentage, muscle mass, functional abilities, cardiorespiratory fitness, VO2 max, and motor skills.

The research focused on studies published between 2014 and 2024. The selected studies were read and analyzed. To be included in the final analysis, they had to meet three criteria: they had to be experimental in nature, related to recreational football, and published between 2014 and 2024. A descriptive method was used for collecting and reviewing previous research, in parallel with theoretical analysis.

Procedure

The selection of studies was based on titles and keywords. Three criteria were applied for selection. The first criterion focused on the research topic, specifically examining the impact of recreational football on body composition, functional abilities, and motor skills. The second criterion required that the studies be experimental in nature. The third criterion was that the studies had to be published between 2014 and 2024. Within the specified time frame, twelve studies closely related to the research topic met the criteria for further consideration.

Figure 1 illustrates the process of collecting, analyzing, and eliminating identified scientific studies.



RESULTS

Table 1 Overview of collected research and basic characteristics of the experimental treatment

Study	Exercise Program & Intensity	Tests and tested parametars	Sample of participants	Results
Andersen et al. (2014)	FG-16 weeks of recreational football (1.6x per week) + CG-strength training (1.5x per week)	YYIE1, VO_2max, TTE HRwlk, HRrun, La^-, STS	63-74 years (68.2±3.2) n=26 M	FG significantly improved VO2max and endurance during intense efforts. Recreational soccer may be an effective alternative to strength training for improving aerobic endurance, functional strength, and cardiovascular efficiency in older adults.
Nielsen (2014)	12 months football vs. 6 months football vs. 3 months spinning/CrossFit	Interviews, thematic analysis, SDT, ATLAS.ti software	39-71 years, n=28, M	FG: 80%–89% continued playing soccer after the program. Spinning/CrossFit: Only 15% kept training. Team sports like soccer better sustain long-term activity in older men.
Randers et al. (2014)	FG-12 weeks of football fitness training (3x per week)	InBody 270, YYIE1, SSBT, 20-m sprint test, WHOQOL-BREF, WEMWBS	60+ years n=66, M/W	Improved postural balance, aerobic endurance, quality of life and mental well-being. There were no significant changes in body composition or sprint performance.
Schmidt et al. (2014)	FG-12 months (2x per week first 4 months, after that 3x) of small-sided football (3v3, 4v4, 5v5) vs SG, CG	Echocardiography, VO2max, BP, lipid profile	65-75 years (68.2±3.2) n=26, M	Soccer training had superior effects to strength training in older inactive men. Improvements included cardiac structure, functional parameters, and aerobic capacity.
Milanović (2015)	FG-12 weeks of recreational football (5v5, 3x per week) vs RG, CG	Tanita BC-418 analyzer, Kistler Quattro Jump platform, COSMED Quark b2 spiroergometer, Technogym RUNRACE tape, flexibility	20-40 years n=64, M	The results show statistically significant differences in the values of VO_2max, half-squat jump, and flexibility. Recreational soccer and continuous running improved cardiovascular fitness and body composition, but only soccer training significantly improved muscular fitness and flexibility.
Milanović et al. (2015)	FG-12 weeks of recreational football (3x per week, 5v5/6v6/7v7), vs RG, CG	BMI, VO2max, Hrmax (Polar Team System), CMJ, SJ, SRT	20-40 years n=69, M	Recreational soccer and moderate-intensity continuous running improve aerobic capacity and reduce body mass in untrained men. Soccer training significantly improved explosive power and flexibility.
Cvetković (2018)	FG-12 weeks of football (3x per week) vs. HIIT training	InBody 720, CMJ, SRT, YYIE1, Polar Team System H7, BP	11-13 years n=42, M	The results showed that FG and HIITG recorded significant improvements in reducing body fat, increasing VO2max, as well as improving muscle strength and endurance, and lower extremity explosive power. FG showed superior results. CG recorded an increase in body mass, BMI and body fat percentage.

Duncan et al. (2022)	FG-12 weeks of recreational football (2x per week) vs CG	Rikli and Jones Senior Fitness test, BMI, BI, RD	61-80 years (66±4) n=26, M	A 12-week recreational soccer program significantly improved: - Lower body strength - Agility and balance -Aerobic endurance
Modena et al. (2023)	Two studies: Interrupted Time-Series Design, Randomized Parallel Trial -12 weeks of small football 5v5 or 6v6; FGLOW- 1x a week; FGMOD-2x per week	BMI ,BI, BP, VO_2maks, lipidni profil (analiza krvi)	30-55 years n=52, M	Study 1: One football training session per week led to improvements in LDL cholesterol and VO_2max, while two training sessions per week further improved body mass, BMI and lipid profile. Study 2: Both groups improved VO_2max and lipid profile. No statistically significant difference was found between them, indicating that football training once a week has positive effects on cardiovascular health in inactive men.
Xu et al. (2024)	FG-16 weeks of small-sided football (5x per week, 3v3, 4v4), vs CG	SDM, VS, SRT, AT, BMI, BI, RD	18-25 years n=60, M/W	A 16-week recreational indoor soccer program produced the following results: Reduction in body fat, BMI, waist and hip circumference; Increase in muscle mass; Improving aerobic endurance; Greater explosive power of the lower extremities.
Skoradal et al. (2024)	FG-12 weeks of football (3x per week), vs CG	WHOQOL-BREF, WEMWBS, Flow Kurz Scale YYIE1, BMI, Polar Teampro, InBody 270, BP, The Standing Stork Balance Test, 20m sprint.	60+ years n=66, M/W	Football has improved the quality of life of the elderly, especially in the domain of perception of the environment (safety, availability of content, opportunities for socialization). There are also significant changes in postural balance, VO_2max, The control group showed improvement on the YYIE1 test.
Boithias et al. (2024)	FG- 6 weeks of football (2x per week)	Senior Fitness Test Manual, BMI, 2.5 Up and Go Test, Chair SRT, 6 Minute Walking Test,WHOQOL-BREF, EMAPS, BPNSF	60+ years n=15, M/W	Significant reduction in body weight and BMI. Increased satisfaction with competence and autonomy, reduced frustration of those needs. No significant changes in physical fitness were noted except for body mass and BMI.

M – Men; W – Women; n = Number of participants; FG – Football Group; CG – Control Group; RG – Running Group; SG- Strenght training Group; BMI – Body Mass Index; SRT – Shuttle Run Test; SDM – Standing Long Jump; VJ – Vertical Jump; AT – Anthropometric Measurements; BI – Bioelectrical Impedance; HD – Hand Dynamometer; VO_2max – Maximal Aerobic Capacity (Maximum Oxygen Consumption); SJ – Squat Jump; CMJ – Countermovement Jump with Arm Swing; BP – Blood Pressure; TTE – Time to Exhaustion on a Bicycle; YYI1 – Yo-Yo Intermittent Endurance Test Level 1; HRmax – Maximum Heart Rate; HRwalk – Heart Rate during Walking; Hrrun – Heart Rate during Running; La^- – Blood Lactate Concentration; STS – Sit-to-Stand Test; WEMWBS – Warwick-Edinburgh Mental Wellbeing Scale; EMAPS – The Motivation for Physical Activity for Health Purposes Scale; BPNSF – Basic Psychological Need Satisfaction and Frustration; SDT - Self-determination theory; SSBT - Standing Stork Balance Test; SRT - Sit-and-Reach Test

DISCUSION

The aim of this study was to determine the impact of recreational football on body composition, functional, and motor abilities based on existing literature. The research included 12 original scientific papers that were thoroughly analyzed.

The results of this study confirm that recreational football has a significant impact on improving body composition, functional, and motor abilities in various populations. Several studies included in the

analysis showed that regular participation in recreational football can lead to a reduction in body fat, an increase in muscle mass, and improvements in cardiovascular endurance (Milanović et al., 2015; Xu et al., 2024). It is particularly important that recreational football offers benefits in terms of explosive strength and agility, which are key factors for improving overall physical fitness.

Studies comparing football training with continuous aerobic exercise showed that the football group had superior results in improving flexibility and lower limb strength (Milanović et al., 2015; Cvetković, 2018). These results suggest that recreational football can be an effective training method for increasing functional capacity and reducing the risk of injury. Similarly, Duncan et al. (2022) demonstrated that a 12-week recreational football program in older adults improved lower body strength, agility, and aerobic endurance. Regarding the older population, studies have shown that recreational football significantly contributes to the improvement of postural balance, cardiovascular efficiency, and quality of life (Randers et al., 2014; Skoradal et al., 2024).

Andersen et al. (2014) showed that recreational football could be an effective alternative to strength training for improving aerobic endurance and functional strength in older adults. These findings are particularly important as they suggest that football training not only helps maintain physical activity in older adults but also improves their mental well-being, which is crucial for long-term health preservation. Moreover, the aspect of socialization should not be overlooked. Socialization plays a key role in maintaining motivation for physical activity. Research shows that team sports, such as recreational football, encourage long-term commitment to exercise more than individual training (Nielsen, 2014). Participants in football groups showed a higher degree of perseverance in physical activity compared to those engaged in spinning and CrossFit, confirming the importance of collective spirit in maintaining motivation.

Schmidt et al. (2014) demonstrated that football training has superior effects compared to strength training in older adults, improving heart structure and aerobic capacity. On the other hand, Milanović's (2015) research indicated that football training is more effective in improving muscular fitness and flexibility compared to continuous running. Modena et al. (2023) investigated the effects of different frequencies of football training and concluded that even one training session per week can improve VO_2max and lipid profile, while two sessions per week further improve body composition and BMI. These results suggest that even minimal involvement in recreational football can have significant health benefits.

Xu et al. (2024) showed that a 16-week small-sided football program significantly improved body composition by reducing body fat and increasing muscle mass in young adults. Skoradal et al. (2024) highlighted that football improves the quality of life in older adults, particularly in terms of socialization and environmental perception.

Boithias et al. (2024) analyzed the short-term effects of recreational football in older adults and found significant reductions in body weight and BMI, along with increased satisfaction with competence and autonomy, but no significant changes in physical fitness.

Considering the results of all the analyzed studies, it can be concluded that recreational football represents an effective form of physical activity that improves body composition, motor, and functional abilities while also positively impacting mental health and socialization. Future research should focus on the long-term effects of football training and potential strategies to optimize its benefits across different populations.

CONCLUSION

Based on the results of the research, it can be concluded that recreational football represents an extremely effective form of physical activity with numerous health benefits. This activity contributes to the reduction of body fat, an increase in muscle mass, and improvement in cardiovascular endurance, making it an attractive alternative to traditional forms of training. In addition to the physical benefits, recreational football improves motor skills, such as agility, explosive strength, and balance, and is especially beneficial for older adults as it positively affects their functional capacity and quality of life.

Besides the physiological advantages, an important aspect of recreational football is socialization, which plays a key role in long-term motivation for physical activity. Studies have shown that participants

in team sports, such as football, are more likely to remain committed to exercise compared to those who practice individual forms of training. This social element contributes to mental well-being and a sense of belonging, further enhancing the effectiveness of football training.

The conclusion of this research is that recreational football can significantly contribute to improving health and physical abilities, regardless of age and fitness level. Its versatility and accessibility make it an ideal choice for those who want to adopt an active and healthy lifestyle. Future research should focus on the long-term effects of football training and strategies for its broader application across the population.

REFERENCES

1. Andersen, T. R., Schmidt, J. F., Nielsen, J. J., Randers, M. B., Sundstrup, E., Jakobsen, M. D., ... & Krustrup, P. (2014). Effect of football or strength training on functional ability and physical performance in untrained old men. Scandinavian Journal of Medicine & Science in Sports, 24, 76–85.
2. Boithias, M., Le, T. T. T., Guillet-Descas, E., Belli, A., Julin, M., & Duncan, M. J. (2024). Physiological and psychological effects of short-term recreational football in adults 60+. International Journal of Environmental Research and Public Health, 21(9), 1194.
3. Castagna, C., Belardinelli, R., Impellizzeri, F. M., Abt, G. A., Coutts, A. J., & D'Ottavio, S. (2007). Cardiovascular responses during recreational 5-a-side indoor soccer. Journal of Science and Medicine in Sport, 10(2), 89–95.
4. Cvetković, N., Stojanović, E., Stojiljković, N., Nikolić, D., Scanlan, A. T., & Milanović, Z. (2018). Exercise training in overweight and obese children: Recreational football and high-intensity interval training provide similar benefits to physical fitness. Scandinavian Journal of Medicine & Science in Sports, 28, 18–32.
5. Duncan, M. J., Mowle, S., Noon, M., Eyre, E., Clarke, N. D., Hill, M., ... & Julin, M. (2022). The effect of 12-weeks recreational football (soccer) for health intervention on functional movement in older adults. International Journal of Environmental Research and Public Health, 19(20), 13625.
6. Elbe, A. M., Strahler, K., Krustrup, P., Wikman, J., & Stelter, R. (2010). Experiencing flow in different types of physical activity intervention programs: Three randomized studies. Scandinavian Journal of Medicine & Science in Sports, 20(s1), 111–117.
7. Gil, S. M., Gil, J., Ruiz, F., Irazusta, A., & Irazusta, J. (2007). Physiological and anthropometric characteristics of young soccer players according to their playing position: Relevance for the selection process. Journal of Strength and Conditioning Research, 21(2), 438–445.
8. Joksimović, S. (2002). Teorija taktike i treninga u fudbalu. Niš: Studentski kulturni centar.
9. Krustrup, P., Aagaard, P., Nybo, L., Petersen, J., Mohr, M., & Bangsbo, J. (2010). Recreational football as a health-promoting activity: A topical review. Scandinavian Journal of Medicine & Science in Sports, 20, 1–13.
10. Krustrup, P., Christensen, J. F., Randers, M. B., Pedersen, H., Sundstrup, E., Jakobsen, M. D., ... & Bangsbo, J. (2010). Muscle adaptations and performance enhancements of soccer training for untrained men. European Journal of Applied Physiology, 108(6), 1247–1258.
11. Malacko, J., Doder, D., Stanković, V., Dokmanac, M., Savić, B., & Doder, R. A. (2015). Comparative analysis of the morphological characteristics of elite karatekas, judokas, taekwondoists, boxers, and wrestlers. International Journal of Morphology, 33(1), 245–250.
12. Milanović, Z. (2015). Uticaj različitih programa vežbanja na fitnes komponente. Univerzitet u Nišu.
13. Milanović, Z., Čović, N., Helge, E. W., Krustrup, P., & Mohr, M. (2022). Recreational football and bone health: A systematic review and meta-analysis. Sports Medicine, 52(12), 3021–3037.
14. Milanović, Z., Pantelić, S., Sporiš, G., Mohr, M., & Krustrup, P. (2015). Health-related physical fitness in healthy untrained men: Effects on VO2max, jump performance and flexibility of soccer and moderate-intensity continuous running. PLoS One, 10(8), e0135319.
15. Modena, R., Impellizzeri, F. M., Fornasiero, A., & Schena, F. (2023). Effects of low vs. moderate dose of recreational football on cardiovascular risk factors. European Journal of Sport Science, 23(6), 1047–1055.
16. Nielsen, G., Wikman, J. M., Jensen, C. J., Schmidt, J. F., Gliemann, L., & Andersen, T. R. (2014). Health promotion: The impact of beliefs of health benefits, social relations, and enjoyment on exercise continuation. Scandinavian Journal of Medicine & Science in Sports, 24, 66–75.
17. Randers, M. B., Andersen, J. L., Petersen, J., Sundstrup, E., Jakobsen, M. D., Bangsbo, J., ... & Krustrup, P. (2014). Exercise performance and cardiovascular health variables in 70-year-old male soccer players compared to endurance-trained, strength-trained, and untrained age-matched men. Journal of Sports Sciences, 32(13), 1300–1308.

18. Rienzi, E., Drust, B., Reilly, T., Carter, J. E., & Martin, A. (2000). Investigation of anthropometric and work-rate profiles of elite South American international soccer players. Journal of Sports Medicine and Physical Fitness, 40(2), 162–169.
19. Schmidt, J. F., Hansen, P. R., Andersen, T. R., Andersen, L. J., Hornstrup, T., Krustrup, P., & Bangsbo, J. (2014). Cardiovascular adaptations to 4 and 12 months of football or strength training in 65- to 75-year-old untrained men. Scandinavian Journal of Medicine & Science in Sports, 24, 86–97.
20. Skoradal, M. B., Sjúrðarson, T., Olsen, H. W., Leifsson, E. N., Pelikan, V., Mohr, M., & Davidsen, A. H. (2024). Evaluation of a football fitness implementation initiative for an older adult population in a small-scale island society. Frontiers in Public Health, 12, 1406601.
21. Xu, Q., Qi, K., Liu, G., Li, T., & Clemente, F. M. (2024). Effects of a 16-week recreational small-sided games soccer intervention on body composition and physical fitness in sedentary young adults: A randomized controlled study. Heliyon, 10(3).

UTICAJ REKREATIVNOG FUDBALA NA TELESNI SASTAV, FUNKCIONALNE I MOTORIČKE SPOSOBNOSTI – SISTEMATSKO PREGLEDNO ISTRAŽIVANJE

Filipović Žaklina, Volaš Dejan, Milošević Nikola, Stanković Nemanja, Stanisavljević Ivan

Sažetak: *Rekreativni fudbal predstavlja svestran i intenzivan oblik fizičke aktivnosti koji se može smatrati odličnom alternativom tradicionalnim oblicima kontinuiranog vežbanja kao što su trčanje, vožnja bicikla i plivanje. Ovaj oblik vežbanja nudi brojne zdravstvene koristi, uključujući poboljšanje telesnog sastava, funkcionalnih sposobnosti i motoričkih veština. Cilj ovog rada je da pruži sistematski pregled postojećih istraživanja o uticaju rekreativnog fudbala na telesni sastav, funkcionalne i motoričke sposobnosti. Analizom podataka iz relevantnih naučnih baza kao što su Google Scholar, SCOPUS i Srpski citatni indeks, obuhvaćeni su radovi koji su ispitivali efekte rekreativnog fudbala u različitim populacijama, uključujući decu, odrasle i starije osobe. Rezultati brojnih studija ukazuju da rekreativni fudbal može dovesti do smanjenja telesne masti, povećanja mišićne mase i unapređenja kardiorespiratorne izdržljivosti. Pored toga, ovaj vid fizičke aktivnosti doprinosi poboljšanju koordinacije, brzine, agilnosti i eksplozivne snage. Zaključak ovog istraživanja je da rekreativni fudbal predstavlja visoko efikasan oblik fizičke aktivnosti koji može doprineti unapređenju zdravlja i fizičkih sposobnosti, nezavisno od uzrasta, pola i nivoa fizičke pripremljenosti. Njegova raznovrsnost čini ga atraktivnim vidom treninga koji ne samo da poboljšava fizičke parametre, već i podstiče društvenu interakciju i dugoročno usvajanje aktivnog načina života.*
Ključne reči: *fudbal, rekreacija, motoričke sposobnosti, funkcionalne sposobnosti, telesni sastav.*

THE COACH-CREATED MOTIVATIONAL CLIMATE: PREDICTORS OF SATISFACTION AND PHYSICAL SELF-EFFICACY OF CADET FOOTBALL PLAYERS

Ivanović Miroljub[1], Ivanović Uglješa[2]
[1]Serbian Academy of Innovation Sciences, Belgrade, Serbia
[2]Telecom Serbia, a. d. Belgrade, Serbia

ORIGINAL SCIENTIFIC ARTICLE
DOI: 10.5937/ATAVPA25058I

Abstract: *The main aim of this research was to examine the relations between the constructs of the coach-created motivational climate, satisfaction, and physical self-efficacy of adolescent football players. The sample included N = 128 football players, average age (M =17.46 years, SD = 1.09). Three measuring instruments were used: Perceived Motivational Climate in Sport Questionnaire (PMCSQ-2; Duda, & Yin, 2000), Athlete Satisfaction Questionnaire (ASQ; Riemer, & Chelladurai, 1998), and The Physical Self-Efficacy Scale (PSE; Ryckman, Robbins, Thornton, & Cantrell, 1982). Linear regression model was tested and it showed that the variables of perceived motivational climate oriented towards learning (β = .42, and β = .42, p ≤ .01) are statistically significant partial predictors of criteria satisfaction and perceived physical ability of young football players. The obtained findings point to the relevance of the insufficiently examined phenomenon of the coach-created motivational climate, physical abilities, and satisfaction of cadet football players. The final analysis includes the theoretical contribution of the results, limitations of the research, operational implications, and the guidelines for future research.*
Key words*: Adolescence, Football, Cadets, Motivational climate, Favoring players*

INTRODUCTION

The assessment of the coach-created motivational climate, satisfaction, and self-efficacy of young athletes is one of the frequent subject matters of psychological research. Seeing how theoretical analyses attribute much significance to the period of adolescence, the fact that a relatively small number of studies have been conducted on adolescents is surprising. Most of the studies have been oriented towards the period of childhood, maturity and old age (M. Ivanović & U. Ivanović, 2012; Notario-Alonso, Prieto-Ayuso, García-Notario & Contreras-Jordán, 2022; Tušak, Corrado, Coco, Tušak, Žilavec, & Masten, 2022). The findings of the aforementioned studies suggest that the coach-created motivational climate is an important determinant of understanding the satisfaction and self-efficacy of an athlete. Internal encouragement in sports is an important efficacy factor, so the aim of every coach is to govern the training in such a way as to create a highly motivated athlete (Matsummoto & Takenaka, 2004). A coach who values skills and cooperation creates a motivational climate oriented towards learning. In such an atmosphere, athletes see that they are required to make an effort in order to develop their skills and that triumph over the opponent is not the only point of training. Athletes perceive the coach as an individual who respects them and gives them a unique support. On the other hand, the aforementioned authors believe that if a coach emphasizes the importance of winning and has a negative attitude towards an athlete who makes a mistake, he then creates a goal oriented atmosphere. In such cases, an athlete perceives the coach as someone who monitors and therefore has different communication with peers. That creates rivalry within a team, and team members focus on personal efficacy. The coach-created motivational climate contributes significantly to athlete's satisfaction (Baletić, 2022). If an athlete sees that the coach's attitude is oriented towards learning, then he or she will feel intrinsic motivation driven by the satisfaction of improving one's skills (Beck, 2003; Ivanović & Ivanović, 2021b).

The period of adolescence is a phase between childhood and adulthood; it is a stage in which a person reaches relative physical and mental maturity – cognitive, emotional, social, psychosexual, and moral maturity in sports (Schmid, Gut, Yanagida, & Conzelmann, 2020). On the other hand, the same research suggests that more than half of adolescents quit training within one year during that period. That would be the reason to examine latent dimensions, the determinants which influence athlete's satisfaction (Baker, Schorer, & Wattie, 2018). According to the study (Adzhar, Abd Aziz, Zakaria, Osman, & Azmi 2019) satisfaction is regarded as a result of intensive and intense mental state which correlates to experience in sports. The findings of this study suggest that an athlete's satisfaction is a relevant factor

in his attention, achievement, and good life. If an athlete is satisfied with his motor skills and the coach's methods to help him reach his maximum psychophysical potential, he will keep achieving success as a competitor. During adolescence, an athlete will specialize for specific branch of sports (Kliethermes et al., 2021). Training at the higher level happens during the time of adolescence, as these studies suggest. In order to achieve significant results, an athlete must always train. Training is a process focused on developing physical strength and improving technique and sports is not just a game but a chance for it to be a profession. Therefore, one of the deciding transformations happening during adolescence is perceiving social relations such as communication with peers and coach; social relations change in a positive way, communication with parents loses its significance and the coach becomes the most important person in an athlete's life because the coach is the one that spends most time with an athlete. In addition, at that age, the coach represents a strong personality with affective attachment who has the aim to influence the development of an adolescent and motivate him to achieve success and satisfaction in sports (Bailey, Cope, & Pearce, 2013; M. Ivanović, Milosavljević, & U. Ivanović, 2017). Apart from motivational atmosphere, perception of self-efficacy is an important factor of athlete's satisfaction (Wilczyńska, Walczak-Kozłowska, Alarcón, Zakrzewska, & Jaenes, 2022). The aforementioned authors define self-efficacy as the self-evaluation of personal success, competence, and organization of activities that are meant to help achieve athletic success. They believe that the construct motivation significantly includes treatment, internal motivation, and achievement is sports. The dimension of confidence is one's own body represents belief in oneself when one needs to present to others skills and physical characteristics, for example speed, strength, coordination, etc. (Reynders, Vansteenkiste, & Van Puyenbroeck, 2019). Athletes who better manifest physical skills and self-efficacy have a higher level of satisfaction, and physical self-efficacy is a relevant factor in athletic achievement and minimizing anxiety (Sklett, Loras, & Sigmundsson, 2018).

The period of adolescence is characterized by morphological changes such as growth spurt, increase in body mass, tendon and muscle lengthening which manifests itself as disproportionate body constitution (Lipshits-Braziler, Amram-Vaknin, Pesin-Michael, & Tatar, 2022). The same authors claim that such age is also characterized by secondary sex characteristics, and due to fast and disproportionate growth a disbalance in body image occurs. Hence, due to all the psychophysical transformations athletes focus on intense work-out, and the athletes who possess a high level of self-efficacy will see themselves as more competent and efficient.

Keeping in mind the lack of research dealing with this phenomenon and the controversial data obtained in the earlier studies, the aim of this research was to examine the interactions between the variables of coach-created motivational climate, satisfaction, and physical self-efficacy in adolescent football players. In accordance with the theoretical framework, empirical results, and the aim of this research, two hypotheses were formulated: H_1 – the assumption is that the constructs of perceived motivational climate oriented towards learning and perceived physical efficacy of cadet football players are statistically significant in predicting the segment of the variance of their perceived physical efficacy; H_2 –motivational climate oriented towards learning is expected to determine the variability of the perceived physical efficacy of adolescent football players.

METHODS

Participants and procedure

This transversal research was conducted on a pertinent sample and it included 128 cadet football players from five clubs of Kolubara-mačva league: "Budućnost-Krušik 2014" (Valjevo), FC "Radnički" (Valjevo), FC "Jedinstvo" (UB), FC "Železničar" (Lajkovac), and FC "Mačva" (Šabac). The average age of participants was M = 17,46 (SD = 1,09). All the participants had a minimum of two years of systematic and organized training, three or more times a week.

The testing was conducted during December 2024. Before the group testing began, information regarding the aim of the research and the procedure of data collecting and recording were given to the participants. Participants also gave informed consent, with previous approval from parents and club

managers. They were also told that they can quit at any time and do not have to answer the questions they do not want. The testing lasted approximately 30 minutes.

Instruments

Perceived Motivational Climate in Sport Questionnaire (PMCSQ-2; Newton, Duda, & Yin, 2000). PMCSQ-2 includes participants' perception regarding the coach-created motivational climate. The short version of this questionnaire was used in this research, and it consisted of 14 claims that are separated into three subscales: (1) motivational climate oriented towards learning (seven items, for example *"He encourages us to teach each other"*), (2) favoring athletes (three claims, for example *"He pays attention only to the 'stars' of the team"*), and (3) punishment for mistakes (four claims, for example *"Whenever an athlete makes a mistake, the coach punishes him"*). The participants had to assess the level of agreement with a statement on a five-point Likert scale that ranges from 1 to 5 (from 1 – *completely untrue* to 5 – *completely true*). The result of each subscale was taken as an average score for all claims from all the participants. The final result was calculated as an arithmetic mean of all the answers from all participants, where higher result means higher level of the expressed construct. Cronbach's alpha coefficient, the type of internal consistency, on this sample was satisfactory and ranges from ($\alpha = .79$) for the dimension motivational climate oriented towards learning, ($\alpha = .87$) for favoring athletes, to ($\alpha = .90$) for punishment for mistakes, which all points to satisfactory reliability of the subscales.

The Physical Self-Efficacy Scale (PSE; Ryckman, Robbins, Thornton, & Cantrell, 1982). PSE includes the self-perception of the participants on their physical ability and confidence regarding their motor skills. The overall scale consists of 22 claims that are separated into two subscales: perceived physical ability and confidence in physical self-presentation. The short version of the subscale perceived physical ability consisting of eight claims was used on this sample and adapted for the participant of the said age. Using the five-point Likert scale (from 1 – *I completely disagree* to 5 – *I completely agree*) a participant had the task to mark the level of agreement with the given statements. The higher score meant the higher level of perceived physical ability. The final score of the PSE is an arithmetic mean of the answers to all the claims. Cronbach's alpha coefficient was used to determine the reliability of the scale and it revealed that the reliability was high ($\alpha = .87$) which means that the instrument used is valid.

Athlete Satisfaction Questionnaire (ASQ; Raimrer & Chelladurai, 1998). The measuring instrument ASQ consists of 56 claims that form 15 subscales. In accordance with the aim of this research, only two subscales were used: a) satisfaction with one's individual performance, and b) satisfaction with athlete's ability utilization. Using the five-point Likert scale (from 1 – *very dissatisfied* to 5 –*very satisfied*) a participant had the task to assess the level of agreement with the given statements. Total score on a used scale is a sum of the results from all five claims and it marks the participant's level of satisfaction, where higher score means higher level of satisfaction. The index of the internal consistency of this measuring construct was satisfactory ($\alpha = .85$).

Statistical analysis

The statistical procedures included taking into consideration the measures of central tendency, correlational analysis (the Pearson correlation coefficient), and the multivariate regression model. Statistical significance was defined on the level $p \leq .01$. All of the results obtained in this study were processed using the standard software *Statistika ver*. 13.

RESULTS

The main descriptive values of the manifested variables were the first to be processed (Table 1). The maximum values of the arithmetic mean can be seen on the values perceived physical ability, satisfaction, and perceived motivational climate oriented towards learning, while average results can be seen on the variables favoring athletes and punishment for mistakes. The results of standard deviation vary significantly. Perceived motivational climate oriented towards learning had minimum variability, while satisfaction and perceived physical ability had maximum distribution of the results. Testing the scores of normal distribution, it has been determined that the values of skewness and kurtosis are acceptable because they do not vary outside of ± 1.5 which makes these parametric statistical methods valid

(Tabachnick & Fidell, 2012).

Table 1 Descriptive statistics of the variables used in the research

Variables	*AM*	*SD*	*Min*	*Max*	*Sk*	*Ku*
Perceived motivational climate oriented towards learning	29.78	4.01	17.00	36.00	-.04	1.24
Favoring athletes	6.43	3.86	2.00	16.00	.82	-.02
Punishment for mistakes	19.94	4.25	3.00	19.00	-.12	.98
Satisfaction	29.46	6.03	14.00	39.00	0.71	-.23
Perceived physical ability	29.88	5.18	16.00	41.00	-.25	.45

Note. AM = arithmetic mean; *SD* = standard deviation; *Max* = maximum value; *Min* = minimum value; *Sk* = standardized skewness; *Ku* = standardized kurtosis.

The results of the correlational analysis are shown in Table 2. The maximum statistically highly significant positive linear correlation was found between the variables perceived physical ability and satisfaction (r = .64, $p \leq .01$), and perceived physical ability and coach's favoring football players (r = .49, $p \leq .01$). The correlation with positive indicators was obtained, which means that participants who manifest higher level of perceived physical ability and favoring from coach have higher levels of satisfaction and physical ability. On the other hand, the minimum significant correlation of low intensity and negative direction was found between perceived motivational climate oriented towards learning and punishing adolescent football players for mistakes (r = -.19, $p \leq .01$). Statistically, this correlation of low intensity points to inverse relations, which means that when one variable increases the other decreases and vice versa.

Table 2 Intercorrelations between PMCSQ-2, ASQ and PSE

Variables	Perceived physical ability	Satisfaction	Perceived motivational climate oriented towards learning	Punishment for mistakes	Favoring athletes
Perceived physical ability		.64**	.29**	.10	-.03
Satisfaction		1	.57**	-.18*	.42**
Perceived motivational climate oriented towards learning			1	-.19*	.49**
Punishment for mistakes				1	.60**
Favoring athletes					1

Note. r = the Pearson correlation coefficient; *p<.01 **p<.05

With the aim of examining the relations between the coach-created motivational climate, satisfaction, and physical self-efficacy in cadet football players, data was analyzed using the method of standardized multiple regression where satisfaction and perceived physical ability were dependent (criterion) variables, and perceived motivational climate oriented towards learning, punishment for mistakes, and favoring athletes were independent (predictor) variables.

The value of multiple correlation coefficient shown in Table 3, with the risk level lover than 1%, is (R = .69) which means that there is intense linear correlation between the group of predictors and criterion. The value of the coefficient of multiple determination (squared R) shows that linear regression model explains 49% of the criterion variable participants' satisfaction.

In the regression model, two predictor variables showed positive and statistically significant partial influence on the variable satisfaction: perceived motivational climate oriented towards learning (β = .42, $p \leq .01$) and perceived physical ability (β = .51, $p \leq .01$). That means that cadet football players who achieve higher results on the: perceived motivational climate oriented towards learning and perceived physical ability have higher score on satisfaction. In addition, the regression equation has shown that the two other independent variables (punishment for mistakes and favoring athletes) are not statistically

significant predictors of the examined population of football players.

Table 3 Multiple regression analysis of criterion variable satisfaction

Predictors	β	*SE*
Perceived motivational climate oriented towards learning	.42**	.12
Punishment for mistakes	.09	1.45
Favoring athletes	.11	.23
Perceived physical ability	.51**	1.16
R .69		
R^2 .49		

Note. B = standardized regression coefficient, SE = standard error, R = multiple correlation coefficient R^2 = coefficient of determination; **p ≤ .01

Table 4 shows the calculated multiple correlation coefficient (R = .56), and with the risk level of 1%, it reveals the moderate intensity of linear correlation between the independent variables and criterion. The predictive model accounts for 20% of the variability of the dependent variable perceived physical ability as the coefficient of determination (squared R) is (R^2 = .20).

Table 4 Multiple regression analysis of criterion variable perceived physical ability

Predictors	β	*SE*
Perceived motivational climate oriented towards learning	.43**	.17
Punishment for mistakes	.08	1.33
Favoring athletes	.03	.49
R .56		
R^2 .20		

Note. β = standardized regression coefficient, SE = standard error, R = multiple correlation coefficient R^2 = coefficient of determination; **p ≤ .01

Only the predictor variable perceived motivational climate oriented towards learning showed the statistically significant partial contribution to multiple regression, with a positive indicator (β = .43, $p \leq .01$). That implies that young football players who realize higher scores on the perceived motivational climate oriented towards learning achieve higher scores on perceived physical ability. On the other hand, the other two examined variables (punishment for mistakes and favoring athletes) did not show any statistical significance.

DISCUSSION

A significant number of empirical studies that dealt with adolescent athletes revealed that pleasure and satisfaction are important determinants of an athlete's decision to quit or keep training. That was precisely the aim of this research, to examine the influence of perceived coach-created motivational climate on perceived self-efficacy and satisfaction of cadet football players.

Research findings show that coach's actions that create motivational climate oriented towards learning and the perceived physical ability are relevant in explaining athlete's satisfaction (M. Ivanović & U. Ivanović, 2022; M. Ivanović & U. Ivanović, 2018; Tušak et al., 2022). The aforementioned authors believe that the adolescent athletes who perceive the coach and his actions that influence their sports technique and skills development will create emotional support and manifest a higher level of satisfaction with their own sports activity. Motivational climate oriented towards learning is created on the basis that the coach-created motivational climate and daily training sessions are necessary for achieving success. In such atmosphere, an athlete perceives the coach as an expert who supports him and teaches him sports techniques, which leads to higher level of satisfaction. However, what contributes

to athlete's satisfaction is also perceived physical ability, for example, speed, strength, and agility, which also has significant influence on confidence, self-efficacy, and achieving success (Zeng, Meng, Sun, & Xie, 2019). The aforementioned authors believe that during adolescence the knowledge regarding body constitution becomes important, while doubt in one's physical competence prevents athlete from expressing his best skills and satisfaction. Physical self-efficacy is an important factor for athletes because their body shape and motor skills, primarily speed and strength, are important factors for winning a game that requires physical contact with an opponent (De Francisco, Arce, Sánchez-Romero, & Vílchez, 2018).

Based on the results of the correlational analysis conducted for this research, one can see that there is a statistically significant correlation between the coach-created climate, physical self-efficacy, and satisfaction in cadet football players. Motivational climate directly contributes to the satisfaction and perceived physical self-efficacy of cadet football players.

The findings of the regression analysis conducted on our sample revealed that the coach-created motivational climate is a significant factor of perceived physical self-efficacy in young football players. The adolescent football players' recognition of physical self-efficacy during training is influenced by various determinants which are created based on how they experience social environment, primarily peers and coach. Cultivating social relations during training sessions is a relevant factor in guiding football players, more significant than their achievement. The relevant factors in the perception of physical self-efficacy are the relationship a coach has with the cadet football players, his method of managing the team, as well as the athlete's belief in his own physical ability. Physical development of an athlete is one of the responsibilities of a coach (Opstoel, Chapelle, Prins, Meester, Haerens, & van Tartwijk, 2020). The aforementioned authors believe that a coach evaluates the level of an athlete's physical ability and the technique elements that need to be perfected for an athlete to achieve better success. A coach also creates a motivational climate oriented towards learning and doesn't see an athlete's imperfections as obstacles but as incentives and approaches the athlete in order to help him overcome his weaknesses. Improving physical competence includes a form of development, not pressure and burden. Such approach does not create rivalry between players as coach teaches his players to compare their achievements to individual improvements, which leads to higher level of self-efficacy, and achievement is regarded as a result of personal effort (M. Ivanović, & U. Ivanović, 2021b; Kenioua & Nawal, 2021). So, thanks to such an atmosphere, athlete is focused more on himself and, with the help of the coach, builds his belief in physical self-efficacy.

This transversal research has a few methodological limitations which have to be taken into account when interpreting the obtained results. First, the pertinent sample was insufficiently representative, and due to the chosen geographic region, one cannot generalize the results for the adolescent football population. Therefore, it is recommended that future research expand to entire Serbia and include a greater number of participants of both sexes, and those who practice individual sports. Another limitation has to do with the method of self-evaluation which means that one cannot exclude the presence of methodological variance and the problems of perceiving one's own behavior. In addition, there is a probability that certain participants gave dishonest and socially desirable answers, which could be caused by the sitting arrangement as participants sat close to each other.

However, despite the methodological limitations, this cross-sectional study offers useful results and an important basis for future research and practice. It shows that the construct coach-created motivational climate explains the part of the proportion of satisfaction and physical self-efficacy of cadet football players, which can serve as a guideline for future research.

As the chosen predictors of the variable motivational climate explained a relatively small percentage of the variance satisfaction and physical self-efficacy, and a big part of the variability remained unexplained, future research should include other variables such as peer and parent evaluation in order to obtain more realistic indicators of criterion variables. However, other variables should be examined as well but in a real sports situation, such as pro-social behavior, emotional intelligence, and stress variance, which could play a significant part in predicting satisfaction and physical self-efficacy. In addition, future research should check the differences in the perceived coach-created motivational climate between the adolescents of both sexes in individual and team sports and the coach's contribution

to their perceived satisfaction and physical self-efficacy. Finally, future research should be longitudinal or experimental, which will enable a better understanding of the complex relations in question.

REFERENCES

1. Adzhar, R. J. I., Abd Aziz, S., Zakaria, J., Osman, N., & Azmi, S. H. (2019). Correlation between leadership style and athlete motivation among males and females' adolescents. *Malaysian Journal of Movement Health & Exercise, 8*(2), 45–56. doi:10.15282/mohe. v8i2.340
2. Bailey, R., Cope, E. J., & Pearce, G. (2013). Why do children take part in, and remain involved in sport? A literature review and discussion of implications for sports coaches. *International Journal of Coaching Science, 7*(1), 56–75.
3. Baker, J., Schorer, J., & Wattie, N. (2018). Compromising talent: issues in identifying and selecting talent in sport. *Quest*, *70*(1), 48–63. doi :10.1080/00336297.2017.1333438
4. Baletić, I. (2022). *Socijalna okolina i sudelovanje mladih u hrvanju* (Neobjavljena doktorska disertacija). Zagreb: Kineziološki fakultet, Sveučilište u Zagrebu.
5. Beck, R. C. (2003). *Motivation: Theories and principles*. Jastrebarsko: Naklada Slap.
6. De Francisco, C., Arce, C., Sánchez-Romero, E. I., & Vílchez, M. d. P. (2018). The mediating role of sport self-motivation between basic psychological needs satisfaction and athlete engagement. *Psicothema, 30*(4), 421–426.
7. Ivanović, M., i Ivanović, U. (2021a). Struktura relacija petofaktorskog modela ličnosti i motivacionih dimenzija kod karatista juniora [The structure of relations between the five-factor model and dimensions of motivation among junior karatekas] *Sport – nauka i praksa, 2*(1), 67–75.
8. Ivanović. M., Ivanović, U. (2021b). Anksioznost i depresivnost determinante zadovoljstva telesnim izgledom kod fudbalera pionira i kadeta [Anxiety and depression as determinants of body image satisfaction among pioneer and cadet football players]. U S. Nešković (Ur.), *Međunarodna konferencija „Država i globalni izazovi bezbednosti"* (str. 87 – 97). Beograd: Centar za strateška istraživanja nacionalne bezbednosti – CESNA.
9. Ivanović, M., & Ivanović, U. (2012). Aspekti self-koncepta predadolescenata kao determinante njihovog bavljenja sportom. [Pre-adolescent self-concept aspects as determinants of engagement in sports activities]. *Sport - nauka i praksa*, *2*(5), 5–21.
10. Ivanović, M., & Ivanović, U. (2018). Gender differences during adolescence in the motives for physical exercise, depression, anxiety and stress [Polne razlike u adolescenciji u motivima za fizičko vežbanje, depresiju, anksioznost i stres]. *EQOL Journal, 10*(1), 17–22.
11. Ivanović. M., Ivanović, U. (2021). Sociodemografske varijable, perfekcionizam, anksioznost i somatizacija kao prediktori školskog uspeha odbojkaša kadeta i juniora[Socio-demographic variables, perfectionism, anxiety and somatization as predictors of school success among cadet and junior volleyball players], *Sportske nauke i zdravlje, 11*(1), 55–64.
12. Ivanović, M., Milosavljević, S., & Ivanović, U. (2017). Opšte nezadovoljstvo telesnim izgledom kao prediktor sprovođenja dijete kod adolescentkinja. [General body image dissatisfaction as the predictor of diet implementation among female adolescents]. In V. Stanković, N. Živanović, & N. Ranković (Eds.), *„Anthropological and Theoantrophological Aspects of Physical Activities from the Constantine the Great to Nowadays*" (pp. 209–221). Leposavić: Univerzitet u Prištini, Fakultet za sport i fizičko vaspitanje.
13. Kenioua, M., & Nawal, K. (2021). Self-efficacy and its relationship with sports achievement motivation and level of aspiration in emerging football plyers U-17 (A field study on football players for Ouargla and Touggourt regions). *Journal of Sport Science Technology and Physical Activities*, 18, 42–55.
14. Kliethermes, S. A., Marshall, S.W., LaBella, C.R., Watson, A. M., Brenner, J. S., … Nagle, K. B. (2021). Defining a research agenda for youth sport specialisation in the USA: the AMSSM Youth Early Sport Specialization Summit. *British Journal* of *Sports Medicine* (BJSM),135–43. doi:10.1136/bjsports-2020-102699
15. Lipshits-Braziler, Y., Amram-Vaknin, S., Pesin-Michael, G., & Tatar, M. (2022). Patterns of online seeking and providing help among adolescents: a preliminary study. *British Journal of Guidance & Counselling,* 50, 29–42.
16. Matsumoto, H., & Takenaka, K. (2004) Motivational profiles and stages of exercise behavior change. *International Journal of Sport and Health Science, 2*, 89–96. doi: 10.5432/ijshs.2.89
17. Newton, M., Duda, J. L. and Yin, Z. 2000. Examination of the psychometric properties of the Perceived Motivational Climate in Sport Questionnaire-2 in a sample of female athletes. *Journal of Sports* Sciences, 18, 275–290. doi:10.1080/026404100365018
18. Notario-Alonso, R., Prieto-Ayuso, A., García-Notario, A., & Contreras-Jordán, O.R. (2022). The sports commitment in football players and its relationship with the coach performance: A systematic review. *Journal of Human Sport and Exercise, in press*, 1, 1–13. doi:10.14198/jhse.2023.182.01

19. Opstoel, K., Chapelle, L., Prins, F. J., De Meester, A., Haerens, L., & van Tartwijk J. (2020). Personal and social development in physical education and sports: A review study. *European Physical Education Review, 26*(4),797–813.
20. Reynders, B., Vansteenkiste, M., & Van Puyenbroeck, S. (2019). Coaching the coach: intervention effects on need-supportive coaching behavior and athlete motivation and engagement. *Psychol Sport Exerc, 43,* 288–300. doi: 10.1016/j.psychsport. 2019.04.002
21. Riemer, H. A., & Chelladurai, P. (1998). Development of the Athlete Satisfaction Questionnaire (ASQ). *Journal of Sport & Exercise Psychology, 20*(2), 127–156.
22. Rogowska, A. M., Tataruch, R., Niedźwiecki, K., & Wojciechowska-Maszkowska, B. (2022). The Mediating Role of Self-Efficacy in the Relationship between Approach Motivational System and Sports Success among Elite Speed Skating Athletes and Physical Education Students. *International Journal of Environmental Research and Public Health*, *19*(5), 2899–2910. doi:10.3390/ijerph19052899
23. Ryckman, R. M., Robbins, M. A., Thornton, B., & Cantrell, P. (1982). Development and validation of a Physical Self-Efficacy Scale. *Journal of Personality and Social Psychology, 42*(5), 891–900. doi:10.1037/0022-3514.42.5.891
24. Schmid, J., Gut, V., Yanagida, T., Conzelmann, A. (2022). Who stays on? The link between psychosocial patterns and changes in exercise and sport behaviour when adolescents make transitions in education. *Appl Psychol Health Well Being. 12*, 312–324. doi:10.1111/aphw.12186.
25. Sklett, V. H., Lorås, H. W., & Sigmundsson, H (2018) Self-Efficacy, Flow, Affect, Worry and Performance in Elite World Cup Ski Jumping. *Frontiers in Psychology,* 9, 1215 –1222. doi: 10.3389/fpsyg.2018.01215
26. Tabachnick, B. G., & Fidell, L. S. (2012). *Using multivariate statistics*. London: Pearson Education.
27. Tenjović, L. (2002). *Statistika u psihologiji*-priručnik. Beograd: Centar za primenjenu psihologiju Društva psihologa Srbije.
28. Tušak, M., Corrado, D. D., Coco, M., Tušak, M., Žilavec I., & Masten, R. (2022). Dynamic Interactive Model of Sport otivation. *International Journal of Environmental Research and Public Health*, *19*(7), 4202–4214. doi:10.3390/ijerph19074202
29. Zeng, Z., Meng, W.Y., Sun, P., Xie, L.S. (2019). An exploratory study of youth soccer players' participation motivation and health-related behaviors. *The Physical Educator, 76*(2), 329–356. doi:10.18666/TPE-2019-V76-I2-8499
30. Wilczyńska, D., Walczak-Kozłowska, T., Alarcón, D., Zakrzewska, D., & Jaenes, J. C. (2022). Dimensions of Athlete-Coach Relationship and Sport Anxiety as Predictors of the Changes in Psychomotor and Motivational Welfare of Child Athletes after the Implementation of the Psychological Workshops for Coaches. *International Journal of Environmental Research and Public Health*. *19*(6), 3462–3474. doi:10.3390/ijerph19063462

MOTIVACIONA ATMOSFERA UTICAJEM TRENERA: PREDIKTOR ZADOVOLJSTVA I TELESNE SAMOUSPEŠNOSTI FUDBALERA KADETA

Ivanović Miroljub, Ivanović Uglješa

Sažetak: *Osnovni cilj ovog empirijskog istraživanja bio je ispitivanje relacija konstrukata motivacione atmosfere uticajem trenera, zadovoljstva i telesne samouspešnosti kod fudbalera adolescenata. Uzorak je obuhvatio N = 128 fudbalera prosečne starosti 17.46 (SD = 1.09 godina). Korišćena su tri merna instrumenta: Upitnik percipiranog motivacionog stanja generisanog od strane trenera (Perceived Motivational Climate in Sport Questionnaire – PMCSQ-2 (Newton, Duda, & Yin, 2000), Upitnik o zadovoljstvu sportista (Athlete Satisfaction Questionnaire – ASQ, Riemer, & Chelladurai, 1998) i Upitnik telesne samouspešnosti (The Physical Self-Efficacy Scale – PSE, Ryckman, Robbins, Thornton, & Cantrell 1982). Testirani regresioni linearni model je pokazao da su varijable percipirano motivaciono stanje orijentisano na učenje (β = .42, i β = .42, p ≤ .01) statistički značajni parcijalni prediktori kriterijuma zadovoljstva mladih fudbalera i percipirane telesne sposobnosti. Dobijeni nalazi osvetljavaju relevantnost do sada nedovoljno istraženih fenomena motivacione klime uticajem trenera, telesne sposobnosti i zadovolstva kod fudbalera u kadetskom uzrastu. Zaključna analiza zbraja teorijski doprinos rezultata, nedostatke, operacionalizovane implikacije, kao i neophodne pravce za buduća istraživanja.*

Ključne reči*: adolescencija, fudbal, kadetski uzrast, motivaciona klima, favorizovanje igrača*

ANALYSIS OF EXERCISE HABITS OF FACULTY OF CHEMISTRY AND CHEMICAL TECHNOLOGY UL AND FACULTY FOR COMPUTER AND INFORMATION SIENCE UL STUDENTS: ORGANIZED AND UNORGANIZED PHYSICAL ACTIVITY

Jamnik Eva
Faculty of Chemistry and Chemical Technology, University of Ljubljana

ORIGINAL SCIENTIFIC ARTICLE
DOI: 10.5937/ATAVPA25066J

Abstract: *Physical activity plays a crucial role in maintaining physical health, improving mental well-being, and enhancing overall quality of life. Among students, whose daily routines are often burdened with academic obligations, maintaining regular physical activity can be challenging. Decisions regarding how often and in what manner to exercise depend on various factors, including the year of study, time constraints, motivation, and accessibility of organized workouts. This research focuses on three key aspects of physical activity among Faculty of Chemistry and Chemical Technology, University of Ljubljana (FKKT) and Faculty for Computer and Information sience, University of Ljubljana (FRI) students: the type of exercise (organized vs. unorganized), the frequency of weekly exercise, and the students' year of study. The study analyzes how students choose to engage in physical activity at different stages of their studies and which exercise habits are most prevalent. The aim is to understand which types of exercise are the most popular, how the frequency of exercise is related to the year of study, and how students' exercise habits change over time. Data were collected through an online survey distributed to students enrolled in the Physical Education course during the semester. The collected data were processed using SPSS and Microsoft Excel. Through this analysis, we aim to gain insight into potential differences between students from different years and develop recommendations for promoting regular physical activity in the student environment. Findings indicate that students engage in both organized and unorganized exercise at similar rates, with a slight preference for unorganized exercise. Those who opt for unorganized exercise tend to be more physically active, especially those who work out multiple times per week. Senior students are generally more physically active and prefer exercising more frequently, suggesting greater independence and awareness of the importance of physical activity in later years of study. In contrast, first-year students tend to be less active and more likely to choose organized exercise.*
Key words: *physical activity, students, exercise types, exercise frequency, year of study.*

INTRODUCTION

Regular physical activity is a key factor in promoting long-term health and well-being (Fahey et al., 2004; Železnik & Vidnar, 2013). Physical activity is an essential part of daily life, with its quality largely depending on the amount of movement incorporated into one's lifestyle. Movement contributes to the overall balance of body and mind and serves as an important counterbalance to the challenges posed by a fast-paced lifestyle and numerous work obligations in modern society (Berčič et al., 2002). Current guidelines recommend that adolescents engage in 60 minutes of moderate to intense physical activity daily, while adults should engage in 30 minutes of physical activity five days per week. This helps maintain and improve physical fitness and the musculoskeletal system. Additionally, regular exercise reduces the risk of common illnesses, strengthens the immune system, and alleviates stress and mental strain (Železnik & Vidmar, 2013; Pate et al., 1995).

Students, who are transitioning from adolescence to adulthood, experience many physical and psychological changes that can significantly impact their life experiences (Lalor et al., 2007). Research has shown that intrinsic motivations, such as enjoyment and challenge, are closely linked to participation in sports activities, whereas extrinsic motivations, such as concern for appearance or stress management, have a greater influence on participation in physical activity (Kilpatrick et al., 2005). Furthermore, factors such as interest in activities, social support, a sense of achievement, and self-confidence are recognized as crucial in promoting regular physical activity (Tsai, 2005). In this context, understanding how different motivational factors influence physical activity is important for developing effective strategies to encourage healthy lifestyle habits among students.

Organized exercise can be defined as planned and structured physical activity, typically led by trained professionals and conducted within specific programs or institutions, such as sports clubs or fitness

centers. In contrast, unorganized exercise refers to spontaneous or casual physical activity that is not formally led or structured by a sports professional.

There are also noticeable differences in participation in organized and unorganized sports activities depending on age. Younger individuals are more likely to participate in organized sports activities, while older individuals tend to prefer unorganized forms of exercise. Possible reasons for higher participation in unorganized activities among older individuals include greater flexibility - unorganized activities allow individuals to adjust the intensity and timing of exercise to their needs and capabilities; accessibility - unorganized exercise does not require special equipment or membership in sports clubs, making it more accessible; social aspects - older individuals may prefer activities they can do alone or in small groups, without the formal structure of organized workouts; educational aspect – Due to higher education levels, they are more informed about the importance of physical activity and capable of creating their own workout programs, requiring less guidance in the exercise process (Zurc, 2008).

RESEARCH OBJECTIVES

The objectives of the research were:

- To determine which type of exercise students prefer—organized or unorganized exercise.
- To examine the relationship between the type of exercise and the frequency of weekly physical activity.
- To identify differences in the type and frequency of exercise between first-year and third-year undergraduate students.
- The following hypotheses were proposed:
- Students prefer unorganized exercise.
- Students who prefer unorganized exercise engage in physical activity more frequently per week than those who participate in organized exercise.
- Third-year students are more likely to engage in unorganized exercise and are more physically active per week compared to first-year students.

METHODS

Research participants

The survey participants were undergraduate students enrolled in the elective course Physical Education. The majority (69%) were students from the Faculty of Chemistry and Chemical Technology, while the remaining (31%) were from the Faculty of Computer and Information Science. A total of 63 respondents participated in the study, including 35 male students (54%) and 30 female students (46%).

Procedure and instruments

Data collection was conducted using a questionnaire consisting of 26 closed-ended questions. For the purposes of this study, data from three specific questions were analyzed, focusing on the choice of exercise type – organized and unorganized, the frequency of weekly exercise and differences between first-year and third-year undergraduate students at FKKT and FRI.

The questionnaire was administered electronically via 1ka in early February 2023. Participants could complete it in their free time, and data collection lasted approximately 14 days. The collected data were first separated from other responses, transferred to Microsoft Excel, and later analyzed using the statistical software IBM SPSS Statistics 20. A frequency and descriptive analysis was conducted for the questions related to the type of exercise (organized vs. unorganized) and the relationship between exercise type and weekly exercise frequency. This relationship was tested using the χ^2 (chi-square) test. Comparisons of exercise type, weekly exercise frequency, and study year were examined using contingency tables.

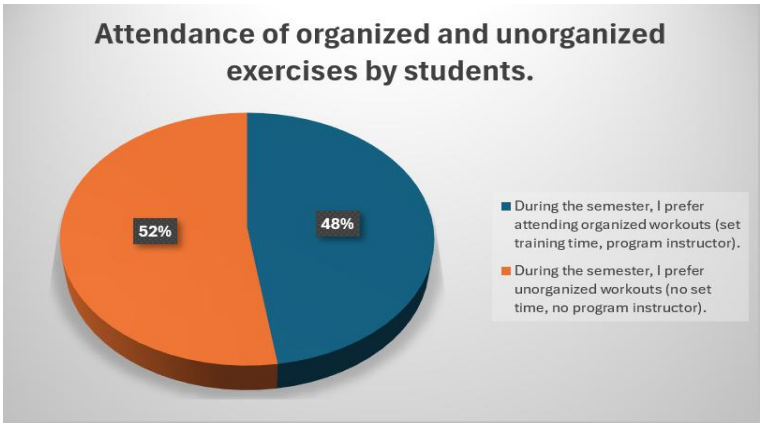
STATISTICAL DATA ANALYSIS

The collected survey data focused on the type and frequency of weekly exercise, which were also analyzed based on study year (first-year vs. third-year students). The selected questions were treated as

ordinal variables. First, data on exercise type, weekly exercise frequency, and study year were processed using frequency and descriptive analysis and presented in tables. The results were then visually represented with graphs to facilitate comparisons among respondents. The relationship between exercise type and weekly exercise frequency was analyzed using the χ^2 (chi-square) test and contingency tables. All results were evaluated at a 5% level of statistical significance.

RESULTS

Figure 1 Comparison of participation in organized and unorganized exercise by students



In Figure 1, a pie chart presents the frequency and descriptive analysis of data comparing participation in organized and unorganized exercise. The results show that 48% of students choose organized exercise, which includes a set schedule and an instructor, while 52% prefer unorganized exercise, meaning there is no fixed time for the workout, and no instructor is present.

Figure 2 Analysis of exercise type and weekly exercise frequency

Type of exercise			Frequency	Percentage	Valid percentage	Cumulative percentage
Organized exercise	Valid	Less than once a week	12	40,0	40,0	40,0
		1-2 times a week	8	26,7	26,7	66,7
		3-4 times a week	5	16,7	16,7	83,3
		5 or more times a week	5	16,7	16,7	100,0
		Total	30	100,0	100,0	
Unorganized exercise	Valid	Less than once a week	2	6,1	6,1	6,1
		1-2 times a week	16	48,5	48,5	54,5
		3-4 times a week	6	18,2	18,2	72,7
		5 or more times a week	9	27,3	27,3	100,0
		Total	33	100,0	100,0	

Figure 3 *χ^2 test – Relationship between exercise type and weekly exercise frequency*

Chi-square test

	Value	df	Sig. (2-tailed)
Pearson's Chi-square test	10,925[a]	3	,012
Odds Ratio	11,750	3	,008
N of valid cases	63		

a. 0 cells (0.0%) have an expected count of less than 5. The smallest expected count is 5.24.

In Figure 2, a frequency and descriptive analysis of exercise type and weekly exercise frequency is presented. The results show that organized exercise is more common among less active individuals (less than once per week), specifically in 40% of cases. On the other hand, unorganized exercise is more popular among more active individuals, particularly those who exercise 1–2 times per week (48.5%) and 5 or more times per week (27.3%). This correlation suggests that more active individuals tend to prefer unorganized exercise, whereas less active individuals are more likely to engage in organized exercise, possibly because they receive more motivation and support in a structured setting.

In Figure 3, the χ^2 test results indicate a p-value of 0.012, which is lower than the conventional significance level of 0.05. This allows us to conclude that there is a statistically significant relationship between exercise type (organized/unorganized) and weekly exercise frequency. In other words, the choice of exercise type is not random, but rather linked to how often an individual engages in physical activity.

Figure 4 Contingency table of exercise type, weekly exercise frequency and study year

Type of Exercise*Exercise frequency per week * Year of study Crosstabulation

Year of study		Frequency of exercise per week				Total
		Less than once a week	1-2 times a week	3-4 times a week	5 or more times a week	
1st year	Organized exercise	6	3	3	4	16
		37,5%	18,8%	18,8%	25,0%	100,0%
		100,0%	21,4%	42,9%	57,1%	47,1%
		17,6%	8,8%	8,8%	11,8%	47,1%
	Unorganized exercise	0	11	4	3	18
		0,0%	61,1%	22,2%	16,7%	100,0%
		0,0%	78,6%	57,1%	42,9%	52,9%
		0,0%	32,4%	11,8%	8,8%	52,9%
		6	14	7	7	34
		17,6%	41,2%	20,6%	20,6%	100,0%
		100,0%	100,0%	100,0%	100,0%	100,0%
		17,6%	41,2%	20,6%	20,6%	100,0%
3rd year	Organized exercise	2	2	1	1	6
		33,3%	33,3%	16,7%	16,7%	100,0%
		100,0%	50,0%	100,0%	20,0%	50,0%
		16,7%	16,7%	8,3%	8,3%	50,0%
	Unorganized exercise	0	2	0	4	6
		0,0%	33,3%	0,0%	66,7%	100,0%
		0,0%	50,0%	0,0%	80,0%	50,0%
		0,0%	16,7%	0,0%	33,3%	50,0%
		2	4	1	5	12
		16,7%	33,3%	8,3%	41,7%	100,0%
		100,0%	100,0%	100,0%	100,0%	100,0%
		16,7%	33,3%	8,3%	41,7%	100,0%
Total	Organized exercise	12	8	5	5	30
		40,0%	26,7%	16,7%	16,7%	100,0%
		85,7%	33,3%	45,5%	35,7%	47,6%
		19,0%	12,7%	7,9%	7,9%	47,6%
	Unorganized exercise	2	16	6	9	33
		6,1%	48,5%	18,2%	27,3%	100,0%
		14,3%	66,7%	54,5%	64,3%	52,4%
		3,2%	25,4%	9,5%	14,3%	52,4%
		14	24	11	14	63
		22,2%	38,1%	17,5%	22,2%	100,0%
		100,0%	100,0%	100,0%	100,0%	100,0%
		22,2%	38,1%	17,5%	22,2%	100,0%

After reviewing the contingency table in Figure 4, we can conclude that third-year students are significantly more physically active with unorganized exercise. A large percentage of them exercise 5 or more times a week (66.7%), compared to first-year students (16.7%). First-year students are somewhat more consistent with organized exercise, with 25.0% exercising 5 times a week, but the difference is less pronounced. In the first year, most students exercise 1–2 times per week (41.2%), indicating a predominance of moderate activity. Fewer students are highly active (5 or more times a week). In the third year, the distribution changes – a larger percentage of students (41.7%) exercise 5 or more times a week, indicating greater intensity and frequency of exercise. Overall, we found that third-year students are generally more physically active, with a larger proportion in the group with the most frequent exercise (5 or more times a week), while first-year students tend to engage in moderate frequency of exercise (1–2 times per week).

DISCUSSION

Physical activity is crucial for our daily well-being, as the quality of our movement is closely linked to its quantity and incorporation into our everyday lifestyle. Regular physical activity contributes to both physical and mental balance, as it helps overcome stress caused by the fast pace of life and numerous work obligations in the modern world (Berčič et al., 2002).

The study included students from the Faculty of Chemistry and Chemical Engineering and the Faculty of Computer Science and Informatics, who are enrolled in the elective course Physical Education. Although the results cannot be generalized to the entire student population, they offer valuable insights into students from both faculties.

For the first objective of the study, we aimed to determine which type of exercise – organized or unorganized – is more popular among students at the Faculty of Chemistry and Chemical Engineering (FKKT) and the Faculty of Computer Science and Informatics (FRI). It was hypothesized that students would prefer unorganized exercise. The analysis showed that choices between the two types of exercise were almost evenly distributed, with a slight preference for unorganized exercise. This indicates diverse preferences regarding the structure of exercise, which is crucial to consider when designing sports programs for students. Similarly, Majerič (2002) found that during his study, the number of students choosing unorganized physical activities increased, while the percentage of participants in organized exercise remained unchanged.

For the second objective, we wanted to examine the relationship between the type of exercise and weekly frequency of physical activity. It was hypothesized that students who prefer unorganized exercise would be more physically active during the week than those attending organized exercise. The results confirmed that the choice of exercise type (organized or unorganized) is indeed related to the frequency of physical activity. Organized exercise is more common among less active individuals, suggesting that they may need more support and guidance. On the other hand, more active individuals tend to prefer unorganized exercise, especially at higher weekly frequencies (1–2 times or 5+ times a week). Research conducted at the University of Zagreb (Caput-Jugonica & Neljak, 2016, in Berčič, 2016) emphasizes the importance of incorporating regular physical activity among students, as a decrease in physical activity is often observed after high school. Although 63.7% of students participate in systematically guided and planned exercises, the lifestyle of the student population remains too sedentary. The authors highlight that the student period is crucial for fostering positive habits and promoting a healthy lifestyle. Studies (Majerič, 2002; Majerič & Zurc, 2016) have also shown that 79.9% of male students and 76.8% of female students in Slovenia engage in regular physical activity. Most students opt for unorganized forms of exercise, with the majority exercising two to three times per week, reaching a total of 3 to 5 hours of physical activity per week. These results confirm that physical activity is highly important for students in Slovenia.

The third objective of the study was to examine the differences in exercise type and frequency between first-year and third-year undergraduate students. It was hypothesized that third-year students would prefer unorganized exercise and be more active weekly compared to first-year students. The results showed that third-year students are significantly more physically active, with 66.7% exercising 5 or more times per week, compared to 16.7% of first-year students. First-year students tend to be more

consistent with organized exercise (25.0% exercising 5 times a week), but most engage in moderate activity (1–2 times a week, 41.2%). Overall, third-year students are more physically active, while first-year students prefer exercising less frequently. Although Vidovič (2018) reports that first-year students are more physically active than older students, physical activity tends to decrease due to greater study burdens and stress in later years. However, the study "Health of Slovenian Students" (2012) showed that third-year students are more physically active compared to first-year students, being more aware of the importance of physical activity for health and thus more motivated to engage in sports activities.

REFERENCES

1. Berčič, H., Sila, B., in Semolič, A. (2002). *Šport v obdobju zrelosti.* Ljubljana: Univerza v Ljubljani, Fakulteta za šport, Inštitut za šport.
2. Berčič, H. (2016). Mednarodni posvet Zdrav življenjski slog študentov na Univerzi v Ljubljani. *Revija Šport* 17 (1-2), 77-84. https://www.fsp.uni-lj.si/mma/17_revija_sport_1-2_2016_77-84_srecanja_bercic.pdf/2018111315094692/?m=1542118186
3. Caput-Jogunica, R. in Neljak, B. (2016). Značaj obavezne nastave tjelesne i zdravstvene kulture na Sveučilištu u Zagrebu. Univerza v Ljubljani.
4. Fahey, Y., Layte, R., & Gannon, B. (2004). *Sports participation and health among adults in Ireland*. Dublin: ESRI. The Economic and Social Research Institute. https://www.researchgate.net/publication/5019290_Sports_Participation_and_Health_Among_Adults_in_Ireland
5. Kilpatrick, M., Hebert, E. in Bartholomew, J. (2005). College students' motivation for physical activity: differentiating men's and women's motives for sport participation and exercise. *Journal of American College Health, 54*(2), 87–94. 10.3200/JACH.54.2.87-94
6. Lalor, K., de Róiste, A., & Devlin, M. (2007). Young people in contemporary Ireland. https://www.researchgate.net/publication/331037223_Young_People_in_Contemporary_Ireland
7. Majerič, M. (2002). *Struktura motivov za Športno dejavnost pri Študentih Univerze v Ljubljani.* [Magistrsko delo]. Univerza v Ljubljani, Fakulteta za sport, Ljubljana.
8. Majerič, M. in Zurc, J. (2016). *Analiza vzorcev vedenj, povezanih zdravjem - pilotna študija pri Študentih Univerze v Ljubljani. Šport, 64* (1-2), 203-208. https://www.dlib.si/stream/URN:NBN:SI:doc-3LVN32VE/74282855-7b38-4769-aee8-2a276566698e/PDF
9. Pate, R. R., Pratt, M., Blair, S., et al. (1995). Physical Activity and public health: A recommendation from the Centers for Disease Control and Prevention and the American College of Sports Medicine. *JAMA, 273*(5), 402–407. 10.1001/jama.1995.03520290054029
10. Tsai, E. (2005). A cross-cultural study of the influence of perceived positive outcomes on participation in regular active recreation: Hong Kong and Australian University Students. Leisure Sciences, 27, 385–404.
11. Vidović, Ž. (2023). *Telesna aktivnost, sedentarno vedenje in učni dosežki študentov* [Magistrsko delo, Univerza v Mariboru, Pedagoška fakulteta]. Digitalna knjižnica Univerze v Mariboru. https://dk.um.si/IzpisGradiva.php?lang=slv&id=83876
12. Juričič, M. (ur). (2012). Zdravje slovenskih študentov. Zbornik zdravje slovenskih študentov 2012. Slovenska študentska organizacija. https://www.sssam.si/wp-content/uploads/2022/01/zbornik-zdravje-slovenskih-studentov-2012.pdf
13. Zurc, Joca. (2008). Umeščenost gibalnih oz. športnih aktivnosti v strukturo prostega časa mladih: Študija primera v Mestni občini Koper. *Socialno delo. 47*, 37-51. https://www.researchgate.net/publication/303163144_Umescenost_gibalnih_oz_sportnih_aktivnosti_v_strukturo_prostega_casa_mladih_Studija_primera_v_Mestni_obcini_Koper
14. Železnik, U. in Vidnar, N. (2013). *Izberi zdrav življenjski slog - naložba v prihodnost*. Slovenj Gradec: Visoka šola za zdravstvene vede.

ANALIZA FIZIČKIH AKTIVNOSTI STUDENATA FAKULTETA ZA KEMIJU I KEMIJSKU TEHNOLOGIJU UL I FAKULTETA RAČUNARSKIH NAUKA I INFORMATIKE UL: ORGANIZOVANA I NEORGANIZOVANA FIZIČKA AKTIVNOST

Jamnik Eva

Sažetak: *Fizička aktivnost igra ključnu ulogu u održavanju fizičkog zdravlja, poboljšanju psihičkog blagostanja i poboljšanju ukupnog kvaliteta života. Među studentima, čiji je život često opterećen studijskim obavezama, mogu se pojaviti izazovi u održavanju redovne fizičke aktivnosti. Odluke o tome koliko često i na koji način vježbati zavise od različitih faktora, uključujući godinu studija, vremenska ograničenja, motivaciju i dostupnost organiziranog vježbanja. U okviru ovog istraživanja fokusirali smo se na ispitivanje tri ključna aspekta fizičke aktivnosti među studentima Fakulteta za kemiju i kemijsku tehnologiju, Univerzitet u Ljubljani (FKKT) i Fakulteta računarskih nauka i informatike, Univerzitet u Ljubljani (FRI): vrstu vježbanja (organizirano vs. neorganizirano), učestalost vježbanja sedmično i godinu studija. Istraživanje analizira kako se studenti odlučuju za bavljenje fizičkom aktivnošću u različitim fazama studija i koje navike vježbanja su najzastupljenije. Svrha istraživanja je da se shvati koje su metode vježbanja najpopularnije, kakva je veza između godine studija i učestalosti vježbanja te kako se mijenjaju navike studenata tokom studiranja. Podatke smo dobili pomoću anketnog upitnika koji je distribuiran putem interneta studentima i studentima koji su upisani na predmet fizičkog vaspitanja tokom semestra. Podaci su obrađeni u računarskom programu SPSS i Microsoft Excel-u. Cilj nam je da steknemo uvid u potencijalne razlike između studenata različitih godina i izradimo preporuke za promovisanje redovne fizičke aktivnosti u studentskom okruženju. Nalazi pokazuju da učenici ravnopravno biraju između organiziranog i neorganiziranog vježbanja, uz nešto veću prednost neorganiziranog vježbanja. Oni koji se odluče za neorganizirano vježbanje češće će biti fizički aktivni, posebno oni koji vježbaju nekoliko puta sedmično. Učenici viših razreda su fizički aktivniji i preferiraju češće vježbanje, što ukazuje na veću samostalnost i svijest o značaju fizičke aktivnosti u višim razredima, dok su mlađi učenici često manje aktivni i češće biraju organizirano vježbanje.*

Ključne riječi: *fizička aktivnost, studenti, metode vježbanja, učestalost vježbanja, godine studija.*

EFEKTI PROGRAMA ZUMBA AEROBIKA NA TRANSFORMACIJU ANTROPOMETRIJSKIH KARAKTERISTIKA KOD MLADIH ŽENA

Špirtović Omer, Čaprić Ilma, Murić Benin, Kahrović Izet, Radenković Oliver, Milić Vladan, Preljević Adem, Biševac Emir, Mekić Raid
Departman za biomedicinske nauke, Državni univerzitet u Novom Pazaru, Srbija

ORIGINAL SCIENTIFIC ARTICLE
DOI: 10.5937/ATAVPA25073S

Sažetak: *Cilj ovog istraživanja bio je da se utvrde efekti dvanaestonedeljnog programa Zumba aerobika na antropometrijske karakteristike mladih žena. Istraživanje je sprovedeno na uzorku od 53 ispitanice, koji je bio podeljen u dve grupe. Subuzorak eksperimentalne grupe činilo je 27 ispitanica (starosti 20±0.7), koje su kroz program Zumba aerobika, uz muzičku pratnju, vežbale tri puta nedeljno, dok je subuzorak kontrolne grupe sačinjavalo 26 ispitanica (starosti 20±0.5), koje nisu bile uključene u programe vežbanja. Korišćene su sledeće mere: telesna težina, obim struka, kožni nabor na trbuhu, kožni nabor na leđima, kožni nabor na nadlaktici, kožni nabor na natkolenici. Nakon realizacije programa Zumba aerobika došlo je do smanjenja telesne mase za -5.08%, obima struka za -4.30%. Kod kožnih nabora dobijeno je statistički značajno smanjenje ($p<0,05$) na finalnom merenju u odnosu na inicijalno merenje: kod trbuha za -21.96%, natkolenice -13.75%, leđa -23.18% i nadlaktice -21.69%. Na osnovu procentualnih promena, jasno je da je program Zumba aerobika imao značajan efekat na smanjenje telesne mase i potkožnog masnog tkiva kod ispitanica eksperimentalne grupe, dok u kontrolnoj grupi nije bilo značajnih promena.*
Ključne reči: *fitness, rekreacija, antropometrijske karakteristike, Zumba aerobic*

UVOD

Sedentarni način života predstavlja značajan rizik za zdravlje savremenog čoveka, posebno u kontekstu povećane učestalosti gojaznosti i njenih pratećih zdravstvenih problema (Park, Moon, Kim, Kong, & Oh, 2020). Fizičke aktivnosti, naročito aerobne vežbe, imaju ključnu ulogu u prevenciji gojaznosti, čime doprinose očuvanju i unapređenju opšteg zdravstvenog statusa pojedinca (Permadi, 2019). Programirano vežbanje omogućava ne samo poboljšanje fizičkih i mentalnih performansi, već i optimizaciju vitalnih fizioloških funkcija organizma (Dyrstad, Edvardsen, Hansen, & Anderssen, 2019). Za postizanje značajnih promena u antropometrijskim karakteristikama tela, primenjuju se različiti aerobni programi vežbanja (Osei-Tutu & Campagna, 2005), čija realizacija je najčešće povezana sa specijalizovanim objektima, fitnes centrima, u kojima vežbači imaju uslove za adekvatnu i stručno vođenu fizičku aktivnost (Yıldız, 2011).

Jedan od značajnih motiva za uključivanje u fitnes programe jeste želja za promenom telesnog izgleda, odnosno oblikovanje figure kroz sistematski i ciljani trening (Larsen, et al., 2021). Osim osnovnih aerobnih aktivnosti poput hodanja i trčanja, koje se tradicionalno koriste za smanjenje telesne mase i modifikaciju telesne kompozicije, sve veća pažnja posvećuje se i raznovrsnim plesnim i ritmičkim vežbama uz muziku, kao što su koraci, poskoci, okreti i skokovi (Yalcinkaya et al., 2020). Redovne fizičke aktivnosti kao što su hodanje, pilates i zumba prepoznate su kao jedne od najefikasnijih i najpopularnijih metoda za prevenciju gojaznosti, gubitak telesne težine i zatezanje tela, naročito kod žena, uz primenu odgovarajuće nutritivne podrške (Aukštuolytė, et al., 2018; İmamoğlu & Özdenk 2019). Međutim, dugotrajni i monotoni treninzi često su razlog zbog kojeg vežbanje nije moguće održavati redovno, što negativno utiče na kontinuitet i efikasnost programa (Ljubojević, Jakovljević, & Popržen, 2014). Iako se zumba izvodi uz muziku i dinamične pokrete, mnogi vežbači ne doživljavaju ove aktivnosti kao tradicionalni trening, već ih percipiraju kao zabavu. Upravo ta prijatna i motivišuća atmosfera čini zumba program efikasnim sredstvom u prevenciji sedentarnih navika i gojaznosti (Nedkova & Nikolova, 2013). Zumba, kao aerobni fitnes program zasnovan na latino plesnim elementima, dostigla je globalnu popularnost – praktikuje se u više od 150 zemalja i okuplja oko 14 miliona učesnika svih uzrasta, uključujući i decu od četvrte godine života, pod nadzorom kvalifikovanih trenera (Sanders, 2012; Devi, 2016). Jedan od razloga njene popularnosti jeste nepostojanje striktno ispravnog ili pogrešnog načina izvođenja pokreta, što dodatno motiviše korisnike da se uključe i kontinuirano bave fizičkom aktivnošću.

Moto zumbe „zaboravi trening i pridruži se zabavi“ podstiče vežbače da percipiraju aktivnost kao prijatno iskustvo koje žele da ponove (Ljubojević et al., 2014). Efekti zumba vežbi uključuju poboljšanje snage, ravnoteže, koordinacije i kardiovaskularne kondicije, kao i značajno smanjenje masnog tkiva, posebno kod žena, što ih čini dinamičnim i efikasnim programom za pozitivne promene telesne kompozicije (Jain & Nigudkar, 2016; Inouye, Nichols, Maskarinec, & Tseng, 2013; Domene, Moir, Pummell, Knox, & Easton, 2016; Eroğlu Kolayiş & Arol, 2020). Brojna istraživanja potvrđuju pozitivan uticaj fitnes programa na transformaciju morfoloških karakteristika, što dalje vodi ka poboljšanju zdravstvenog i telesnog statusa pojedinca (Štalec, Katić, Podvorac, & Katović, 2007; Holmerová et al., 2010; Zaletel et al., 2013). Posebno je značajno praćenje obima struka kao jednostavnog i pouzdanog indikatora abdominalne gojaznosti, koja je povezana sa zdravstvenim rizicima, posebno u oblasti kardiorespiratorne kondicije. Upotreba obima struka kao alatke za ranu detekciju rizika od gojaznosti i kardiometaboličkih oboljenja ima važnu primenu u kliničkoj praksi (Barber et al., 2014). Preporučeni pragovi za abdominalnu gojaznost definisani su kao 80 cm i 88 cm za žene, odnosno 94 cm i 102 cm za muškarce (Katzmarzyk et al., 2011). Cilj ovog istraživanja bio je da se ispita efekat dvanaestonedeljnog programa zumba aerobika na antropometrijske karakteristike mladih žena, sa posebnim akcentom na promene koje ukazuju na poboljšanje zdravstvenog statusa.

MATERIJAL I METODE

Uzorak ispitanika

Pedeset i tri od 58 ispitanica, mladih žena, starosti 20±0.7 godina, završilo je program obuke i učestvovalo u inicijalnom i finalnom merenju. Četiri učesnice su ispale iz eksperimentalne grupe zbog bolesti i nedostatka motivacije za vežbanjem, a jedana učesnica kontrolne grupe je bila odsutana tokom završnog testiranja. Subuzorak eksperimentalne grupe (E), činilo je 27 ispitanica, koje su kroz program Zumba aerobika, programa uz muzičku pratnju, vežbale tri puta nedeljno, koristile uobičajnu ishranu i nisu bolovale od bilo kakvih hroničnih bolesti, niti imale bilo kakve smetnje u radu lokomotornog sistema što bi moglo ograničiti njihov obim pokreta tokom realizacije treninga. Ekperimentalni tretman je realizovan u sali za vežbanje Državnog univerziteta u Novom Pazaru. Subuzorak kontrolne grupe (K) činilo je 26 ispitanica, koje su nastavile sa svakodnevnim životnim aktivnostima za vreme trajanja eksperimenta i nisu učestvovale u nekoj od fizičkih aktivnosti.

Uzorak mernih instrumenata

Efekti programa aerobnog vežbanja na antropometrijske karakteristike proučavani su na osnovu toga kako je taj trening uticao na telesnu težinu, volumenoznost i debljinu kožnih nabora. Korišćenje su sledeće mere: telesna težina, obim struka, kožni nabor trbuha, kožni nabor leđa, kožni nabor nadlaktice i kožni nabor natkolenice. Antropometrijsko merenje je izvršeno upotrebom standardnih mernih instrumenata propisanih Međunarodnim biološkim programom (IBP). Telesna težina (kg) je merena uz pomoć aparata za bioelektričnu impedansu TANITA UM-72 (Monitor sastava tela, Tanita Corp, Tokio, Japan) (Vasold, et al. 2019), which has been used in many studies (Mustedanagić, et al. 2016; Bratić, et al. 2022). Kožni nabori su mereni pomoću Harpenden skinfold caliper (Rutherford, et al. 2011; Naz, et al.2017) dok je obim struka izmeren santimetarskom trakom. Nakon inicijalnog merenja primenjen je dvanaestonedeljni program vežbanja, a nakon toga i završno merenje kako bi se utvrdili postignuti efekti treninga. Tokom testiranja temperatura vazduha u prostoriji se kretala od 23°C do 26°C, a početno i završno merenje uvek je počinjalo u 11 časova i završavalo se do 14 časova da bi se isključile dnevne varijacije merenja.

METODE RADA

Rekreativni fitnes program Zumba aerobic u koji su bile uključene ispitanice E grupe izvođen je tri puta nedeljno sa ciljem uticaja na njihovu telesnu građu. U periodu od 12 nedelja održano je 36 treninga. Svaki trening je trajao 60 minuta i sastojao se od uvodno-pripremnog dela, glavnog dela gde se puls ispitanika kretao od 121 do 166 otkucaja u minuti i završnog dela. Optimalni intenzitet je izračunat na osnovu maksimalne frekvencije otkucaja srca (220 – godine starosti ispitanika). Za monitoring srčane frekvence, tokom trajanja fizičkih aktivnosti, koristio se Polar V800, koji je dokazano validan i pouzdan

merni instrument (Caminal, et al. 2018). Ispitanici su dobrovoljno pristupili merenjima i ispoštovani su svi pedagoški i fiziološki principi prilikom vežbanja. Program vežbanja je bio koncipiran tako da su se u prvom mesecu izvodile jednostavnije vežbe sa manjim opterećenjem, a zatim da bi se postigao efekat vežbanja, opterećenje se postepeno povećavalo i izvodile su se i složenije vežbe.

U uvodno-pripremnom delu, u trajanju od 10% od ukupnog trajanja treninga, sa ciljem uvođenja u rad, zagrevanja i pripreme za naredna naprezanja, koristili su se ciklični trenažeri i izvodile vežbe dinamičkog istezanja. Prvi deo glavnog dela treninga, u trajanju od 55% ukupnog trajanja treninga, osmišljen je tako da se kroz plesne koreografije podstakne sagorevanje kalorija, poboljša kondicija i doprinese dobrom raspoloženju. Drugi deo glavnog dela treninga iznosio je 25% od ukupnog trajanja treninga i u njemu su primenjivane vežebe za jačanje ruku i ramenog pojasa, trbušnog zida, leđa i nogu. U završnom delu treninga, u vremenskom periodu od 10 % ukupnog trajanja treninga, izvodile su se vežbe relaksacije sa ciljem smirivanja organizma a zatim i vežbe istezanja gde se posebno naglasak stavio na istezanje kičmenog stuba, opuštanja muskulature i vraćanja vitalnih funkcija na početni nivo.

Tabela 1 Osnovne karakteristike treninga snage i aerobnog treninga

Struktura obuke	**Trajanje (60min)**	**Aktivnost/sadržaj**
Uvodno-pripremni	10%	Ciklični trenažeri Vežbe dinamičkog istezanja
Glavni	55% (Plesne koreografije uz latino muziku, po principu intervalnog rada)	Salsa Reggaeton Merengue Cumbia Samba - Koreografije uključuju osnovne korake: “Side step”, “Grapevine”, “Twist”, “Hip roll”, “Body wave”, “Step touch” - Intenzitet varira: brze i spore pesme se smenjuju radi kardio izazova i aktivnog oporavka
	25%	10x3 vežbi za jačanje ruku (propadanja sa klupe) 10x3 vežbi za jačanje leđa sa elastičnom trakom (veslanje u pretklonu) 15x3 vežbi za jačanje stomaka (dodir pete iz ležećeg položaja) 10x3 vežbi za jačanje nogu (bugarski iskoraci, polučučnjevi uz oslonac) 60s “dead bug” 60s bočni plank sa podizanjem noge 60s “bird dog”
Završni	10%	vežbe istezanja i labavljenja.

Statistička obrada podataka

Za obradu podataka korišćen je IBM SPSS 20.0 koji radi pod Microsoft Windows okruženjem. Rezultati su prikazani tabelarno. Prikazana je deskriptivna statistika - za kvantitativne podatke su izračunati aritmetička sredina i standardna devijacija. Kako bi se utvrdile razlike između dve grupe žena (eksperimentalne i kontrolne) u pogledu antropometrijskih karakteristika na inicijalnom i finalnom merenju, sproveden je t-test za nezavisna merenja. U cilju utvrđivanja razlika između ispitanika eksperimentalne, odnosno, kontrolne grupe na inicijalnom i finalnom merenju, primenjen je t-test za uparene (zavisne) uzorke.

Prikaz rezultata istraživanja

U istraživanju je učestvovalo 27 ispitanica eksperimentalne i 26 ispitanica kontrolne grupe. Ispitivanje je obavljeno u dva navrata: inicijalno i finalno merenje. Ispitanice u eksperimentalnoj grupi su bile uključene u program Zumba aerobika, programa uz muzičku pratnju što je podrazumevalo vežbanje tri puta nedeljno, dok ispitanice u kontrolnoj grupi nisu bile uključene u vežbanje. U Tabeli 2 je predstavljeno poređenje dve grupe ispitanica (eksperimentalne i kontrolne grupe) na inicijalnom merenju u pogledu antropoloških karakteristika.

Tabela 2 Poređenje ispitanica eksperimentalne i kontrolne grupe u pogledu antropometrijskih karakteristika – inicijalno merenje

Karakteristika	Grupa	N	M	SD	t	p
telesna masa	eksperimentalna	27	54.91	8.22	-0.129	.898
	kontrolna	23	55.31	9.15		
obim struka	eksperimentalna	27	70.17	6.05	0.147	.884
	kontrolna	23	69.85	6.03		
kožni nabor nadlaktice	eksperimentalna	27	12.59	6.18	0.558	.581
	kontrolna	23	11.34	6.37		
kožni nabor stomaka	eksperimentalna	27	16.08	6.34	0.695	.492
	kontrolna	23	14.47	6.66		
kožni nabor leđa	eksperimentalna	27	10.18	3.55	0.375	.710
	kontrolna	23	9.68	4.05		
kožni nabor butine	eksperimentalna	27	19.56	5.81	0.025	.980
	kontrolna	23	19.51	6.49		

Napomena: N – broj ispitanika, M – aritmetička sredina, SD – standardna devijacija, t – statistik, ** značajnost na nivou .01.**;** * značajnost na nivou .05.

U pogledu telesne mase nisu utvrđene statistički značajne razlike između dve grupe ispitanica (t(30)=-0.129, p=.898). Ispitanice eksperimentalne grupe (M=54.91, SD=8.22) se ne razlikuju statistički značajno od ispitanica kontrolne grupe u pogledu navedene karakteristike na inicijalnom merenju (M=55.31, SD=9.15). U pogledu obima struka nisu utvrđene statistički značajne razlike između dve grupe ispitanica (t(30)=-0.147, p=.884). Ispitanice eksperimentalne grupe (M=70.17, SD=6.05) se ne razlikuju statistički značajno od ispitanica kontrolne grupe u pogledu navedene karakteristike na inicijalnom merenju (M=69.85, SD=6.03). Kožni nabor nadlaktice je karakteristika po kojoj se ne razlikuju ispitanice eksperimentalne i kontrolne grupe (t(30)=-0.558, p=.581). Prosečna vrednost kožnog nabora u eksperimentalnoj grupi iznosi 12.59, a standardna devijacija 6.18, a u kontrolnoj grupi prosečna vrednost je 11.34, a standardna devijacija 6.37. U pogledu kožnog nabora stomaka nisu utvrđene statistički značajne razlike između dve grupe ispitanica (t(30)=0.695, p=.492).

Tabela 3 Poređenje ispitanica eksperimentalne i kontrolne grupe u pogledu antropometrijskih karakteristika – finalno merenje

Karakteristika	Grupa	N	M	SD	t	p
telesna masa	eksperimentalna	27	52.12	8.09	-1.139	.264
	kontrolna	23	55.64	9.34		
obim struka	eksperimentalna	27	67.15	6.49	-1.280	.210
	kontrolna	23	70.01	5.95		
kožni nabor nadlaktice	eksperimentalna	27	9.86	5.55	-0.830	.413
	kontrolna	23	11.61	6.34		
kožni nabor stomaka	eksperimentalna	27	12.55	6.30	-0.873	.390
	kontrolna	23	14.58	6.80		
kožni nabor leđa	eksperimentalna	27	7.82	3.60	-1.467	.153
	kontrolna	23	9.78	3.95		
kožni nabor butina	eksperimentalna	27	16.87	5.36	-1.316	.198
	kontrolna	23	19.61	6.43		

Ispitanice eksperimentalne grupe (M=16.08, SD=6.34) se ne razlikuju statistički značajno od ispitanica kontrolne grupe u pogledu navedene karakteristike na inicijalnom merenju (M=14.47, SD=6.66). Ni u pogledu prosečnnog nabora leđa ne postoje statistički značajne razlike između dve grupe ispitanica (t(30)=0.375, p=.710). Prosečna vrednost kožnog nabora leđa u eksperimentalnoj grupi iznosi 10.18, standardna devijacija 3.55, dok prosečna vrednost u kontrolnoj grupi iznosi 9.68, a standardna

devijacija 4.05. Ni u pogledu kožnog nabora butina nisu ustanovljene statistički značajne razlike između dve grupe (t(30)=0.025, p=.980). Prosečna vrednost kožnog nabora butina u eksperimentalnoj grupi iznosi 19.56, a standardna devijacija 5.81, dok u kontrolnoj grupi iznosi 19.51, a standardno odstupanje 6.49. U Tabeli 3 je predstavljeno poređenje dve grupe ispitanica (eksperimentalne i kontrolne grupe) na finalnom merenju u pogledu antropoloških karakteristika.

U pogledu telesne mase nisu utvrđene statistički značajne razlike između dve grupe ispitanica (t(30)=-1.139, p=.264). Ispitanice eksperimentalne grupe (M=52.12, SD=8.09) se ne razlikuju statistički značajno od ispitanica kontrolne grupe u pogledu navedene karakteristike na finalnom merenju (M=55.64, SD=9.34). U pogledu obima struka nisu utvrđene statistički značajne razlike između dve grupe ispitanica (t(30)=-1.280, p=.210). Ispitanice eksperimentalne grupe (M=67.15, SD=6.49) se ne razlikuju statistički značajno od ispitanica kontrolne grupe u pogledu navedene karakteristike na finalnom merenju (M=70.01, SD=5.95). Kožni nabor nadlaktice je karakteristika po kojoj se ne razlikuju ispitanice eksperimentalne i kontrolne grupe (t(30)=-0.830, p=.413). Prosečna vrednost kožnog nabora u eksperimentalnoj grupi iznosi 9.86, a standardna devijacija 5.55, a u kontrolnoj grupi prosečna vrednost je 11.61, a standardna devijacija 6.34. U pogledu kožnog nabora stomaka nisu utvrđene statistički značajne razlike između dve grupe ispitanica (t(30)=-0.873, p=.390). Ispitanice eksperimentalne grupe (M=12.55, SD=6.30) se ne razlikuju statistički značajno od ispitanica kontrolne grupe u pogledu navedene karakteristike na finalnom merenju (M=14.58, SD=6.80). Ni u pogledu prosečnog nabora leđa ne postoje statistički značajne razlike između dve grupe ispitanica (t(30)=-1.467, p=.153). Prosečna vrednost kožnog nabora leđa u eksperimentalnoj grupi iznosi 7.82, standardna devijacija 3.60, dok prosečna vrednost u kontrolnoj grupi iznosi 9.78, a standardna devijacija 3.95. Ni u pogledu kožnog nabora butina nisu ustanovljene statistički značajne razlike između dve grupe (t(30)=-1.316, p=.198). Prosečna vrednost kožnog nabora butina iznosi u eksperimentalnoj grupi 16.87, a standardna devijacija 5.36, dok u kontrolnoj grupi iznosi 19.61, a standardno odstupanje 6.43.

Tabela 4 Poređenje ispitanica u pogledu antropometrijskih karakteristika na incijalnom i finalnom merenju – eksperimentalna grupa

Karakteristika	Merenje	N	M	SD	t	p
telesna masa	inicijalno	27	54.91	8.22	9.072	<.001
	finalno	27	52.12	8.09		
obim struka	inicijalno	27	70.17	6.05	8.175	<.001
	finalno	27	67.15	6.49		
kožni nabor nadlaktice	inicijalno	27	12.59	6.18	6.921	<.001
	finalno	27	9.86	5.55		
kožni nabor stomaka	inicijalno	27	16.08	6.34	7.976	<.001
	finalno	27	12.55	6.30		
kožni nabor leđa	inicijalno	27	10.18	3.55	8.367	<.001
	finalno	27	7.82	3.60		
kožni nabor butina	inicijalno	27	19.56	5.81	6.836	<.001
	finalno	27	16.87	5.36		

Rezultati t-testa uparenih uzoraka pokazuju da postoje statistički značajne razlike u vrednostima telesne mase na inicijalnom i finalnom merenju (t(17)=9.072, p<.001). Naime, ispitanice su na inicijalnom merenju imale veću telesnu masu (M=54.91, SD=8.22) u poređenju sa finalnim merenjem (M=52.12, SD=8.09). Utvrđene su statistički značajne razlike u obimu struka na inicijalnom i finalnom merenju (t(17)=8.175, p<.001). Ispitanice su na inicijalnom merenju imale veći obim struka (M=70.17, SD=6.05) u poređenju sa finalnim merenjem (M=67.15, SD=6.49). Takođe, utvrđene su statistički značajne razlike između dva merenja u pogledu kožnog nabora nadlaktice (t(17)=6.921, p<.001). Na inicijalnom merenju kožni nabor ruke je veći (M=12.59, SD=6.18) u poređenju sa finalnim merenjem (M=9.86, SD=5.55). Pored navedenog, utvrđene su statistički značajne razlike između dva merenja u pogledu kožnog nabora stomaka (t(17)=7.976, p<.001). Na inicijalnom merenju kožni nabor stomaka je veći (M=16.08, SD=6.34) u poređenju sa finalnim merenjem (M=12.55, SD=6.30). Utvrđene su statistički

značajne razlike između inicijalnog i finalnog merenja u pogledu kožnog nabora leđa (t(17)=8.367, p<.001). Na inicijalnom merenju kožni nabor leđa je veći (M=10.18, SD=3.55) u poređenju sa finalnim merenjem (M=7.82, SD=3.60). Najzad, utvrđene su statistički značajne razlike između dva merenja u pogledu kožnog nabora butina (t(17)=6.836, p<.001). Na inicijalnom merenju kožni nabor butina je veći (M=19.56, SD=5.81) u poređenju sa finalnim merenjem (M=16.87, SD=5.36).

Tabela 5 Poređenje ispitanica u pogledu antropometrijskih karakteristika na incijalnom i finalnom merenju – kontrolna grupa

Karakteristika	Merenje	N	M	SD	t	p
telesna masa	inicijalno	23	55.31	9.15	0.298	.770
	finalno	23	55.64	9.34		
obim struka	inicijalno	23	69.85	6.03	-1.501	.157
	finalno	23	70.01	5.95		
kožni nabor nadlaktice	inicijalno	23	11.34	6.37	-2.157	.050
	finalno	23	11.61	6.34		
kožni nabor stomaka	inicijalno	23	14.47	6.66	-1.385	.189
	finalno	23	14.58	6.80		
kožni nabor leđa	inicijalno	23	9.68	4.05	-1.407	.183
	finalno	23	9.78	3.95		
kožni nabor butina	inicijalno	23	19.51	6.49	-1.883	.082
	finalno	23	19.61	6.43		

Rezultati t-testa uparenih uzoraka pokazuju da ne postoje statistički značajne razlike u vrednostima telesne mase na inicijalnom i finalnom merenju (t(14)=0.298, p=.770). Naime, ispitanice su na inicijalnom merenju imale telesnu masu (M=55.31, SD=9.15) u poređenju sa finalnim merenjem (M=55.64, SD=9.34). Nisu utvrđene statistički značajne razlike u obimu struka na inicijalnom i finalnom merenju (t(14)=-1.501, p=.157). Ispitanice su na inicijalnom merenju imale obim struka (M=69.85, SD=6.03) u poređenju sa finalnim merenjem (M=70.01, SD=5.95). Takođe, nisu utvrđene statistički značajne razlike između dva merenja u pogledu kožnog nabora nadlaktice (t(14)=-2.157, p=.050). Na inicijalnom merenju kožni nabor ruke iznosi (M=11.34, SD=6.37) u poređenju sa finalnim merenjem (M=11.61, SD=6.34). Pored navedenog, nisu utvrđene statistički značajne razlike između dva merenja u pogledu kožnog nabora stomaka (t(14)=-1.385, p=.189). Na inicijalnom merenju kožni nabor stomaka iznosi (M=14.47, SD=6.66) u poređenju sa finalnim merenjem (M=14.58, SD=6.80). Nisu utvrđene statistički značajne razlike između inicijalnog i finalnog merenja u pogledu kožnog nabora leđa (t(14)=-1.407, p=.183). Na inicijalnom merenju kožni nabor leđa iznosi (M=9.68, SD=4.05) u poređenju sa finalnim merenjem (M=9.78, SD=3.95). Najzad, nisu utvrđene statistički značajne razlike između dva merenja u pogledu kožnog nabora butina (t(14)=-1.883, p=.082). Na inicijalnom merenju kožni nabor butina iznosi (M=19.51, SD=6.49) u poređenju sa finalnim merenjem (M=19.61, SD=6.43).

DISKUSIJA

Svrha ove studije bila je da se utvrde efekti programa Zumba aerobica na antropometrijske karakteristike mladih žena koje vežbaju. Treninzi koji su se obavljali tri puta nedeljno bili su koncipirani tako što se u jednom delu glavnog dela treninga realizovao program Zumba aerobika a u drugom obavljale odgovarajuće vežbe snage kako bi se postigao što bolji efekat. Treninzi su se odvijali u vremenskom trajanju od 60 minuta, a intenzitet vežbanja se kretao od 60-85% od maksimalne frekvencije srca. Naša studija pokazuje da je primenjeni program vežbanja, gde se primenjivao trening izdržljivosti i snage u trajanju od 180 minuta nedeljno, pozitivno uticao na sve varijable. Nakon realizacije programa vežbanja Zumba aerobika uz mužičku pratnju, kod E grupe, na finalnom merenju u odnosu na inicijalno merenje došlo je do smanjena telesne mase za -5,08% što je u skladu sa rezultatima koji su u svojim istrazivanjima dobili Pantelić et al. (Pantelic, et al. 2013) gde se jasno vidi uticaj tromesečnog programa aerobnog plesa na telesnu masu mladih žena i gde je na finalnom merenju u odnosu na inicijalno merenje telesna masa smanjena za -3,7%. Studije koje su se bavile gojaznim ženama

pokazuju da stanje stečeno kao rezultat zumba vežbi pozitivno utiče na zdravlje i da se mogu preporučiti kao efikasan metod za kontrolu telesne težine kod gojaznih žena (Paoli & Bianco, 2015; Cugusi et al., 2016; Micallef, 2014). Stiegler & Cunliffe (Stiegler, et al. 2006) upućuju na vezu između količine aerobnih vežbi i ukupnog smanjenja telesne mase. Tokom programa treninga aerobne izdržljivosti telesna masa se smanjuje, dok vrednosti bezmasne mase ostaju iste ili se povećavaju (20,26%). Nakon realizacije programa Zumba aerobica došlo do je do smanjenja obima struka za -4,30%. Kod kožnih nabora stomaka -21.96%, leđa -23,18%, natkolenice -13,75%, nadlaktice -21.69%, vidi se statistički značajno smanjenje ($p<0,05$) na finalnom merenju u odnosu na inicijalno merenje. Kompleks vežbi snage obuhvatao je vežbe za mišiće celog tela a primarno je ciljao na mišiće trbušnog zida i leđa, stoga je verovatno izazvao promenu u smanjenju obima struka, uglavnom zbog smanjenja masnog tkiva. Rezultati dobijeni u studiji Rýzková et al. (Rýzková, et al. 2018) ukazuju da je šestonedeljnim programom treninga izržljivosti i snage poboljšana fizička spremnost ispitanika a to se najviše odrazilo kod mišića trupa. Većina istraživanja provedenih tokom osam nedelja ukazuje na pozitivne učinke Zumba Fitness programa na smanjenje potkožnog masnog tkiva (Ljubojević, et al. 2014 , Güçlüöver, et al. 2020). Dobijeni rezultati u domenu antropometrijskih karakteristika ukazuju da je primena eksperimentalnog tretmana dovela do statistički značajnih promena u okviru pojedinih antropometrijskih varijabli. Uticaj programa Zumba aerobika, koji je pokazao izraženo smanjenje telesne mase i kožnih nabora, ukazuje na njegovu visoku praktičnu vrednost za osobe koje teže poboljšanju estetskog izgleda i regulaciji telesne mase – faktora koji su usko povezani sa unapređenjem opšteg zdravstvenog stanja. Na osnovu ovih rezultata, Zumba aerobik se može preporučiti kao efikasna strategija u okviru grupnih fitness programa za populaciju mladih žena sa prekomernom telesnom masom. Pored estetskih efekata, takav pristup može doprineti redukciji zdravstvenih rizika povezanih sa gojaznošću i sedentarizmom. Međutim, u cilju sveobuhvatnije evaluacije uticaja aerobnog treninga izdržljivosti, buduće studije bi trebalo da uključe praćenje promena u dnevnim aktivnostima van strukturiranog treninga, kao i preciznu kontrolu unosa kalorija. Nedostaci ove studije odnose se na: (1) smanjen broj učesnica koje su u potpunosti završile eksperimentalni program, što može uticati na statističku snagu rezultata; (2) izostanak sistematskog praćenja aktivnosti van treninga (npr. korišćenjem akcelerometara ili dnevnika aktivnosti); i (3) nekorišćenje validiranih instrumenata za retrospektivno beleženje energetskog unosa.

Treba naglasiti da metode zasnovane na samoprijavljenom opozivu unosa energije mogu biti podložne pristrasnostima i varijabilnosti, te kao takve često nude ograničenu tačnost i pouzdanost u kvantifikaciji stvarnog energetskog balansa.

ZAKLJUČAK

Rezultati sprovedenog istraživanja, koje je obuhvatilo dvanaestonedeljni Zumba fitnes program na uzorku od 27 mladih žena, pokazali su statistički značajne promene u antropometrijskim parametrima. Utvrđeno je značajno smanjenje telesne mase, potkožnog masnog tkiva (izraženog kroz kožne nabore), kao i obima struka, što ukazuje na efikasnost primenjenog programa u redukciji telesne mase i masnog tkiva.Posebno je važno naglasiti da je Zumba fitnes program pokazao visok potencijal u ciljanom smanjenju potkožnog masnog tkiva, što predstavlja jedan od najčešćih razloga za uključivanje žena u grupne programe vežbanja. Ovaj oblik fizičke aktivnosti se izdvaja svojom specifičnom strukturom koja kombinuje elemente latino plesnih koreografija sa intenzivnim aerobnim vežbama, uz pratnju ritmične muzike. Takav pristup doprinosi stvaranju pozitivne i motivišuće atmosfere tokom vežbanja, često opisane kao "Zumba žurka", što podstiče doslednost i dugoročno angažovanje učesnica. Iako je Zumba fitnes sve popularniji oblik grupnog vežbanja, naučna literatura koja se bavi analizom njegovih efekata i dalje je relativno oskudna u poređenju sa drugim oblicima aerobnog treninga. Razlog tome delimično leži u činjenici da je Zumba fitnes još uvek relativno nov koncept u okviru savremenih pristupa fizičkoj aktivnosti. Potrebna su dalja istraživanja koja će detaljno ispitati efekte ovog oblika vežbanja na različite populacione grupe i u različitim kontekstima (prevencija gojaznosti, kardiometaboličko zdravlje, psihološki benefiti itd.).

Ova studija predstavlja doprinos naučnoj bazi podataka o efektima Zumba fitnes programa, ukazujući na njegovu praktičnu vrednost u smanjenju rizičnih antropometrijskih parametara kod mladih žena sa prekomernom telesnom masom što može imati važnu ulogu u očuvanju i unapređenju.

LITERAURA

1. Aukštuolytė, E., Mauricienė, V., Daunoravičienė, A., Knispelytė, G., & Berškienė, K. (2018). Dynamics of body composition and body image of sedentary working women who attend Zumba or functional training programs: Pilot study. *Baltic Journal of Sport and Health Sciences*, 2(109), 2–8.
2. Barber, J., Palmese, L., Chwastiak, L. A., Ratliff, J. C., Reutenauer, E. L., Jean-Baptiste, M., et al. (2014). Reliability and practicality of measuring waist circumference to monitor cardiovascular risk among community mental health center patients. *Community Mental Health Journal*, 50, 68–74.
3. Bratić, M., Đosić, A., Živković, D., Živković, M., Bjelaković, L., Stojanović, N., et al. (2022). The effects of the aerobic endurance running program on the morphological characteristics of adolescent girls with different nutritional status. *International Journal of Morphology,* 40(5), 1335–1343.
4. Caminal, P., Sola, F., Gomis, P., Guasch, E., Perera, A., Soriano, N., et al. (2018). Validity of the Polar V800 monitor for measuring heart rate variability in mountain running route conditions. *European Journal of Applied Physiology,* 118, 669–677.
5. Cugusi, L., Wilson, B., Serpe, R., Medda, A., Deidda, M., Gabba, S., et al. (2016). Cardiovascular effects, body composition, quality of life and pain after a Zumba® fitness program in Italian overweight women. *Journal of Sports Medicine and Physical Fitness*, 56(3), 328–335.
6. Devi, G. (2016). Effect of Zumba dance on blood pressure. *Journal of Pharmaceutical Sciences and Research*, 8(6), 501–505.
7. Domene, P. A., Moir, H. J., Pummell, E., Knox, A., & Easton, C. (2016). The health-enhancing efficacy of Zumba® fitness: An 8-week randomised controlled study. *Journal of Sports Sciences*, 34(15), 1396–1404.
8. Dyrstad, S. M., Edvardsen, E., Hansen, B. H., & Anderssen, S. A. (2019). Waist circumference thresholds and cardiorespiratory fitness. *Journal of Sport and Health Science*, 8(1), 17–22.
9. Eroğlu Kolayiş, I., & Arol, P. (2020). The effect of Zumba exercises on body composition, dynamic balance and functional fitness parameters in 15–17 years old women with high body mass index. *Pedagogy of Physical Culture and Sports*, 24(3), 118–124.
10. Güçlüöver, A. (2020). The effect of 8-week Zumba® fitness on body composition of Turkish women. *Progress in Nutrition*, 22(3), 316–322.
11. Holmerová, I., MacHácová, K., Vanková, H., Veleta, P., Jurasková, B., Hrnciariková, D. & Andel, R. (2010). Effect of the exercise dance for seniors (EXDASE) program on lower-body functioning among institutionalized older adults. *Journal of aging and health*, *22*(1), 106-119.
12. İmamoğlu, M., & Özdenk, S. (2019). The effect of 12-week regular Pilates, step and Zumba training program on muscle and fat weight. *Journal of Exercise Therapy and Rehabilitation Studies*, 7(11), 33–37.
13. Inouye, J., Nichols, A., Maskarinec, G., & Tseng, C.-W. (2013). A survey of musculoskeletal injuries associated with Zumba. *Hawai'i Journal of Medicine & Public Health*, 72(12), 433–436.
14. Jain, P. K., & Nigudkar, M. R. (2016). Effect of 12-week Zumba program and healthy diet on anthropometry, body composition and fitness parameters in working women. *Journal of Nutrition, Health & Food Engineering,* 5(4), 672–677.
15. Karaba-Jakovljević, D. (2016). Assessment methods of body composition. Praxis Medica, 45(3–4), 71–77.
16. Katzmarzyk, P. T., Bray, G. A., Greenway, F. L., Johnson, W. D., Newton, R. L., Jr., Ravussin, E., et al. (2011). Ethnic-specific BMI and waist circumference thresholds. *Obesity,* 19(6), 1272–1278.
17. Larsen, S., Mozdoorzoy, T., Kristiansen, E., Nygaard Falch, H., Aune, T. K., & van den Tillaar, R. (2021). A comparison of motives by gender and age categories for training at Norwegian fitness centres. *Sports*, *9*(8), 113.
18. Ljubojević, A., Jakovljević, V., & Popržen, M. (2014). Effects of Zumba fitness program on body composition of women. *SportLogia*, 10(1), 29–33.
19. Micallef, C. (2014). The effectiveness of an 8-week Zumba programme for weight reduction in a group of Maltese overweight and obese women. *Sport Sciences for Health*, 10(3), 211–217.
20. Mustedanagić, J., Bratić, M., Milanović, Z., & Pantelić, S. D. (2016). The effect of aerobic exercise program on the cardiorespiratory fitness and body composition of female college students. *Facta Universitatis, Series: Physical Education and Sport*, 145-158.
21. Naz, H., Mushtaq, K., Butt, B. A., & Khawaja, K. I. (2017). Estimation of body fat in Pakistani adult: A comparison of equations based upon skinfold thickness measurements. *Pakistan Journal of Medical Sciences*, 33(3), 635.
22. Nedkova, M., & Nikolova, E. (2013). Methodology for basic education of Zumba fitness for university students. *Acta Physica Educationis et Sport*, 3(2), 248–250.
23. Osei-Tutu, K. B., & Campagna, P. D. (2005). The effects of short-vs. long-bout exercise on mood, VO2max, and percent body fat. *Preventive Medicine*, 40(1), 92–98.

24. Pantelić, S., Milanović, Z., Sporiš, G., & Stojanović-Tošić, J. (2013). Effects of a twelve-week aerobic dance exercises on body compositions parameters in young women. *International Journal of Morphology*, 31(4), 1164–1170.
25. Paoli, A., & Bianco, A. (2015). What is fitness training? Definitions and implications: A systematic review article*. Iranian Journal of Public Health*, 44(5), 602–614.
26. Park, J. H., Moon, J. H., Kim, H. J., Kong, M. H., & Oh, Y. H. (2020). Sedentary lifestyle: overview of updated evidence of potential health risks. *Korean journal of family medicine*, 41(6), 365.
27. Permadi, A. W. (2019). The benefits of aerobic training for improving quality of life: A Critical Review of Study. *WMJ (Warmadewa Medical Journal)*, *4*(2), 57-60.
28. Rutherford, W. J., Diemer, G. A., & Scott, E. D. (2011). Comparison of bioelectrical impedance and skinfolds with hydrodensitometry in the assessment of body composition in healthy young adults. *ICHPER-SD Journal of Research,* 6(2), 56–60.
29. Rýzková, E., Labudová, J., Grznár, L., & Šmída, M. (2018). Effects of aquafitness with high intensity interval training on physical fitness. Journal of Physical Education and Sport, 18, 373–381.
30. Sanders, M. E. (2012). Zumba fitness is gold for all ages. *ACSM's Health & Fitness Journal*, 16(2), 25–28.
31. Štalec, J., Katić, R., Podvorac, Đ., & Katović, D. (2007). The impact of dance-aerobics training on the morpho-motor status in female high-schoolers. *Collegium Antropologicum,* 31(1), 259–266.
32. Stiegler, P., & Cunliffe, A. (2006). The role of diet and exercise for the maintenance of fat-free mass and resting metabolic rate during weight loss. *Sports Medicine*, 36(3), 239–262.
33. Vasold, K. L., Parks, A. C., Phelan, D. M. L., Pontifex, M. B., & Pivarnik, J. M. (2019). Reliability and validity of commercially available low-cost bioelectrical impedance analysis. *International Journal of Sport Nutrition and Exercise Metabolism,* 29(4), 406–410.
34. Yalcinkaya, N., Çetin, O., Beyleroglu, M., Isik, O., Eker, S., & Bilge, M. (2020). Effect of alkaline diet with 8-week step aerobic exercise on body composition and aerobic exercise performance of sedentary women. *African Educational Research Journal,* 22(1), 11–18.
35. Yıldız, S. M. (2011). An importance-performance analysis of fitness center service quality: Empirical results from fitness centers in Turkey. *African Journal of Business Management*, 5(16), 7031–7041.
36. Zaletel, P., Gabrilo, G., & Perić, M. (2013). The training effects of dance aerobics: A review with an emphasis on the perspectives of investigations. *Collegium antropologicum*, *37*(2), 125-130.

THE EFFECTS OF THE ZUMBA AEROBICS PROGRAM ON THE TRANSFORMATION OF ANTHROPOMETRIC CHARACTERISTICS IN YOUNG WOMEN

Špirtović Omer, Čaprić Ilma, Murić Benin, Kahrović Izet, Radenković Oliver, Milić Vladan, Preljević Adem, Mekić Raid, Biševac Emir

Abstract*: The aim of this study was to determine the effects of a twelve-week Zumba aerobics program on the anthropometric characteristics of young women. The study was conducted on a sample of 53 participants, divided into two groups. The experimental group sub-sample consisted of 27 participants (aged 20±0.7), who exercised three times a week through the Zumba aerobics program, accompanied by music, while the control group sub-sample consisted of 26 participants (aged 20±0.5), who were not involved in any exercise programs. The following measures were used: body weight, waist circumference, skinfolds at the abdomen, back, upper arm, and thigh. After the implementation of the Zumba aerobics program, there was a reduction in body weight by -5.08% and waist circumference by -4.30%. For skinfolds, there was a statistically significant reduction ($p<0.05$) in the final measurement compared to the initial measurement: abdomen -21.96%, thigh -13.75%, back -23.18%, and upper arm -21.69%. Based on the percentage changes, it is clear that the Zumba aerobics program had a significant effect on the reduction of body weight and subcutaneous fat in the participants of the experimental group, while no significant changes occurred in the control group.*

Key words*: Fitness, recreation, anthropometric characteristics, Zumba aerobics*

METABOLIČKI EFEKTI FIZIČKE AKTIVNOSTI KOD OSOBA SA DIJABETESOM TIPA 1: STUDIJA SLUČAJA

Mekić Raid[1], Paunović Miloš[2], Mekić Merisa[3], Radenković Oliver[1], Murić Benin[1], Kahrović Izet[1], Špirtović Omer[1], Čaprić Ilma[1], Milić Vladan[1]

[1]Departman za biomedicinske nauke, Državni univerzitet u Novom Pazaru, Srbija
[2]Fakultet sporta i fizičkog vaspitanja, Univerzitet u Nišu, Srbija
[3]Medicinski fakultet, Univerzitet u Ljubljani, Slovenija

ORIGINAL SCIENTIFIC ARTICLE
DOI: 10.5937/ATAVPA25082M

***Sažetak**: Fizička aktivnost igra ključnu ulogu u regulaciji dijabetesa tipa 1 kod mladih, posebno kada se odvija u okruženju sa povećanom koncentracijom kiseonika. Ova studija ispituje uticaj sportske gimnastike i prirodnih činilaca na kontrolu glikemije kod osoba sa dijabetesom tipa 1. Korišćena je metoda studije slučaja, kroz sedmodnevni eksperimentalni tretman, u kojem je praćen nivo glikemije kod insulin-zavisne i insulin-nezavisne osobe u različitim vremenskim intervalima. Planirana fizička aktivnost obuhvatala je umerenu šetnju i sobnu gimnastiku, pri čemu su nivoi glukoze mereni pre i posle aktivnosti. Rezultati ukazuju na to da fizička aktivnost na otvorenom može doprineti stabilizaciji nivoa glikemije kod osoba sa dijabetesom tipa 1, ali ne može zameniti terapiju insulinom. Uočeno je da redovna fizička aktivnost dovodi do smanjenja dnevnih oscilacija glikemije, pri čemu su najveći benefiti primećeni kod planiranih aktivnosti umerenog intenziteta. Ovi nalazi mogu doprineti razvoju smernica za optimalno planiranje fizičke aktivnosti kod osoba sa dijabetesom tipa 1, kao i unapređenju edukacije nastavnika fizičkog vaspitanja i sportskih trenera o prilagođavanju vežbi za ovu populaciju.*
***Ključne reči**: dijabetes tip 1, fizička aktivnost, regulacija glikemije, sportska gimnastika, prirodni činioci.*

UVOD

Šećerna bolest ili dijabetes mellitus predstavlja hronično metaboličko oboljenje koje karakteriše poremećena homeostaza glukoze u organizmu, uz istovremene disfunkcije metabolizma masti i proteina. Dijabetes mellitus tip 1 (DMT1) spada u autoimune bolesti, a karakteriše ga destrukcija beta ćelija pankreasa koje luče insulin, što dovodi do apsolutnog nedostatka ovog hormona. Posledično, dolazi do nemogućnosti ćelija da koriste glukozu iz krvi, što dovodi do hiperglikemije i brojnih akutnih i hroničnih komplikacija (Brkić, 2016).

Različiti patološki procesi mogu doprineti uništenju pankreasnih ćelija koje proizvode insulin. Iako genetska predispozicija igra značajnu ulogu u razvoju bolesti, smatra se da faktori okoline, uključujući ishranu, virusne infekcije i stres, takođe mogu biti okidači autoimunog odgovora koji dovodi do uništenja beta ćelija (Martinović, 2018). Dijabetes tip 1 se najčešće dijagnostikuje u detinjstvu i adolescenciji, te se u literaturi često naziva juvenilni dijabetes. Najveća incidencija zabeležena je kod osoba mlađih od 20 godina, pri čemu se učestalost oboljenja značajno povećala u poslednjim decenijama (American Diabetes Association, 2022).

Prestanak ili nedovoljna proizvodnja insulina ima za posledicu da ćelije ne mogu koristiti glukozu iz krvi za energetske potrebe, uprkos njenoj visokoj koncentraciji u cirkulaciji. Usled toga, dolazi do povećane produkcije glukoze u jetri (glukoneogeneza) i razgradnje masnih rezervi, što vodi do stvaranja ketonskih tela i metaboličke acidoze – ketoacidoze, koja može imati ozbiljne posledice po organizam ako se ne tretira adekvatno (Kitabchi, Umpierrez, Miles & Fisher, 2009).

Iako terapija insulinom ostaje osnovni tretman za osobe sa dijabetesom tip 1, sve veći broj istraživanja ukazuje na značaj neterapijskih pristupa u regulaciji bolesti, od kojih je fizička aktivnost jedan od ključnih faktora. Redovno i prilagođeno fizičko vežbanje doprinosi poboljšanju metaboličke kontrole, povećava osetljivost na insulin, smanjuje rizik od hiperglikemije i poboljšava opšte zdravstveno stanje pacijenata (Kostić et al., 2009). Osim toga, fizička aktivnost sprovedena u prirodnim uslovima, uz povećan unos kiseonika i povoljne klimatske faktore, može imati dodatne benefite na cirkulaciju, kardiovaskularni sistem i opšte blagostanje pacijenata sa dijabetesom tip 1.

Cilj ovog istraživanja je da se ispita kako fizička aktivnost, posebno sportska gimnastika i kretanje na

svežem vazduhu, utiču na kontrolu glikemije kod mladih sa dijabetesom tipa 1. Analizom metaboličkih parametara, nastojimo da utvrdimo da li i u kojoj meri ovakve aktivnosti poboljšavaju regulaciju šećera u krvi i opšte zdravstveno stanje obolelih. Konkretno, istraživanje se fokusira na uticaj sportske gimnastike, prirodnih činilaca i fizičke aktivnosti na poboljšanje kontrole dijabetesa kod mladih, kroz analizu njihovog efekta na metaboličke parametre i fiziološke reakcije organizma.

UTICAJ FIZIČKE AKTIVNOSTI NA KONTROLU DIJABETESA KOD MLADIH

Frederik Banting i Čarls Best su 1922. godine prvi izolovali insulin iz pankreasa, čime je značajno promenjena prognoza i kvalitet života osoba sa dijabetesom (Simoni, Hill & Vaughan, 2002). Uprkos napretku u terapiji, dijabetes tipa 1 i dalje predstavlja ozbiljan zdravstveni problem, sa tendencijom rasta incidencije među mlađom populacijom. Savremeni način života karakteriše smanjena fizička aktivnost, nepravilna ishrana i povećana izloženost stresu, što doprinosi otežanoj kontroli ove bolesti (American Diabetes Association, 2009).

Fizička aktivnost čini značajan deo ukupnih dnevnih aktivnosti dece i adolescenata i ima ključnu ulogu u prevenciji i terapiji dijabetesa. Pored pozitivnog uticaja na opšte zdravlje, ona doprinosi poboljšanju metaboličke kontrole i povećava osetljivost na insulin. Ipak, metabolički odgovori organizma na fizičku aktivnost razlikuju se između zdravih osoba i osoba sa dijabetesom, što zahteva poseban pristup prilikom planiranja fizičkog vežbanja kod obolelih (Čizmić, 2011).

Brojna istraživanja potvrđuju da fizička aktivnost adekvatnog intenziteta povećava senzitivnost na biološko dejstvo insulina, kako kod zdravih osoba, tako i kod osoba sa dijabetesom (Đorđević et al. 2015). Stoga se preporučuje da fizička aktivnost kod dece i adolescenata sa dijabetesom bude planirana i prilagođena individualnim metaboličkim potrebama (Tahirović, Toromanović, Bačaj & Hasanović, 2006).

Metabolički odgovori organizma na fizičku aktivnost

Za obavljanje mišićnog rada neophodna je dodatna energija, pri čemu se primarni izvori energije menjaju u zavisnosti od intenziteta i trajanja aktivnosti. Glavni izvori energije su glukoza i slobodne masne kiseline, koje potiču iz krvi, jetre, mišića i masnog tkiva. U mirovanju, mišići prvenstveno koriste slobodne masne kiseline, dok prelaskom u aktivno stanje počinju da koriste glukozu i glikogen. Tokom početnih sekundi vežbanja, glikogen iz mišića predstavlja primarni izvor energije, nakon čega dolazi do povećanog iskorišćenja glukoze iz krvi (Kostić et al., 2009).

Insulin igra ključnu ulogu u omogućavanju ulaska glukoze u ćelije. Tokom fizičke aktivnosti, povećan mišićni rad doprinosi produženom otvaranju ćelijskih membrana za unos glukoze, čime se poboljšava njena iskorišćenost u energetske svrhe. Međutim, kod osoba sa dijabetesom tipa 1, metabolički odgovori zavise od nivoa insulina u krvi. Ako je koncentracija insulina niska, fizička aktivnost može izazvati hiperglikemiju i ketoacidozu, dok u stanju visokih nivoa insulina može doći do hipoglikemije (de Leiva-Hidalgo, Brugués & de Leiva-Pérez, 2020).

Optimalno vreme i način sprovođenja fizičke aktivnosti kod osoba sa dijabetesom tipa 1

Kako bi se smanjili metabolički rizici, fizička aktivnost kod mladih obolelih od dijabetesa treba da se sprovodi uz pažljivo prilagođavanje vremenskog rasporeda primene insulina i unosa hrane. Na osnovu fizioloških reakcija organizma, metabolički odgovor na fizičku aktivnost zavisi od sledećih faktora:

1. Vremenskog odnosa između primene insulina i početka fizičke aktivnosti,
2. Vremena unosa hrane i dejstva insulina,
3. Intenziteta i trajanja fizičke aktivnosti.

Preporučuje se planirana fizička aktivnost, jer neplanirana aktivnost može dovesti do nepredviđenih metaboličkih reakcija. Međutim, kako je kod mlađe populacije spontana fizička aktivnost česta, potrebno je razviti strategije za njenu bezbednu primenu.

Preporuke za optimalno sprovođenje fizičke aktivnosti kod osoba sa dijabetesom tipa 1

Kako bi se smanjili rizici hipoglikemije i hiperglikemije tokom i nakon fizičke aktivnosti, neophodno je pridržavati se sledećih preporuka:

1. Svakodnevna fizička aktivnost u trajanju od 30-40 minuta (šetnja, vožnja bicikla, sobna gimnastika, plivanje, ples) može doprineti optimalnoj metaboličkoj kontroli.
2. Optimalno vreme za fizičku aktivnost je nakon obroka, kada je nivo insulina stabilan.
3. Izbegavati fizičku aktivnost u periodima maksimalnog i minimalnog delovanja insulina, kako bi se smanjio rizik od hipoglikemije ili hiperglikemije.
4. Unos ugljenih hidrata pre, tokom i nakon fizičke aktivnosti zavisi od nivoa glukoze u krvi. U slučaju niskih vrednosti glikemije (≤5 mmol/L), preporučuje se unos 10-15 g ugljenih hidrata pre aktivnosti.
5. Merenje nivoa glukoze i ketona pre fizičke aktivnosti je od ključne važnosti. Ako je nivo glukoze >16 mmol/L uz prisustvo ketona, fizičku aktivnost treba odložiti.
6. Ukoliko fizička aktivnost traje duže od 30 minuta, preporučuje se dodatni unos 10-20 g ugljenih hidrata tokom aktivnosti.
7. Ukoliko se tokom vežbanja jave simptomi hipoglikemije, potrebno je odmah prekinuti aktivnost i uneti brzorazgradive ugljene hidrate (npr. 10-15 g glukoze ili voćnog soka).
8. Praćenje glikemijskih vrednosti nakon fizičke aktivnosti može ukazati na potrebu za prilagođavanjem doze insulina. Hipoglikemija se može javiti i nekoliko sati nakon vežbanja, pa je preporučljivo smanjenje doze insulina pre spavanja.
9. Osobe sa dijabetesom treba da nose identifikacionu karticu sa osnovnim medicinskim podacima u slučaju potrebe za hitnom medicinskom intervencijom.
10. Fizičku aktivnost treba izbegavati tokom akutnih infekcija i drugih bolesti, dok se metabolička kontrola ne stabilizuje.
11. Deca i adolescenti sa dijabetesom treba da budu pod nadzorom osoba koje su upoznate sa mogućim komplikacijama, kako bi se u slučaju potrebe pravovremeno reagovalo.

MATERIJAL I METODE

Dizajn studije

Ovo istraživanje je sprovedeno kao studija slučaja sa kontrolom pre i posle intervencije, s ciljem procene uticaja planirane fizičke aktivnosti na nivo glikemije kod osoba sa i bez dijabetes melitusa tipa 1. Istraživanje je trajalo od 1. do 7. januara 2022. godine, a fizička aktivnost je bila unapred isplanirana i kontrolisana u smislu trajanja i intenziteta.

Uzorak ispitanika

U istraživanju su učestvovala dva ispitanika:

- Insulin-zavisna osoba (muškog pola, starosti 32 godine), kod koje je dijabetes tipa 1 dijagnostikovan 2000. godine. Ispitanik koristi intenzivni insulin režim sa četiri dnevne doze: pre doručka (8 jedinica novorapida), pre ručka (10 jedinica novorapida), pre večere (8 jedinica novorapida) i pre spavanja (10 jedinica lantusa).
- Insulin-nezavisna osoba (zdrav ispitanik), koja služi kao kontrolni subjekt radi praćenja fizioloških oscilacija glikemije u odsustvu dijabetesa.

Kriterijumi uključivanja su bili: odsustvo drugih hroničnih oboljenja, sposobnost sprovođenja planirane fizičke aktivnosti i stabilna metabolička kontrola kod ispitanika sa dijabetesom.

Eksperimentalni protokol

Planirane fizičke aktivnosti obuhvatale su vežbe umerenog do visokog intenziteta, što je u skladu sa preporukama Svetske zdravstvene organizacije za unapređenje zdravlja i prevenciju hroničnih bolesti kod odraslih osoba (World Health Organization [WHO], 2010).

Aktivnosti su uključivale:

- Umerenu šetnju u trajanju od 60–90 minuta, dužine 4–6 km, realizovanu na terenima sa ravnim deonicama i blagim usponima. Šetnje su bile organizovane jednog dana u prepodnevnom, a narednog dana u popodnevnom terminu.
- Sobnu gimnastiku, sprovođenu naizmenično sa šetnjom, koja je obuhvatala:

- Standardne vežbe istezanja i mobilnosti (prema smernicama American College of Sports Medicine, 2021):
  - istezanje zadnje lože (hamstrings stretch)
  - istezanje listova (calf stretch)
  - istezanje primicača buta (adductor stretch)
  - istezanje grudnih mišića (chest stretch)
  - istezanje ramenog pojasa (shoulder stretch)
  - rotacije trupa (trunk rotation stretch)
  - bočno istezanje trupa (lateral trunk stretch)
  - dodatno: podizanje na prste i kruženje rukama, u cilju aktivacije cirkulacije i mobilizacije ramenog pojasa. Svaka vežba se izvodila u trajanju od 10–30 sekundi, sa dva ponavljanja po položaju, umerenim intenzitetom koji omogućava blago naprezanje, ali bez bola.
- Vežbe snage umerenog intenziteta: čučnjevi, trbušnjaci i sklekovi, izvođeni u jednoj seriji sa najviše do deset ponavljanja, kako bi se aktivirale glavne mišićne grupe bez prekomernog zamora.

Ispitanici su svakodnevno konzumirali identične obroke kontrolisane energetske vrednosti, uz precizno planirane užine između glavnih obroka.

Planirane fizičke aktivnosti sprovođene su u turističkom primorskom naselju Dubrava (Bar, Crna Gora), na nadmorskoj visini od 0–80 metara. Ova lokacija je odabrana zbog specifičnih klimatskih karakteristika, uključujući prisustvo ruže vetrova i visokog sadržaja kiseonika, što se prema ranijim istraživanjima povezuje sa poboljšanom cirkulacijom i metaboličkom stabilnošću kod osoba sa dijabetesom.

Merni instrumenti i procedure

Nivo glikemije meren je četiri puta dnevno pomoću standardizovanog glukometra Contour Plus:

1. Pre doručka (08:15 h)
2. Pre ručka (13:00 h)
3. Pre večere (19:00 h)
4. Pre spavanja (22:30 h)

Uzorci krvi uzimani su ubodom u jagodicu prsta, korišćenjem sterilnog lanceta Microlet. Dodatno, pre i posle fizičke aktivnosti vršeno je praćenje glikemije kako bi se procenio akutni efekat vežbanja.

Raspored dnevnih aktivnosti tokom eksperimentalnog perioda prikazan je u Tabeli 1.

Tabela 1 Prikaz dnevnih aktivnosti tokom eksperimentalnog perioda

Aktivnost	Neparni dani (1,3,5,7.01.2022.)	Parni dani (2,4,6.01.2022.)
Ustajanje	8h	8h
Provera glikemije	8h 15’	8h 15’
Prijem insulina	8h 15’	8h 15’
Doručak	8h 30’	8h 30’
Fizička aktivnost	sobna gimnastika od 10h-11h	šetnja 10h – 11h 30’
Užina	11h	11h
Provera glikemije	13h	13h
Prijem insulina	13h	13h
Ručak	13h 30’	13h 30’
Fizička aktivnost	šetnja 15-16,30	gimnastika 15-16
Užina	16h	16h
Provera glikemije	19h	19h
Prijem insulina	19h	19h
Večera	19h 30’	19h 30’
Provera glikemije	22h 30’	22h 30’
Prijem insulina	22h 30’	22h 30’
Obrok pre spavanja	23h	23h

REZULTATI

Deskriptivna statistika

Podaci su analizirani pomoću deskriptivne statistike (Tabela 2) i predstavljeni grafički.

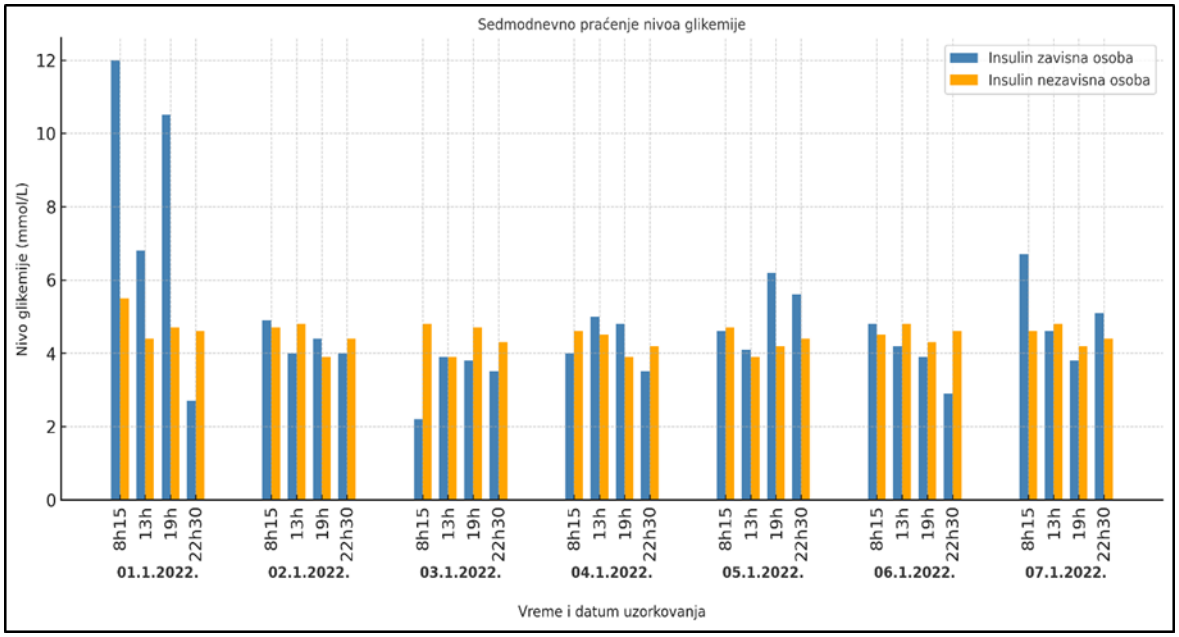
Tabela 2 Deskriptivni parametri vrednosti glikimeje

	Insulin zavisna	Insulin nezavisna
Mean	4.875	4.475
Standard Error	0.397267	0.066791
Median	4.3	4.5
Mode	4	4.4
Standard Deviation	2.102137	0.353422
Sample Variance	4.418981	0.124907
Kurtosis	5.424068	1.42792
Skewness	2.172693	0.39066
Range	9.8	1.6
Minimum	2.2	3.9
Maximum	12	5.5
Sum	136.5	125.3
Count	28	28

U Tabeli 2 prikazani su deskriptivni parametri glikemije kod insulin-zavisnog i insulin-nezavisnog ispitanika. Prosečna glikemija bila je nešto viša kod insulin-zavisnog (4.875 mmol/L) u poređenju sa insulin-nezavisnim (4.475 mmol/L). Međutim, ključna razlika ogleda se u raspršenosti: kod insulin-zavisnog standardna devijacija je bila 2.10 mmol/L, uz raspon vrednosti od 2.2 do 12.0 mmol/L, dok je kod insulin-nezavisnog varijabilnost bila znatno manja (SD = 0.35; raspon 3.9–5.5 mmol/L). Distribucija kod insulin-zavisnog pokazala je jaku pozitivnu asimetriju i izražene ekstreme, dok je kod insulin-nezavisnog bila stabilna i umereno desno asimetrična.

Na osnovu sprovedenog sedmodnevnog eksperimentalnog tretmana i praćenja nivoa glikemije kod ispitanika sa dijabetesom tipa 1 i kontrolnog ispitanika, dobijeni su rezultati koji su prikazani u Grafikonu 1.

Grafikon 1 Prikaz sedmodnevnog praćenjanivoa glikemije



DISKUSIJA

Rezultati istraživanja jasno ukazuju da, iako su prosečne vrednosti glikemije između grupa relativno slične (razlika 0.40 mmol/L), varijabilnost kod insulin-zavisnog ispitanika je značajno veća — sa širokim rasponom, visokom standardnom devijacijom i distribucijom koja pokazuje jaku desnu asimetriju i visoki kurtosis. Ovo ukazuje na prisustvo hipoglikemije i hiperglikemije, što potvrđuje da insulin-zavisni pacijenti doživljavaju značajne dnevne oscilacije u nivou glukoze u krvi. U kliničkoj praksi, ovakva nestabilnost glikemije (glycemic variability, **GV**) prepoznata je kao nezavisan terapijski cilj, pored standardnog praćenja HbA_1c (Kovatchev, 2017; Lachin et al., 2017).

Glikemijska varijabilnost se povezuje ne samo sa povećanim rizikom od akutnih hipoglikemijskih epizoda, već i sa mikro- i makrovaskularnim komplikacijama, uključujući neuropatiju, retinopatiju, nefropatiju i kardiovaskularne bolesti, kao i sa povećanim rizikom od mortaliteta (Saisho, 2014; Lachin et al., 2017). Takođe, dostupni podaci ukazuju da GV može biti povezana sa neurokognitivnim disfunkcijama i psihološkim poremećajima (Lazar, Ionita, Reurean-Pintilei & Timar, 2024).

Kombinovanjem ovih nalaza, može se zaključiti da GV kod insulin-zavisnog pacijenta predstavlja dvostruki izazov: sa jedne strane, povećava rizik od akutnih i hroničnih komplikacija, a sa druge, može biti značajno modifikovana pravilno programiranom fizičkom aktivnošću (Yardley & Sigal, 2015; Colberg et al., 2016; Riddell et al., 2017). Kontinuirano praćenje glikemije (CGM) i analiza parametara varijabilnosti (SD, CV, MAGE, TIR) omogućavaju detaljnije razumevanje metaboličkih oscilacija i efikasnije prilagođavanje fizičke aktivnosti i terapije (Lazar et al., 2024). Čak i u prediabetičnim stanjima, povećana GV signalizira beta-ćelijsku disfunkciju i rizik progresije bolesti (Saisho, 2014).

Sedmodnevni eksperimentalni protokol sproveden u ovoj studiji dodatno potvrđuje značaj kontrolisane fizičke aktivnosti u regulaciji glikemije kod osoba sa dijabetesom tipa 1. Prvobitno uočene veće oscilacije glikemije tokom prvog dana istraživanja verovatno su rezultat kombinacije faktora: povećane fizičke aktivnosti i adaptivne reakcije organizma. Kod osoba sa dijabetesom tipa 1, fizičko opterećenje inicijalno može izazvati povećanje glukoze u krvi (post-exercise hyperglycemia) zbog aktivacije simpatičkog nervnog sistema i oslobađanja kontrregulatornih hormona kao što su adrenalin i kortizol. Ovi hormoni stimuliraju hepatičku glukoneogenezu i glikogenolizu, što može privremeno podići nivo glukoze (McClure, Carr, Boulé, & Yardley, 2024). Nakon nekoliko dana kontinuiranog i pravilno tempiranog programa fizičke aktivnosti, metabolizam glukoze se adaptira, poboljšava se insulinska senzitivnost mišića i regulacija glikemije postaje stabilnija, što se manifestuje smanjenjem oscilacija u narednim danima (Zhou et al., 2020). Najniže vrednosti glikemije kod insulin-zavisnog ispitanika zabeležene su trećeg dana u jutarnjim satima (2.2 mmol/L), dok su najviše vrednosti registrovane prvog dana pre doručka (12.0 mmol/L), što naglašava potrebu za pažljivim planiranjem aktivnosti u skladu sa insulinskom terapijom i nutritivnim unosom. Kontrolni ispitanik, bez dijabetesa, pokazao je stabilne vrednosti glikemije, što potvrđuje efikasnost fizioloških mehanizama regulacije glukoze kod zdravih osoba (Kostić et al., 2009).

Planirane aktivnosti obuhvatile su kombinaciju umerene šetnje i sobne gimnastike (istezanje i mobilizacione vežbe), uz umerene vežbe snage, čime je omogućena aktivacija glavnih mišićnih grupa, poboljšanje cirkulacije i optimizacija metaboličkog odgovora, bez prekomernog rizika od oscilacija glikemije (WHO, 2010; Čizmić, 2011; ACSM, 2021). Pojava hipoglikemije u večernjim satima ukazuje na značaj preciznog tempiranja fizičke aktivnosti i prilagođavanja unosa ugljenih hidrata, što je u skladu sa nalazima da fizičko opterećenje povećava potrošnju glukoze i može dovesti do odložene insulinske reakcije (Čizmić, 2011). Istovremeno, izvođenje aktivnosti u prirodnom okruženju sa povećanim sadržajem kiseonika može dodatno doprineti efikasnijoj oksidaciji glukoze i boljoj metaboličkoj regulaciji (de Leiva-Hidalgo et al., 2020).

U celini, rezultati istraživanja potvrđuju da pažljivo planirana fizička aktivnost, u kombinaciji sa odgovarajućom terapijom i nutritivnim strategijama, predstavlja efikasan i bezbedan metod za smanjenje glikemijske varijabilnosti i poboljšanje metaboličke kontrole kod osoba sa dijabetesom tipa 1. Ipak, optimalni obrasci i dugoročni efekti fizičke aktivnosti zahtevaju dodatna istraživanja u cilju individualizacije pristupa i maksimalnog smanjenja rizika od neželjenih oscilacija, uzimajući u obzir individualne razlike u insulinskoj terapiji, nivou fizičke aktivnosti i životnim navikama.

ZAKLJUČAK

Rezultati sprovedenog istraživanja ukazuju da fizička aktivnost predstavlja značajan regulator glikemijske kontrole kod osoba sa dijabetesom tipa 1. Planirane i kontrolisane vežbe, naročito kada se izvode u prirodnom okruženju sa povećanim sadržajem kiseonika, doprinele su stabilizaciji koncentracije glukoze u krvi, smanjenju dnevnih oscilacija glikemije i poboljšanju ukupne metaboličke kontrole. Ovi nalazi potvrđuju prethodna istraživanja koja ističu važnu ulogu fizičke aktivnosti u povećanju insulinske osetljivosti i boljoj iskorišćenosti glukoze u perifernim tkivima (Yardley & Sigal, 2015; Colberg et al., 2016).

Međutim, fizička aktivnost ne može zameniti insulin u terapiji dijabetesa tipa 1, već njen efekat zavisi od adekvatne insulinske podrške. Nepravilno tempiranje i doziranje fizičke aktivnosti mogu dovesti do hipoglikemijskih ili hiperglikemijskih epizoda, što potvrđuje potrebu za pažljivim planiranjem vežbanja u skladu sa nutritivnim unosom i režimom insulina (Riddell et al., 2017).

Pored direktnih efekata na glikemiju, vežbanje u prirodnim uslovima bogatim kiseonikom može imati dodatne benefite kroz poboljšanje mikrocirkulacije, smanjenje oksidativnog stresa i modulaciju inflamatornih procesa. Time se otvara prostor za šire razumevanje uloge fizičke aktivnosti ne samo u kontroli glikemije, već i u unapređenju celokupnog metaboličkog profila osoba sa dijabetesom tipa 1.

Ipak, ograničenje ovog istraživanja ogleda se u malom uzorku ispitanika i kratkom trajanju tretmana, zbog čega rezultati ne mogu biti generalizovani na širu populaciju. Buduća istraživanja treba da obuhvate veći broj učesnika, duže periode praćenja, kao i detaljnije analize efekata fizičke aktivnosti na druge parametre metaboličkog zdravlja, uključujući insulinsku rezistenciju, lipidni status i inflamatorne biomarkere. Na taj način moguće je pružiti sveobuhvatnije smernice za optimalnu integraciju fizičke aktivnosti u terapijske protokole za osobe sa dijabetesom tipa 1.

LITERATURA

1. American Diabetes Association. (2009). Standards of medical care in diabetes—2009. *Diabetes care*, *32*(Suppl 1), S13-S61. https://doi.org/10.2337/dc09-S013
2. American College of Sports Medicine. (2021). *ACSM's guidelines for exercise testing and prescription* (11th ed.). Alphen aan den Rijn: Wolters Kluwer.
3. American Diabetes Association. (2022). Standards of medical care in diabetes—2022 abridged for primary care providers. *Clinical Diabetes*, 40(1), 10-38.
4. Brkić, M. (2016). *Šećerna bolest kao javnozdravstveni problem*. Diplomski rad, Osijek: Sveučilište Josipa Jurja Strossmayera.
5. Colberg, S. R., Sigal, R. J., Yardley, J. E., Riddell, M. C., Dunstan, D. W., Dempsey, P. C., Horton, E. S., Castorino, K., & Tate, D. F. (2016). Physical activity/exercise and diabetes: A position statement of the American Diabetes Association. *Diabetes Care*, 39(11), 2065–2079. https://doi.org/10.2337/dc16-1728
6. Čizmić, M. (2011). Therapeutic aspects of individually measured physical activity. *Cancer*, *7*, 8-10.
7. Đorđević, N., Ajduković, Z., Šehalić, M., Marjanović, D., Mitić, A., Dragojević, I., & Ilić, A. (2015). Diabetes mellitus and oral health. *Praxis medica*, *44*(2), 67-73. https://doi.org/10.5937/pramed1502067D
8. de Leiva-Hidalgo, A., Brugués, E., & de Leiva-Pérez, A. (2020). The true Banting and Best story: The priority rule and the discovery of the antidiabetic hormone. *Unveiling Diabetes-Historical Milestones in Diabetology*, 29, 84-102.
9. Kostić, N., Čaparević, Z., Marina, Đ., Ilić, S., Radojković, J., Ćosić, Z., & Bakić-Ćelić, V. (2009). Clinical evaluation of oxidative stress in patients with diabetes mellitus type II: Impact of acute exercise. *Vojnosanitetski pregled*, 66(6), 459-464. https://doi.org/10.2298/VSP0906459K
10. Kovatchev, B. P. (2017). Metrics for glycaemic control—from HbA1c to continuous glucose monitoring. *Nature Reviews Endocrinology*, 13(7), 425–436. https://doi.org/10.1038/nrendo.2017.36
11. Kitabchi, A. E., Umpierrez, G. E., Miles, J. M., & Fisher, J. N. (2009). Hyperglycemic crises in adult patients with diabetes. *Diabetes care*, *32*(7), 1335. https://doi.org/10.2337/dc09-9032
12. Lachin, J. M., Bebu, I., Bergenstal, R. M., Pop-Busui, R., Service, F. J., Zinman, B., & Nathan, D. M. (2017). Association of glycemic variability in type 1 diabetes with progression of microvascular outcomes in the Diabetes Control and Complications Trial. *Diabetes Care*, 40(6), 777–783. https://doi.org/10.2337/dc16-2233
13. Lazar, S., Ionita, I., Reurean-Pintilei, D., & Timar, B. (2024). How to measure glycemic variability? A literature review. *Medicina*, 60(1), 61. https://doi.org/10.3390/medicina60010061

14. Martinović, T. I. (2018). *Ultrastrukturne promene u limfocitima periferne krvi bolesnika sa diabetes mellitus-om tip 2*. Doktorska disertacija, Beograd: Medicinski fakultet.
15. McClure, R. D., Carr, A. L., Boulé, N. G., & Yardley, J. E. (2024). An aerobic cooldown after morning, fasted resistance exercise has limited impact on post-exercise hyperglycemia in adults with type 1 diabetes: A randomized crossover study. *Canadian Journal of Diabetes*, 48(6), 387–393. https://doi.org/10.1016/j.jcjd.2024.04.002
16. Riddell, M. C., Gallen, I. W., Smart, C. E., Taplin, C. E., Adolfsson, P., Lumb, A. N., Kowalski, A., Rabasa-Lhoret, R., McCrimmon, R. J., Hume, C., Annan, F., Fournier, P. A., Graham, C., Bode, B., Jones, T. W., & Millán, I. S. (2017). Exercise management in type 1 diabetes: A consensus statement. *The Lancet Diabetes & Endocrinology*, 5(5), 377–390. https://doi.org/10.1016/S2213-8587(17)30014-1
17. Saisho, Y. (2014). Glycemic variability and oxidative stress: A link between diabetes and cardiovascular disease? *International Journal of Molecular Sciences*, 15(11), 18381–18406. https://doi.org/10.3390/ijms151118381
18. Simoni, R. D., Hill, R. L., & Vaughan, M. (2002). The discovery of insulin: the work of Frederick Banting and Charles Best. *Journal of Biological Chemistry*, 277(26), e15-e15.
19. Tahirović, H., Toromanović, A., Bačaj, D., & Hasanović, E. (2006). Epidemiološke karakteristike šećerne bolesti tip 1 u dobi od 0 do 14 godina u tuzlanskom kantonu. *Pedijatrija Danas: Pediatrics Today*, *2*(2).
20. World Health Organization. (2010). *Global recommendations on physical activity for health*. Geneva: World Health Organization. https://www.who.int/publications/i/item/9789241599979
21. Yardley, J. E., & Sigal, R. J. (2015). Exercise strategies for hypoglycemia prevention in individuals with type 1 diabetes. *Diabetes Spectrum*, 28(1), 32–38. https://doi.org/10.2337/diaspect.28.1.32
22. Zhou, Z., Sun, B., Huang, S., Zhang, Y., Zhang, X., & Liu, J. (2020). Glycemic variability: Adverse clinical outcomes and how to improve it? *Cardiovascular Diabetology*, 19, 102. https://doi.org/10.1186/s12933-020-01085-6

METABOLIC EFFECTS OF PHYSICAL ACTIVITY IN INDIVIDUALS WITH TYPE 1 DIABETES: A CASE STUDY

Mekić Raid, Paunović Miloš, Mekić Merisa, Radenković Oliver, Murić Benin, Kahrović Izet, Špirtović Omer, Čaprić Ilma, Milić Vladan

Abstract*: Physical activity plays a crucial role in the regulation of type 1 diabetes in youth, especially when performed in environments with increased oxygen concentration. This study examines the impact of sports gymnastics and natural factors on glycemic control in individuals with type 1 diabetes. A case study method was employed over a seven-day experimental treatment, monitoring glycemic levels in insulin-dependent and non-insulin-dependent individuals at various time intervals. The planned physical activity included moderate walking and indoor gymnastics, with glucose levels measured before and after the activities. The results indicate that outdoor physical activity can contribute to the stabilization of glycemic levels in individuals with type 1 diabetes but cannot replace insulin therapy. Regular physical activity was observed to reduce daily glycemic fluctuations, with the greatest benefits noted in planned moderate-intensity activities. These findings may contribute to the development of guidelines for optimal planning of physical activity in individuals with type 1 diabetes and improve the education of physical education teachers and sports trainers in adapting exercises for this population.*
Key words*: type 1 diabetes, physical activity, glycemic regulation, sports gymnastics, natural factors.*

RESEARCH ON THE CHALLENGES AND STRATEGIES FACED BY COMMUNITIES IN PROMOTING THE SPORTS INTANGIBLE CULTURAL HERITAGE

Guanwen Zhou
Faculty of Sport and Physical Education, University of Niš, Serbia

PROFESSIONAL ARTICLE
DOI: 10.5937/ATAVPA25090G

Abstract: *Sports intangible cultural heritage, including ethnic traditional sports and games, represents the achievements of people's long-term efforts, possessing rich historical significance and artistic value. Protecting and promoting these ancient sports at the grassroots community level can help preserve traditional culture and raise public awareness of sports, thereby achieving sustainable and healthy development. However, challenges such as a shortage of skilled inheritors, inadequate sports facilities, and insufficient funding hinder their promotion. This study examines these issues and proposes actionable solutions, including creating model communities, renovating sports venues, securing funds through multiple channels, and introducing traditional sports in schools.*
Key words: *Community, sports, intangible cultural heritage*

INTRODUCTION

Traditional ethnic sports are cultural creations forged through long-term labor practices over the course of history, embodying the wisdom in daily living of various regions and ethnic groups. In 2003, UNESCO adopted the Convention for the Safeguarding of the Intangible Cultural Heritage. Since then, numerous traditional sports worldwide have been inscribed on the Intangible Cultural Heritage lists, and countries have actively responded by incorporating their outstanding traditional sports into national-level safeguarding systems.

Today, amid sustained economic development and growing awareness of physical fitness, exercise has become an indispensable part of modern lifestyles. Hundreds of sports options are available for daily activities, and new forms of athletic games continue to emerge. However, the widespread use of the internet has allowed video games to consume significant amounts of people's time, causing a decline in participation in physical sports. This poses a serious challenge to the survival of traditional ethnic sports and games.

As the fundamental unit of the social organism, a community serves as a microcosm of the broader society and shoulders the responsibility of being a "testing ground" for social development. Community centers and associations created and managed by communities themselves can play a vital role in supporting the transmission of intangible cultural heritage (ICH) and raising public awareness of its importance to the community (Valentina, 2020). Conducting social pilot programs within specific communities can provide invaluable reference for other communities, thereby influencing the planning and development of society as a whole. Thus, this paper proposes that vigorous efforts should be made to promote the transmission and development of sports-related intangible cultural heritage within grassroots communities. This aims not only to preserve traditional history and culture but also to enhance residents' willingness to participate in sports activities by doing so.

METHODS

This study is based on a literature search conducted via Google Scholar. Building upon extensive reading and referencing of relevant professional literature, it integrates theoretical analysis, content analysis, as well as logical induction and deductive reasoning to examine the current challenges facing sports intangible cultural heritage within community development, and then proposes specific coping strategies.

THE DILEMMA OF INHERITING SPORTS INTANGIBLE CULTURAL HERITAGE

Lack of talent in inheriting sports intangible cultural heritage

Culture is created, sustained, and refined by humanity. Consequently, bearers are the core element in the protection of sports intangible cultural heritage (ICH). Currently, the declining number of outstanding bearers has become a serious and undeniable reality. Many ICH projects face the issue of aging bearers and participants, or even a break in transmission（Zhang, 2023）.In the process of rapid urbanization, the large-scale migration of rural residents to cities has intensified population loss in rural areas. Compounded by historical and natural constraints, economic development remains challenging in some remote regions. These factors collectively make it difficult for a significant amount of sports ICH rooted in rural communities to find sufficient and suitable successors, ultimately leading to a break in transmission.

Secondly, sports intangible cultural heritage has developed over millennia and is now rich in meaning. However, due to the way they are passed down, many practitioners master the skills and performance techniques but lack deep theoretical understanding, failing to grasp the cultural depth behind them（Jiang et al.,2024）.

Additionally, the influence of modern emerging sports continues to deepen, and their reach far exceeds that of relatively slower-paced traditional sports. This has led to a widespread lack of public interest in traditional sports（Ma et al., 2024）. As a component of mass sports, community sports are characterized by their voluntary nature. The choice of sports activities by residents depends on their personal interests. These various factors make the promotion and popularization of traditional sports at the grassroots community level a daunting challenge, directly hindering the cultivation of a new generation of practitioners for traditional sports.

Insufficient community sports facilities

Ample community sports facilities are the fundamental material support for residents' participation in physical exercise, and their supply level primarily depends on the local economic development. However, the problem of insufficient public sports facilities remains widespread in most cities today, and the situation is even more severe in vast rural areas. With the continuous boom in urban development and construction, land is becoming increasingly scarce, making it difficult to guarantee the public sports facilities that urban residents are entitled to. The residents' strong demand for exercise stands in sharp contrast to the sports equipment that is scattered, limited in number, and insufficient in supply.

Furthermore, the intangible cultural heritage of sports is extensive and profound, featuring diverse activities with distinct regional characteristics. Activities such as equestrian skills and water sports, for instance, struggle to find space for practice in land-scarce cities once removed from their native environments. Therefore, the lack of objective material conditions poses great challenges to the widespread preservation of intangible cultural heritage in sports.

Insufficient funds for sports development

Currently, the development of community sports relies primarily on government fiscal allocations, with private capital playing a minimal role. Due to varying levels of economic development across regions, government investment in sports also differs significantly. Remote regions receive particularly inadequate funding.

Simultaneously, the protection of sports intangible cultural heritage faces numerous challenges. These include a lack of specialized protection agencies, unclear ownership, and modernization and commercialization tendencies in the transmission process. This has led to increasingly constrained survival space.（Gao, 2023）

Sustained efforts in cultivating the transmission of sports intangible cultural heritage require substantial financial investment. However, the vast majority of talent cultivation initiatives are currently undertaken spontaneously by civil society organizations. Limited by their own scale, these organizations can provide only severely limited support.The shortage of both policy support and funding constitutes the primary bottleneck constraining the cultivation of talent for sports intangible cultural heritage.

STRATEGIES FOR DEVELOPING SPORTS INTANGIBLE CULTURAL HERITAGE IN THE COMMUNITY

Create sports intangible cultural heritage demonstration communities

Sports intangible cultural heritage activities embody profound artistic value and serve as both recreation and education. Through participation, people are subtly and profoundly influenced. To effectively protect and pass on these precious legacies, and to promote the harmonious development of community sports through traditional sports programs, it is essential to establish a multi-party collaborative governance system. The core objective is to enhance residents' participation and satisfaction.

Establish a "government-led, community-collaborated, resident-participated" community sports model

Government-led planning and guarantee

Government-led planning and safeguarding should involve studying and formulating systems such as community development plans for sports-related intangible cultural heritage, evaluation standards, and sports facility management measures, to coordinate the allocation of sports resources. Additionally, a community supervision and evaluation mechanism centered on resident satisfaction should be established, authorizing third parties to oversee the use of special funds, facility construction and maintenance, residents' fitness status, and activity implementation.

Community collaboration stimulates vitality

Community organizations should contribute to community building by expanding the team of sports professionals, promoting sports programs, offering fitness guidance, encouraging resident participation in exercise, and organizing sports competitions. In serving the community, these organizations must promptly identify residents' difficulties and requests. Through communication and coordination with government departments, experts, and scholars, they can provide practical suggestions for developing improvement plans.

Focusing on residents, enhancing participation experience and sense of identity

Creating a sports atmosphere and guiding concepts

Community residents are both the starting point and the ultimate goal of community development. The fundamental criterion for measuring its effectiveness lies in residents' recognition and satisfaction.Governments, communities, sports clubs, and other stakeholders should actively guide residents to adopt sound perspectives on health and sports, fostering a vibrant sports culture within communities. Only when residents personally experience the value of traditional sports – such as the enjoyment and health benefits they offer – will they develop a genuine appreciation for them. By regularly organizing popular competitions that resonate with the public, traditional sports can be seamlessly integrated into residents' daily lives. Neighbors should be encouraged to support one another in physical activities, promoting collective well-being. Additionally, collaborations with non-governmental research teams can be established to conduct lectures, educating the public about the rich cultural heritage behind traditional sports.

Expand ways for residents to participate in community construction

Encourage residents to not only participate in sports activities, but also engage in the governance process of community sports. By leveraging both online and offline interactions, we can solicit broad input and guide residents to focus on community sports affairs, actively offering suggestions. This allows them to gain a sense of involvement and fulfillment through their contributions, ultimately integrating more residents into the development of community sports.

Innovate, promote and optimize sports events

Practitioners of intangible cultural heritage (ICH) in sports are pivotal to the construction of ICH communities. Efforts should be community-based and practitioner-centered to broaden participation, enhance appeal, and encourage local residents to engage in traditional sports. Innovation can be introduced to certain traditional sports while preserving their essence—for instance, simplifying overly complex forms and appropriately lowering intensity levels—better to align activities with the needs of

the general public. Governments, communities, and residents must provide essential support through measures such as venue provision and fostering an interactive environment. This requires collaborative support and coordination from multiple stakeholders.This will ultimately motivate more residents to participate in physical exercise, promote neighborhood interaction, allow everyone to share the benefits of sports, and build a healthy, happy, and supportive sports community.

Adapt to local conditions and build, renovate, and utilize sports venues

The current distribution of public sports facilities in urban communities is uneven. Older communities, constrained by limited public space, typically suffer from a shortage of sports facilities. They often only have a small number of outdated fitness equipment installed by the government during earlier initiatives. Meanwhile, some newly developed, upscale communities are equipped with relatively comprehensive sports venues.

Therefore, the government should, considering the need to preserve local sports-related intangible cultural heritage, reasonably plan dedicated areas and invest in constructing corresponding venues and necessary equipment. Simultaneously, where conditions permit, efforts should be made to adapt to local conditions, fully utilize existing sports facilities, showcase the distinctive features of traditional sports, and organize various engaging activities.

Additionally, during holidays, we could explore the "government-society collaboration" model for organizing sports events. We may actively host diverse community sports competitions targeting small units such as families, residential buildings, and neighborhoods, thereby mobilizing residents' enthusiasm for participation and fostering a vibrant community sports atmosphere. At the same time, we could organize sports performances, exhibitions, lectures, and exchanges of management experience.

These activities, on one hand, can broaden residents' perspectives on sports, while on the other, they provide insights and references for improving community sports initiatives in the future. By participating in these rich and varied community sports and cultural activities, residents can not only strengthen their bodies, cultivate their character, and delight their minds but also enhance their sense of teamwork and experience the cohesive spiritual strength of the community. The participation process naturally brings neighbors closer, establishing harmonious and close connections between people and the community, thereby strengthening residents' sense of community identity and belonging.

Use multiple channels to raise funds

In the provision of community sports services, relying solely on the participation of governments and enterprises is far from sufficient. It is essential to introduce multiple stakeholders to bridge the supply gap. Governments can collaborate with organizations such as enterprises, sports foundations, clubs, and associations to jointly raise funds and resources. These entities can then be entrusted with the production of community sports services, thus enabling support for traditional sports activities, programs, and institutions in areas such as venue construction, event organization, and expert training （Xue et al.,2023）.

For traditional sports, it is essential to establish support and collaboration mechanisms with civil research organizations and universities, while encouraging diversified forms of social funding to protect sports-related intangible cultural heritage. Additionally, efforts should be made to pool collective wisdom in developing innovative adaptations of these cultural assets by integrating local cultural characteristics. This includes creating cultural and tourism products and leveraging emerging information technologies to enhance online promotion and visibility.

The interdependent and complementary cooperation between the government and sports social organizations not only helps the government reduce provision costs and enhance community sports service quality, but also enables sports social organizations to obtain policy incentives and various forms of support, thereby expanding their social influence.

Carry out traditional sports activities on campus

To ensure effective transmission of a skill or project, the student community serves as an ideal teaching audience. For sports that do not demand extensive equipment or dedicated practice venues,

inheritors may collaborate with primary and secondary school administrators based on their capacity. They can serve as extracurricular instructors after school hours in the form of clubs or interest-based activities to teach traditional sports. Currently, some schools in China have launched the "Taichi on Campus" program. Practice has demonstrated that, with proper guidance, Taichi can not only be successfully integrated into school curricula—contributing to cultural heritage preservation—but also enhance educational outcomes（Tian et al.,2025）

Additionally, higher education institutions may hire excellent inheritors with teaching qualifications to offer specialized or elective courses on traditional sports, building a distinctive curriculum system. Government education and sports departments should provide encouragement and support to schools that actively establish such specialized courses and allocate funding for sports facilities and equipment as appropriate. At the same time, students' education requires the supportive attitude of parents. Good home-school relationships contribute to the mutual reinforcement of family education and school education（Huo 2023）.Education can only be effective when parents understand and support their children's participation in traditional sports, recognizing the importance of sports for youth development.

CONCLUSION

The preservation and transmission of intangible cultural heritage is a long-term endeavor. A central challenge lies in how to garner broader attention for ancient traditions within contemporary society. Building upon an analysis of the current difficulties in transmission, this paper proposes several actionable countermeasures. It emphasizes that the concerted efforts of the government, communities, and residents are indispensable—each playing a vital role.

Furthermore, beyond grassroots community organizations, assistance from educational institutions is crucial. Leveraging schools' platforms and facilities can provide students with opportunities to engage with these traditional practices. Parents should also collaborate with the government and schools, supporting their children's participation in sports activities. Ultimately, this integrated approach aims to foster a holistic environment—encompassing schools, communities, and families—where individuals are immersed in traditional culture.

REFERENCES

1. Valentina, L. Z. (2020). Community participation in Intangible Cultural Heritage safeguarding. *Правоведение*, *64*(1), 23-34.
2. Zhang, H. (2023). Research on the History, Dilemma and Optimization Strategies for the Preservation of Intangible Cultural Heritage of Sports in China. *Journal of Humanities, Arts and Social Science, 2023, 7 (4)*.
3. Jiang, L., & Huang, L. (2024). The current situation and strategies of sustainable development of a state-level intangible cultural heritage project Choi Lei Fut in the context of the new era: Analysis based on questionnaire survey and field interviews. *J. Infrastructure, Policy Dev*, *8*(9), 7460.
4. Wenbo, M., Hongjie, C., & Xiao, L. (2024). Realistic Dilemma and Realization Path of the Deep Integration of Sports Intangible Cultural Heritage and Tourism. *Realistic Dilemma and Realization Path of the Deep Integration of Sports Intangible Cultural Heritage and Tourism*, *6*(3), 235-246.
5. Gao, J. (2023). Construction of digital protection path for intangible cultural heritage of ethnic minority traditional sports: take Tibetan traditional sports as an example. *J. Sociol. Ethnol*, *5*(9), 27-32.
6. Xue, X., & Hongsaenyatham, P. (2023). The Development of a Sustainable Model for Promoting Chinese Traditional Sports "NADAM" under the Background of The Belt and Road. *International Journal of Sociologies and Anthropologies Science Reviews*, *3*(5), 171-184.
7. HUTONG, T., & WENMEI, D. (2025). Study on Sustainable Development of Sports Intangible Cultural Heritage into Campus: an Analysis of Tai Chi Chuan. *Romphruek Journal of the Humanities and Social Sciences*, *43*(1), 307-332.
8. Wenjie, H. (2023). The Practical Path of Campus Inheritance of Sports Intangible Heritage under the Background of the. *Academic Journal of Humanities & Social Sciences*, *6*(15).

КОМПЕНТЕНЦИЈЕ И КОМПЕТЕНЦИЈСКИ ПРИСТУП УПРАВЉАЊУ ЉУДСКИМ РЕСУРСИМА У СПОРТУ

Аземовић Нецад[1], Мујановић Рифат[2], Мујановић Дино[3]
[1]Универзитет Привредна Академија у Новом Саду, Србија
[2]Департман за Биомедицинске науке, Државни Универзитет у Новом Пазару, Србија
[3]Факултет за спорт и физичко васпитање, Нови Сад, Србија

PROFESSIONAL ARTICLE
DOI: 10.5937/ATAVPA25095A

Сажетак: *Основни циљ овог рада је упознавање са теоретским и методским основама улоге и значаја компентенција менаџера које су од перманентног значаја за постизање високих спортских резултата. Овај рад би требало да помогне стицању базичних знања приликом управљања људским ресурсима у спорту. Људски ресурси ангажовани у раду једне спортске организације суштински представљају кључ њеног успеха. Нажалост актуелна спортска пракса показује да већина спортских организација код нас још увек не препознаје ову чињеницу. То је нарочито уочљиво када је реч о контексту менаџмента спортских организација. У Р.Србији, још увек, њихови управљачки делови не успевају да одаберу, али и задрже, квалитетан мемаџерски кадар. На тај начин остају ускраћени, у првом реду, за потенцијале који омогућавају квалитетну конкурентску предност. Јер, да би се одабрао квалитетан кадар неопходно је добро организовати сам процес селекције и изабрати кандидате који су спремни да буду ефикасни у свом раду, а истовремено и лојални својој спортској организацији.*
Кључне речи: *менаџерске компетенције*, *приступи управљању, спортски резултати*

УВОД

Нови концепт приступа људским ресурсима у пословној сфери, са којом савремени спорт има бројних додирних тачака, изузетно истиче значај знања, образовања и способности кадрова. Дакле њихових укупних компетенција, као кључног фактора за развој одређене организације, као и спортске области у целини. Поједини потенцијали човека се морају унапређивати образовањем и иновацијом знања, које треба перманентно развијати, усавршавати и промовисати, како би се ти потенцијали трансформисали у капитал (вредност), односно свесну и сврсисходну активност у свим радним процесима. Другим речима, савремене концепције менаџмента у спорту афирмишу и потенцирају значај људских ресурса у остваривању жељених и постављених циљева организације (пре свега спортских организација – клубова, али и других организационих облика неопходних за егзистенцију спортске делатности), где је квалитет кадровског потенцијала директно одговоран за координацију и усмеравање управљачких процеса, односно непосредно утиче на све активности у спорту. Менаџментске активности у спортским организацијама неизоставно су директно повезане са радном ефикасношћу, што у први план ставља питање компетенција људских ресурса. На тај начин се оне појављују као веома мерљива категорија, која се евалуира одговарајућим (прихваћеним) организацијским стандардима. Дакле, посматрано и са позиција менаџмента у спорту, може се констатовати да компетенције представљају врло „мерљиву" категорију у конкретном сапортском систему.

РАЗЛИЧИТИ ПРИСТУПИ УПРАВЉАЊУ ЉУДСКИМ РЕСУРСИМА У СПОРТУ

У најопштијим разматрањима појмова компетенција *иу компететност*, може се поћи од њиховог најопштијег одређења, односно сематичке основе. Тако, појам *компетенција* (лат. *цомпетентиа*) означава надлежност, меродавност, поље рада неког надлештва; подручје у којем нека особа поседује знања, искуства и вештине. С друге стране, појмовна одредница *компетентан* повезана је, такође, са надлежношћу и меродавношћу особе, али и са формалном и/или стварном оспособљеношћу за неки посао (Јовановић, 2006).

Неке од дефиниција компетенција се могу видети кроз ставове појединих аутора. Бојатис (Боуатзис, 1982) је дефинисао да компетенција представља основну карактеристику особе која резултира у ефикасном и/или супериорном обављању посла... може бити особина, мотив,

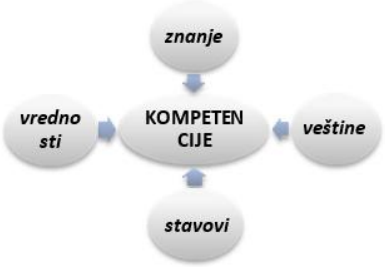
вештина, аспект слике о себи или социјалне улоге, као и корпус знања коју она/он користи. Вудруф (Woodруффе, 1991) сматра да су компетенције скуп понашања које особа мора извести да би задатке и функције посла обавила компетентно, док Вар и Конер (Wapp анд Цоннер, 1992) сматрају да се компетенција за неки посао посматра као скуп понашања, знања, процеса мишљења и/или ставова за које је вероватно да се рефлектују у обављању посла, а који досежу до претходно дефинисаних елементарних, базичних и високих нивоа стандарда. С друге стране Грин (Греен, 1999) сматра да су индивидуалне компетенције мерљиве радне навике и личне вештине које се користе за постизање радних циљева, а Курц и Бартрам (Курз анд Бартрам, 2002, стр. 229) стоје на становишту да компетенције обухватају скупове понашања који су инструментални за постизање жељених резултата и исхода.

Без обзира на различите ауторе и њихове приступе, може се сматрати да у теорији егзистирају две релативно самосталне групе ставова. Прву чине оне дефиниције које се односе на квалификације или стандарде обављања посла, док се друга групација односи на посматрање компетенција као одреднице за високу успешност на послу или супериорно обављање посла.

Међутим, у теоријским разматрањима, поред проблема дефинисања концепта, отворена питања за расправу у вези са компетенцијама чини и блискост са појмом *компетентност*. Наиме, неки аутори користе термин *цомпетенце* (надлежност и/или способност), а други *цомпетенцу* (делокруг), односно користећи их као синониме. Мада се већина слаже да су то повезани и комплементарни појмови, ипак их диференцира као релативно самосталне одреднице. Док *цомпетенце* у суштини означава умешност (стручност) у односу на неке специфичне радне активности и према унапред дефинисаном стандарду, *цомпетенцу* се у првом реду односи на понашања која подржавају успешно обављање одређених радних активности (не на спецификацију вештина и знања, већ на начин примене, тј. како се те вештине и знања користе при обављању радних активности) (*Курз анд Бартрам*, 2002). Исти аутори (стр. 235) ова два појма разликују у следећим аспектима: (1) компетенције се дефинишу у акционим и циљно оријентисаним терминима; (2) компетенције представљају репертоаре понашања људи, док је стручност 'стање' нивоа постигнућа; (3) стручност се односи на постигнуће (стечена знања, вештине, квалификације и искуства) и увек се посматра у прошлом времену (шта је нека особа до сада постигла, док ништа не говори о томе шта би све још могла постићи); (4) компетенције се могу, такође, третирати уназад (тзв. кружно процењивање, са повратном информацијом), али се првенствено посматрају у садашњости (у контексту актуелне процене), као и у будућности (као компетенцијски потенцијал); (5) повезаност компетенције и стручности огледа се у њиховој међусобном корелацији, тако што се индивидуална стручност демонстрира применом одговарајуће компетенције унутар радног окружења, на начин да се ефикасно и ефективно остварује постављени циљ.

Дакле, посматрано и са позиција менаџмента у спорту, може се констатовати да компетенције могу бити тесно повезане са радном ефикасношћу, што их чини веома мерљивом категоријом, а која се евалуира опште прихваћеним организацијским стандардима. На њихово побољшање се може утицати перманентном едукацијом, тако да се, у суштини, главним компонентама компетенција људи у спортским организацијама сматрају: 1) знање, 2) вештине, 3) ставови и 4) вредности (Слика 1).

Слика 1 Основне компоненте компетенција у спортском менаџменту



Извор: креација аутора

Управљање људским ресурсима у савременим организацијама постаје све важније питање њиховог развоја, односно самог опстанка на тржишту. Међу више различитих модела и приступа овом проблему, у последње време све више пажње се посвећује тзв. *компетенцијском приступу* управљања људским ресурсима, који може бити апликативан и у спортским организацијама.
Развој овог модела почео је крајем двадесетог века, односно од како се у пословним окружењима интензивније почело размишљати о појму компетенција запослених. Овај приступ у проучавању и пракси управљања људским ресурсима, веома популаран у Америци и Великој Британији, последњих десетак година се почео интензивније ширити на простору Европске уније, пре свега Скандинавије, али и у азијском подручју, где се у појединим земљама примењује и на националном нивоу (Jovanović, R, 2006). Основна идеја развијања модела усмерена је на дефинисање система за ефикасно понашање појединаца са циљем да се одаберу прави људи за улазак у (спортску) организацију, те успоставе стандарди њихове едукације. Након тога и дефинисање стандарда њиховог индивидуалног (и колективног) развоја на начин који највише одговара циљевима организације. То, свакако, треба да прати и адекватност награђивања, као и развоја стандарда за управљање њиховим каријерама. Наравно, све ово је у складу са настојањима (спортске) организације да буде што ефикаснија и ефективнија као целина.

Битну улогу у појављивању и прихватању компетенцијског модела управљања људским ресурсима одиграо је контекст промена у пословном окружењу у последњих двадест година. Пословни амбијент је постао све интензивнији, турбулентнији и подложан брзим променама, што је створило услове за појаву све веће бриге за компетенције запослених (људских ресурса) као одговора на промене до којих је долазило. Овакве тенденције нису мимоишле ни спорт, као саставног дела глобалног тржишта (посебно професионалног спорта), тако да дотадашња традиционална (ригидна) подела послова постаје неодржива и штетна за компетитивност већине организација (и спортских организација). У савремено конципираним и структуираним радним организацијама послови постају дифузнији, без јасних граница; запослени се све више бирају за припадност организацији, селекција се усмерава на уклапање у постојећу организацијску структуру посматрану као целина, која поседује своју организацијску климу и културу базирану на учењу и знању, уместо на досадашње бирање појединца за фиксни посао, односно конкретно радно место (*Спаррош*, 1997). Апликативност оваквих појава на спортске организације је, дакле, више него очигледна. Из ових разлога, дакле, организацијска идентификација знања, вештина, способности, вредности, као и других карактеристика појединаца, које су битне за спортску организацију као целовит систем (тиме и за њену ефикасност), добија на својој значајности.

Различите индивидуалне карактеристике људских ресурса у спортској организацији, према овом концепту, траже јасан израз и менаџментску оријентацију ка новом приступу у којем доминира ограничени, циљно усмерен и релативно мањи број компетенција појединаца. Промена организацијског фокуса (са захтева посла на карактеристике појединца), тражи промену метода и процеса у управљању људским ресурсима. Тако да се у овом контексту развијају и нови модели управљања људским ресурсима, оријентисани на појединца. Управо је та идеја универзалности и широка примењивост компетенција на целу организацију разлог растуће популарности компетенцијског модела у пракси пословних организација (Caldwell 2010). У актуелној литератури из области менаџмента истичу се три релативно различита приступа компетенцијском моделу, који, сваки за себе, могу бити добра подлога за даља проучавања овог приступа и на подручју спортског менаџмента. Први се заснива на истраживањима Бојатиса (*Цалдwелл,* 2010) који полази од претпоставке да ефикасност и напредак организације зависи, у првом реду, од њених менаџера, односно да су карактеристике особа које воде организацију кључене за њен успех. Такође, он уочава да се менаџери у пракси бирају на основу имплицитних теорија које говоре о моделу „успешног менаџера". Полази од става да постоји одређени фиксни број *компетенција* у односу на које се сви менаџери разликују, те на основу истраживања (обухватило око 2000 менаџера, у 41 различитом послу) дефинише 21 компетенцију битну за посао менаџера. Примењујући *ЈЦАМ* метод (*Јоб Цомпетенце Ассессмент Метход*) тих 21 компетенција разврстао је две групе:

(1) *основне граничне компетенције* које представљају минималне предуслове за успешан рад менаџера, али оне не обезбеђују изврсност у обављању посла и не утичу битно на њу; тако да је неопходна (нпр: логичко размишљање, тачна процена себе, спонтаност, слеф. концепт, и сл.) и друга група, а то су (2) *супериорне компетенције* које доводе до ефикасног, врхунски реализованог квалитета посла (постиже их тек сваки десети менаџер; нпр: оријентација на ефикасност, интерес за утицај, управљање групним процесима, истрајност, прилагодљивост, и сл.) (према: *Wood анд Пауне*, 1998). Дакле, реч је о приступу оријентисаном на појединца.

С друге стране Прахалад и Хамел (*Прахалад анд Хамел*, 1990, стр. 82) у свом моделу полазе од организацијског нивоа. Дефинишу појам *кључне компетенције* којима је обухваћен јединствени скуп техничких вештина, а које су битне за ефикасност организације. Дакле, овде је у првом реду реч о *компетенцијама организације*, а не само појединца. Кључне компетенције на организацијском нивоу рефлектују се и на фундаменталне особине појединаца (*КСАО*: *Кнowледге* – знање; *Скиллс* – вештине; *Абилитиес* – способности; *Отхер цхарацтеристицс* – остале карактеристике појединца потребне да би се посао добро обавио). Ове особине појединца, које су интегрисане у кључне компетенције организације, омогућавају јој да се брзо прилагођава на промене у окружењу (на тржишту). За организацију, компетенција се у првом реду односи на учење и развој, односно „колективно учење у организацији" (Штимац, 2006).

Трећи приступ се заснива на једном од, у литератури, запаженијих савремених модела Робертсона, Калинана и Бартрама (*Робертсон, Цаллинан анд Бартрам,* 2002) који је утемељен на тзв. *понашајним компетенцијама*. Факторизацијом су издвојили четири групе варијабли значајних за успешно обављање посла: (1) *компетенцијски потенцијал* (индивидуалне карактеристике особе неопходне за реализацију жељених понашања), (2) *компетенције* (скуп пожељних понашања, при чему је пожељно понашање дефинисано кроз исходе према којима су та понашања усмерена), (3) *контекст* (ситуациони фактори који одређују која су то понашања и исходи пожељни; заснивају се на карактеристикама организације и на карактеристикама социјалних односа у организацији), и (4) *резултати и исходи* (кроз интеракцију компетенцијског потенцијала с једне стране и контекстуалних утицаја с друге, развијају се компетенције као ефикасни одговори на захтеве посла).

Оно што може представљати значајну одредницу приликом разматрања питања компетенција у спортским организацијама јесу предности које поједини компетенцијски модели имају на дугорочну оријентисаност спортске организације. Тачније на реализацију њене визије и мисије, што је уско повезано са организацијским опредељењима која усмеравају пажњу на повезаност обављања посла са стратешким циљевима организације.

Без обзира на то што се спортске организације и, уопште, спортско организовање у неком окружењу, међусобно могу знатно разликовати (у односу на грану спорта, стратешко усмерење, територијални обухват, и сл.), што са собом носи и егзистенцију њихових различитих потреба, могу се евидентирати неки заједнички именитељи који су препознатљиви у већини модела компетенција. Један број модела инсистира на организацијским вредностима и стратегијама, док други истичу улогу компетенција у контексту олакшавања рада и комуникације код запослених, односно дефинишу очекивања од људских ресурса (уз утврђивање особине, знања и вештина које су важне за обављање послова и задатака) (Caldwell, 2010). Због тога су видљива два главна подручја у којима се очекују побољшања у активностима људских ресурса увођењем компетенцијских модела. Наиме, циљ развијања конкретног модела је да, с једне стране одражава организацијске вредности и стратегије, што олакшава њихово прихватање у свим сегментима рада (спортске) организације (и од свих запослених), а с друге стране да свим њеним члановима омогући јасно разумевање очекивања која се постављају пред њих, те на основу тога објективизују оцене њиховог радног учинка.

Мада су различити компетенцијски модели, како је већ и речено, различито поставили основу одређења компетенција, посебно код модела који се заснивају на индивидуалним компетенцијама (карактеристике појединца – једни инсистирају на знању и вештинама, док други у први план постављају понашања и мотивацију) заједничке одреднице су им: вредности, интереси, способности, искуства, особине и ставови (*Курз анд Бартрам*, 2002) (Слика 2). Дакле,

може се констатовати да је осовни циљ компетенција (њиховог моделирања, примене и развоја) усмерен на развој људских ресурса у (спортским) организацијама (*Стореу*, 2016).

Слика 2 Компетенцијски модел, садржајна структура у спортској организацији

Извор: креација аутора

ЗНАЊЕ КАО ДЕТЕРМИНАНТА РАЗВОЈА КОМПЕНТЕНЦИЈА МЕНАЏЕРА У СПОРТУ

Савремено организоване спортске организације (спортски системи), пред које се данас постављају високи захтеви спортске делатности у целини (како у домену спортско-тренажне технологије, тако још више у простору управљања организацијама), намеће и неопходност обезбеђивања високо стручних људских ресурса, који поседују специфична знања и применљиве вештине. Због тога је спортски менаџмент данас још увек суочен са проблемом и питањем како задовољити велику потражњу за квалитетним кадровима у спорту. Односно са каквим ће знањима, умећем и способностима, односно компетенцијама, стручни кадрови обављати све сложеније и одговорније послове у спортским организацијама као сложеним системима (Нешић, 2012).

У различитим теоријским концептима и методама којима се настоји извршити систематизација знања, посматрано са аспекта менаџмента у спорту, могу се веома апликативним узети оне класификације које доприносе развоју идеје о важности знања у спорту, односно оне које су значајне за контекст пословања и функционисања спортских организација. Тако, на пример, према Заку (Caldwell, 2010) основна подела садржи пет типова знања: (1) декларативно – у основи подразумева спознају о томе „*шта* треба знати о некоме или нечему" (у менаџменту популатно названо *know- what*); (2) процедурално – подразумева познавање процедура и методологије (знати *како* – *know-xow*); (3) каузално – познавање контекста активности и садржаја према којем је усмерено знање (знати *зашто* – *know-wxy*); (4) кондиционално – све оно што може да идентификује временске параметре примене знања (знати *када* – *know-wxeн*); и (5) релационо – познавати односе и релације актера који учествују у реализацији знања (знати *ко/шта*; с *ким/чим* – *know-wxo, know-wxepe*).

Наведени типови знања се могу сматрати и кључним компонентама менаџерског знања у спорту, посебно посматрано са аспекта развоја менаџерских компетенција. Посебно се то односи на примену знања у реализацији менаџмент функција у спортским организацијама, а нарочито функције планирања, где се види директна кореспондентност наведених типова знања са садржајима планирања. Наиме, у процесима израде плансиких докумената у спортској организацији, у основи, мора се одговорити на „шест питања" која усмеравају планску активност, а то су: *зашто* се нешто ради (дефинише контуре/концептуализацију плана), *шта* се ради (одређује циљ), *када* се ради (дефинише временске параметре и рокове), *како* се ради (детерминише методологију рада, тј. реализације планских задатака који су у функцији ефикасног остваривања циљева), *ко* ради (идентификује непосредне извршиоце и нихове одговорности) и *где* се активност претежно обавља (идентификује пословно окружење) (Табела 1).

Табела 1 Кореспондентност компоненти знања са менаџерским активностима планирања у спортским организацијама

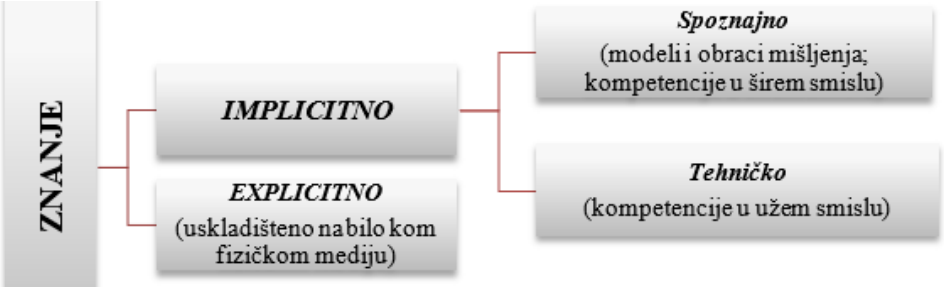
Komponente znanja		Elementi planiranja
znati:		znati definisati u planu:
zašto	→	***konceptualizacija*** plana
šta	→	definisanje ***cilja/ciljeva***
kako	→	***metodologija*** rada
kada	→	***vremenski rokovi***
ko	→	***izvršioci***
gde	→	identifikacija ***okruženja***

Извор: креација аутора

Такође, знање се може поделити и са аспекта колективитета, тако да постоји: (а) *индивидуално* (обухвата знање појединаца и оно може бити *опште* и *посебно*; опште се односи на познавање одређених области које су предмет интересовања шире популације и као такво доступно је свима, а углавном се стиче током процеса основног образовања; док посебно знање обухвата познавање неких ужих области интересовања, те за разлику од општег знања није свима доступно, већ је „привилегија" оних који имају више образовне нивое) и (б) *колективно* (знање које поседује нека организациона целина). У овом контексту спортску организацију треба посматрати као скуп појединаца, што усмерава на закључак да је колективно знање једнако кумулативу знања појединаца који конституишу одређену спортску организацију. Такође, овако схваћено колективно знање неизоставно убухвата и синергијску компоненту, која подразумева да појединци поред сопственог знања, у свом активном сарадничком односу, стварају и додатно знање које је резултат когнитивног процеса и односи се на унапређење знања. За спортске организације је јако значајно да у свом саставу имају људе који поседују шири дијапазон знања, али и већи број појединаца који су познаваоци неких специфичних области значајних за рад и егзистенцију конкретне спортске организације (посебно је у овом смислу значајно тренерско знање).

Надаље, када се сагледава стратегија управљања знањем (и компетенцијама) у спортским организацијама тада се као детерминанта намеће подела на: *имплицитно* (*тацит*; персонално знање оличено у индивидуалном искуству и укључује неопипљиве факторе као што су: лична уверења, перспективе, вредности и сл.) и *експлицитно* (*експлиците*; знање које може да буде изражено у формалном језику и размењивано између појединаца) (*Муррау анд Смолник*, 2011). У контексту менаџерских компетенција у спорту (и њиховог развоја) посебно је значајан контекст имплицитног знања, где се кроз простор *спознајног* знања креирају модели и обрасци мишљења (суштински представљају компетенције у ширем смислу), док се у простору *техничког* налазе све неопходне детерминанте знања које чине суштинску подлогу за успешно обављање стручних послова људских ресурса у спорту (компетенције у ужем смислу) (Слика 3).

Слика 3 Врсте знања као основа менаџерских компентенција у спорту



Извор: Нешић, 2008, стр. 305

Управљање знањем у спортским организацијама треба да обезбеди успешно креирање адекватног процеса којим се сва расположива а за конкретну организацију релевантна знања, могу успешно прикупљати, систематизовати, те у потребном тренутку и дистрибуирати. То, у крајњем исходу, доводи до стварања адекватних организацијских компетенција. Како ће изгледати систем управљања знањем, односно на који начин ће се он успоставити и како ће функционисати, то зависи искључиво од конкретне ситуације у којој се спортска организација налази.

Модели управљања знањем су бројни и различити. Међутим, у досадашњој спортској пракси, посебно у спортским организацијама локалног нивоа и значаја, нису уочени неки јасно дефинисани модели управљања знањем (а тиме и модели развоја компетенција). Стога се као теоријски апликативан може посматрати један од основних модела узетих из организацијских теорија (Јовановић,2006) који подразумева четири међусобно повезане фазе:
(1) *креирање знања* (унос новог знања у организацију, који обухвата подфазе: откривања, прикупљања и развоја новог знања), (2) *чување знања* (скуп активности који се односи на правилно „складиштење" прикупљеног знања и његов опстанак унутар организацијског система), (3) *трансфер знања* (активности преношења знања између делова организације и појединаца) и (4) *коришћење знања* (активности које се односе на практичну примену стечених знања у свакодневним активностима спортске организације).

Такође, може се апликативним за спортске организације узети и Мејов модел (Премовић Ј и Премовић Т, 2009) који дефинише да је за ефикасно управљање организационим знањем, неопходно обезбедити функционисање пет елемената: (1) посвећивање пажње перманентном учењу, (2) комбиновање знања и искуства, (3) подела постојећег организационог знања, кроз међусобну сарадњу и комуникацију, (4) стална присутност и доступност информација, и (5) коришћење и развијање постојећег знања. У овом моделу приоритетна важност се придаје нематеријалним организацијским вредностима (у односу на материјалне), уз перманентни развој интелектуалног капитала (спортске) организације путем вредновања индивидуалних способности, индивидуалне и колективне мотивације, организационе климе и ефективности радних група (тимова, екипа, и сл.). Такође, овде до изражаја долази значај индивидуалног учења и развоја кроз унапређење компетенција, уз одговарајуће вредновање и поклањање пажње искуству, као и системима организацијске базе података.

ЗАКЉУЧАК

Да би успешно одговорили комплексним задацима и реализовали постављене циљеве, менаџери у спортским организацијама морају да стекну одређени фонд знања (теоријских и практичних). А да би се стечено знање могло адекватно реализовати у непосредном раду, неопходно је поседовање одређених компетенција које им омогућавају ефикасно извршавање постављених задатака. Имајући у виду претходне опсервације у овом раду, може се сматрати да је апликативност компетенцијског модела у спортским организацијама сасвим могућа. Посебно ако се има у виду досадашња теоријска подлога спортског менаџмента која детерминише да компетенције кадрова у спорту (људских ресурса) представљају акциону подлогу за реализацију радних задатака у спортској организацији. Стога се као основа за дефинисање хипотетског компетенцијског модела у спортском менаџменту могу сматрати следеће групе компетенција спортских менаџера: 1) *Концептуалне* компетенције (јасно разумевање улоге спорта у целини, као и спортске организације и њеног окружења; способност креирања и контроле планова рада). 2) Компетенције *интерперсоналне интеракције* (способност руковођења групом и организацијом, способност адекватне комуникације са корисницима, сарадницима и окружењем; способности које омогућавају посредовање међу људима); и 3) *Техничке* компетенције (способност реализације техничко-стручних проблема у спортској организацији; посебно у контексту вођења административно-управљачких активности – организовање и вођење седница, конципирања и реализације буџета, промоције спортске организације, коришћења информатичко-техничких средстава, знање страних језика итд.).

ЛИТЕРАТУРА

1. Bahtijarević-Šiber, F. (1999). *Management ljudskih potencijala.* Zagreb: Golden marketing.
2. Barcelona, B., Ross, C. M. (2004). An Analysis of the Perceived Competencies of Recreational Sport Administrators. *Journal of Park & Recreation Administration*, 22(4), 25–42.
3. Balduck, AL., Rossem, A., Buelens, M. (2009). Identifying Competencies of Volunteer Board Members of Community Sports Clubs. *Nonprofit and Voluntary Sector Quarterly*, 38(2), 170–181.
4. Boyatzis, R. E. (1982). *The competent manager: a model for effective performance*. London: Wiley.
5. Caldwell, R. (2010). Are HR Business Partner Competency Models Effective. *Applied H. R. M. Research*, 12(1), 40–58.
6. Dalton, M. (1997). Are Competency Models a Waste? *Training and Development*, 51(10), 46–50.
7. Green, P. C. (1999). *Building Robust Competencies: Linking Human Resource Systems to Organizational Strategies*. San Francisco: Jossey- Bass.
8. Horch, H. D., Schutte, N. (2003). Competencies of sport managers in German sport clubs and sport federations. Managing Leisure, 8(2), 70– 84.
9. Heijke, H., Meng, C., Ris, C. (2003). Fitting to the Job: The role of generic and vocational competencies in adjustment and performance. *Labour Economics*, 10(2), 215–229.
10. Jovanović, R. (2006). *Veliki leksikon stranih reči i izraza*. Beograd: Alnari.
11. Kan, S., Wang J., Li Chaoping**,** L. (2002). Assessment on Competency Model of Senior Managers. *Acta Psychologica Sinica*, 3, 43–52.
12. Koenigsfeld, P. J., Kim, S. H., Cha, J., Cichy, F. R. (2012). Developing a competency model for private club managers. *Inetrantional Journal of Hospitality Management*, 31(3), 633–641.
13. Kurz, R., Bartram, D. (2002). Competency and Individual Performance: Modelling the World of Work. In I. T. Robertson, M. Callinan and D. Bartram (Eds), *Organizational Effectiveness: The Role of Psychology* (225–255). Chichester: John Wiley.
14. Lievens, F., Sanchez, J. I., De Corte, W. (2004). Easing the Inferential Leap in Competency Modeling: The Effects of Task-related Information and Subject Matter Expertise. *Personnel Psychology*, 57, 881–904.
15. Maksimović, N. (2008). Kompetencije sportskih menadžera. *Aktuelno u praksi*, 20(7), 121–127.
16. Murray, E. J., Smolnik, S. (2011). *Strategic for Knowledge management Success: Exporing Organizational Efficacy*. New York: Information Science Reference.
17. Nešić, M. (2008). *Sport i menadžment*. Novi Sad: Tims.
18. 18.Nešić, M., Nešić, B. (2012). Učeća sportska organizacija kao izraz novog preduzetništva u sportu. *Poslovna ekonomija*, 6(1), 443–463.
19. Premović, J., Premović, T. (2009), Upravljanje znanjem i stručno obrazovanje u Srbiji. *Norma*, 14(2), 161–178.
20. Prahalad, C. K., Hamel, G. (1990). The Core Competence of the Corporation. *Harvard Business Review*, *May–June*, 79–91.

COMPETENCES AND COMPETENCE APPROACH TO HUMAN RESOURCES MANAGEMENT IN SPORTS

Azemovoć Nedžad, Mujanović Rifat, Mujanović Dino

Abstracts*: The main goal of this paper is to introduce the theoretical and methodological foundations of the role and importance of managerial competencies that are of permanent importance for achieving high sports results. This paper should help in acquiring basic knowledge when managing human resources in sports. Human resources engaged in the work of a sports organization essentially represent the key to its success. Unfortunately, current sports practice shows that most sports organizations in our country still do not recognize this fact. This is especially noticeable when it comes to the context of sports organization management. In the Republic of Serbia, their management departments still fail to select, but also retain, quality managerial staff. In this way, they remain deprived, first of all, of the potential that enables a quality competitive advantage. Because, in order to select quality staff, it is necessary to organize the selection process well and choose candidates who are ready to be efficient in their work, while at the same time being loyal to their sports organization.*

Key words: *managerial competencies, management approaches, sports results*

DANCE AND MOVEMENT THERAPY

Ćeremidžić Tatjana, Ćeremidžić Dejan
Faculty of Physical Education and Sport, University of East Sarajevo, Republic of Srpska, Bosnia and Herzegovina

PROFESSIONAL ARTICLE
DOI: 10.5937/ATAVPA25103C

Abstract: *Since human prehistory, dance has been used for therapeutic purposes, and on that basis, dance and movement therapy was conceived, which over time developed into a distinct (psycho) therapeutic approach. Dance/Movement Therapy (DMT), sometimes abbreviated as "dance therapy," developed in the 1940s in the USA and reached Europe in the 1970s. Dance therapy is a body-oriented therapy based on the use of dance and movement as a creative process, with the goal of integrating the emotional, cognitive, social, and physical characteristics of each individual, that is, connecting body, mind, and spirit. This type of therapy includes the therapeutic use of movement and psychomotor expression as the main means of analysis and intervention. In addition to focusing on the way of moving and body posture, importance is also given to other nonverbal signs such as breathing, gestures, facial expressions, muscle tone, rhythm of movement, use of space, etc. Dance and movement therapy has proven to be extremely useful for different groups of people and is intended for all ages. This therapy can be performed individually, in pairs, or in groups. Through analysis, we come to the conclusion that this special form of therapy purposefully uses movement and dance for healing and health improvement, and it affects general cognitive functioning, especially memory, enhances nonverbal communication skills, and reduces stress levels, as well as influencing affective processes in people. Spontaneous movement improvisation enables clients to try new ways of being and to experience.*
Key words: *dance, movement, therapy.*

INTRODUCTION

Dance, as a specific anthropomotor activity, holds an important place in various areas of life and work of both children and adults. Due to the specificity of its content and application, dance is studied within the theory and practice of sports, physical education, recreation, rehabilitation, and other social sciences. The fundamental element and means of dance is movement. Dance is a way of expressing a person's spiritual states, and throughout human history, it has become the most immediate celebration of the mind and body. In all epochs of civilization, it has been given great importance.

It is a fact that the need to dance lies in human nature. Throughout history, dance has taken many forms, yet one thing remains constant — there has never been a period in which dance was not part of culture, whether as a social custom, a ritual, a way of marking events, or simply an occasion for joy and entertainment. Dance can be described as an ideal and efficient form of physical activity, playing an essential role in modern human life by contributing to the development of motor, functional, and cognitive abilities, as well as having a positive impact on emotional and social aspects. What is especially important is that it is not limited by age; it teaches people to master their bodies and minds, increases working capacity, promotes a positive mood, and, most importantly, enables individuals through movement and dance to express what cannot be expressed in words

Dance and movement therapy, or Dance/Movement Psychotherapy (DMP), is a therapeutic approach that relies on physical movement and dance as the primary methods for exploring inner emotional and psychological states. This form of therapy has deep roots in human history, as dance has always been used as a means of emotional expression, ritual, and healing. Developed as a specific therapeutic approach in the mid-20th century, DMP has since become an important tool in contemporary psychotherapy, known for its ability to integrate body, mind, and spirit through the creative expression of movement.

In the 21st century, the entire world is turning toward recreation as a means of improving health. Physical exercise — and dance as a form of physical activity — plays a significant role in achieving and maintaining health. Being healthy is the greatest wealth, yet it is often not appreciated enough while we have it. Health should be viewed not merely as the absence of disease but as the ability to adequately respond to the many challenges of everyday life through its physical, psychological, and social

dimensions. In this type of therapy, dance is applied either as a preventive measure or as a means of specific treatment. The focus of treatment is directed toward neuropsychic hypersensitivity

PREVIOUS RESEARCH ON THE EFFECTS OF DANCE AND MOVEMENT THERAPY

Numerous studies have been conducted in an attempt to demonstrate the positive effects of dance on an individual's health and quality of life. These studies have established that dance plays a multifaceted role in contemporary psychotherapy. Dance and movement therapy is a holistic approach that integrates the body, emotions, and mind. Its effects are not limited to physical expression but also include psychological release, personal growth, and the restoration of a sense of wholeness. Dance therapy is based on the relationship between physical movement and emotions, and in this therapy, dance movements and techniques are used to improve multiple functions of the body.

Previous research has confirmed the effectiveness of this therapy among children and adolescents with emotional and social difficulties and developmental disorders (autism, ADHD), among adults with psychological issues (anxiety, depression, PTSD, body image disturbances, and low self-esteem), and among elderly individuals (dementia and cognitive impairments).

Through the application of dance and movement therapy, it has been found that children with illnesses who attended dance classes read better, had improved concentration, and were more open to cooperation — they engaged more in conversations and activities.

Gillan (1992) observed improved communication through dance movements in children. Dance activities enhance psychomotor, cognitive, and socio-affective functioning. This therapy enables children to express themselves better, gain self-confidence, relax, develop communication skills, and achieve greater socialization, among other benefits.

A pilot study examined the effects of a classical ballet program designed specifically for children with cerebral palsy. At the end of the program, therapists noted that the children experienced enjoyment and satisfaction during the training, showed increased motivation for other extracurricular activities, and parents positively evaluated their children's participation in the therapeutic program. Dance and movement therapy has also proven highly effective for individuals with Down syndrome, as it combines physical activity, emotional expression, and social interaction — all of which have a positive effect on the motor, cognitive, and social development that is often impaired in these individuals.

Some researchers have also focused on examining the connection between feelings of pleasure and changes in neurohormonal status under the influence of dance/movement psychotherapy. For instance, Jeong et al. (2005) reported that, after a 12-week therapeutic program, adolescents with mild depressive disorder showed a statistically significant increase in plasma serotonin and dopamine levels.

For blind and visually impaired individuals, dance therapy leads to greater confidence and freedom of movement, improved spatial awareness and perception of the environment, as well as easier recognition of sounds and rhythm (Hećimović et al., 2014).

A group of authors (Koch et al., 2007), in their study *"The Joy Dance: Specific Effects of a Single Dance Intervention on Psychiatric Patients with Depression"*, investigated a sample of 31 patients (18 women and 13 men) diagnosed with depression as a primary or secondary condition. The participants were divided into three groups: (1) the dance therapy group (group circle dance with jumps), (2) the music listening therapy group (listening to the same music used in the dance therapy group), and (3) the exercise group (stationary cycling with a heart rate matching that of the dance group). Among the patients in the dance therapy group, a significant reduction in depressive symptoms was observed, while the health condition of participants in the other two groups remained unchanged.

Research results indicate positive secondary effects of dance/movement psychotherapy compared to pharmacotherapy. While medications may cause fatigue, changes in muscle tone, nervousness, and similar side effects, dance and movement psychotherapy has a positive and empowering effect on the body, acting preventively against cardiovascular diseases, obesity, anxiety, and more.

Neuroscientific studies suggest that dance and movement stimulate brain regions associated with emotions, motor functions, and cognition. Dancing activates the limbic system and prefrontal cortex, which can contribute to emotional regulation. Kattenstroth (2013) noted that dance increases synaptic plasticity and improves memory function in older adults. Kattenstroth emphasized that dance, as a tool

for enhancing synaptic plasticity, can be crucial for improving the quality of life of older people. This research supports the use of dance not only as a form of physical activity but also as an important factor in preventing cognitive decline and neurodegenerative diseases such as Alzheimer's. Therefore, dance is beneficial in therapies for elderly individuals, as it not only contributes to physical fitness but also provides cognitive stimulation, making it a comprehensive approach to maintaining mental health in aging.

Among adults with mental health disorders, dance improves coordination and motor skills, communication, and self-confidence, corrects movement stereotypes, and reduces psychological tension.

In the largest neuropsychiatric hospital in Buenos Aires (Argentina), tango is used as a therapy to help psychiatric patients and depressed individuals who feel lonely. It is considered highly effective because it involves calm and measured movements that are not performed in a fast rhythm, and the social aspect of the dance, combined with its physical benefits, improves the quality of life of patients and reduces feelings of loneliness. For this reason, tango therapy is increasingly used in the treatment of Alzheimer's and Parkinson's diseases, social phobia, marital and sexual therapy, and depression. Consequently, tango has for years been used as a form of therapy to awaken (or strengthen) sexual energy among couples.

HISTORICAL DEVELOPMENT OF DANCE AND MOVEMENT THERAPY

The application of dance as a targeted therapy is still relatively little known in professional literature. Dance therapy uses dance movements to address emotional, cognitive, social, behavioral, and physical difficulties. It is based on the understanding that movements and emotions are directly connected, thereby creating a healthy balance between mind and body. As early as the 19th century, dance therapy was known, with the first written documents on the subject dating back to that time, but it was recognized as a formal therapeutic approach only in 1940. Dance and movement therapy emerged from various cultural and psychotherapeutic traditions.

During the 1940s in the United States, dance therapy began to develop as a specific approach within psychotherapy. Dance therapies relied on ideas from psychology, particularly theories emphasizing the role of the body in emotional and psychological processes. In Europe, dance therapy was recognized as a therapeutic method in the 1970s, and today it is practiced worldwide.

The pioneers of dance/movement psychotherapy are considered to be Marian Chase, Mary Whitehouse from the United States, and Elsa Gindler from Europe. All three were initially dancers who observed the therapeutic effects of dance in the participants of their dance workshops. During their professional dance careers, they noticed the psychotherapeutic impact of movement and dance on their students and, in collaboration with doctors and psychiatrists, began treating patients with psychological difficulties or disorders through the use of movement and dance.

After World War II, Marian Chase conducted dance workshops in psychiatric clinics with individuals suffering from post-traumatic stress disorder (PTSD). Mary Whitehouse worked primarily with participants experiencing issues related to modern life. Professional associations also began to form, such as the American Dance Therapy Association (ADTA) and the European Association for Dance Movement Therapy (EADMT).

Education for dance psychotherapists varies worldwide: it may be offered at universities as part of postgraduate or undergraduate programs (USA, United Kingdom, etc.), through institutions with a set number of dance therapy hours, or within psychotherapist associations in individual countries (Germany, Poland, etc.)

THEORETICAL AND PRACTICAL FRAMEWORK OF DANCE/MOVEMENT THERAPY (DMT)

Dance/Movement Therapy (DMT) is defined as the use of movement and dance in a creative process with the aim of developing emotional, cognitive, social, and physical integration in an individual. The primary goal of dance or movement therapy is the process of raising awareness and improving three key elements in a person: self-perception, nonverbal communication skills, and the range and quality of emotional experiences.

It helps individuals enhance their functional and motor abilities and serves as a highly effective intervention for mental health issues, including stress reduction and alleviation of symptoms associated with conditions such as anxiety and depression. This therapy is used to address a variety of physical and mental health problems, including anxiety, arthritis, dementia, depression, multiple sclerosis, autism, Parkinson's disease, post-traumatic stress disorder (PTSD), and others.

The objective of dance therapy is not the perfect execution of movements, but the expression of inner states through bodily movement. It is important to emphasize the connection between body and mind—our emotions often manifest in the body through various movement patterns, and dance allows us to become aware of and release them. Therefore, Dance/Movement Therapy (DMT) supports the integration of body and psyche. Individuals do not need prior dance experience to participate, and the therapy is experiential, creative, and often nonverbal.

Psychotherapists in this approach frequently rely on Laban Movement Analysis to observe clients' movements. According to this framework, movement can be examined through four main factors: space, time, flow, and weight (force or strength). In terms of time, movements can be fast or slow; in relation to space, movements can be direct or indirect; regarding flow, movements can be free or bound; and in terms of weight, movements can be light or strong. These four factors correspond to the individual's internal psychological state: the use of space relates to thinking, time to decision-making, flow to feelings, and weight to identity. Consequently, different emotional states (e.g., joy or anger) elicit different types of movements.

PRINCIPLES, METHODS, AND TECHNIQUES OF DANCE/MOVEMENT THERAPY

Theoretical Principles in Dance/Movement Therapy

Dance/Movement Therapy is based on several key theoretical principles:

1. **Holistic Approach** – Therapy connects body, mind, and spirit, creating a unique dynamic between the client's physical and emotional state. The goal of therapy is to enable the integration of internal processes through creative movement expression.
2. **Bodily Expression** – Movement and dance allow clients to express themselves in ways that often go beyond verbal communication. Through bodily expression, clients can explore suppressed emotions and deep inner processes.
3. **Rhythm and Space** – Therapy focuses on the rhythm of movements, how the client uses space, energy, and breath, all of which can provide insight into the person's emotional state.
4. **Improvisation and Spontaneity** – Spontaneous movements, which are not pre-planned, allow clients to explore unknown parts of themselves, fostering personal transformation and self-awareness

Methods and Techniques in Movement and Dance Therapy

Movement and Dance Therapy uses various methods and techniques to achieve therapeutic goals:

- **Individual work** – The client focuses on the internal process through movement, using improvisation to express emotions and thoughts.
- **Partner work** – Dancing or moving with a partner allows for the exploration of relational dynamics, helping to develop social skills and resolve interpersonal conflicts.
- **Group therapy** – Group exercises facilitate social interaction and collaborative creation, fostering a sense of community and understanding among participants.

There are several key techniques in dance psychotherapy:

- **Movement improvisation** – Free movement to music, without rules, to release suppressed emotions.
- **Mirroring** – The therapist observes and imitates the client, building trust and connection.
- **Emotional dance** – Expressing specific emotions through dance movements.
- **Dance meditation** – Focusing on conscious breathing and slow dance movements to achieve relaxation.

Structure of a Therapeutic Session

Sessions can be individual or group-based, and their structure depends on the client's goals and the therapeutic approach:

- **Warm-up** – Involves simple movements that help establish body awareness and connection.
- **Main part** – Utilizes guided or spontaneously expressed movements that allow for emotional expression, exploration of internal experiences, or work on specific psychological themes.
- **Reflection and integration** – Involves conversation or other nonverbal exchanges that enable processing and understanding of the experience.

Applicability to different groups

Movement and Dance Therapy can be used with various ages and populations:

- **Children and adolescents** – Therapy is used to address emotional difficulties, reduce aggression, and improve social skills.
- **Adults** – It can help reduce stress, anxiety, and depression, as well as work with trauma and emotional challenges.
- **Older adults** – In this group, therapy can enhance motor skills, balance, and social interaction, while reducing symptoms of depression

EFFECTS OF MOVEMENT AND DANCE THERAPY

Movement and dance therapy has proven effective in working with various groups and issues, including:

1. **Reduction of stress and anxiety** – Through physical activity and the release of emotional blocks, therapy reduces stress levels and promotes relaxation.
2. **Enhancement of emotional regulation** – Through dance and movement, clients can learn to better recognize, understand, and regulate their emotions.
3. **Improvement of social skills** – In group therapy, participants develop better interpersonal skills, learning about cooperation and emotional interaction.
4. **Increase of cognitive abilities** – Therapy can positively impact cognitive functions, including attention, memory, and problem-solving skills.
5. **Physical and mental integration** – The integration of body and mind through movement enables clients to achieve balance between physical health and emotional well-being.

As previously mentioned, dance therapy helps individuals express feelings and thoughts. Through dance, the body sends messages to the mind that help process various emotions, feelings, and thoughts. Age, talent, and dance skills are not important, as the emphasis is on movements that emerge from within. Dance and music encourage suppressed content to surface, making the unconscious conscious.

The most important aspect is to create a sense of comfort for the individual and encourage them to surrender to music and dance movements, allowing suppressed feelings and thoughts to emerge. In addition to focusing on movement and body posture, other nonverbal signs shown by the client are also important, including breathing, gestures, facial expressions, muscle tonus, rhythm of certain movements, use of space, and more.

Body expression, whether in daily situations or in spontaneous dance improvisation without predetermined movements, is spontaneous and unconscious. Verbal expression is easier to control because word choice can be consciously manipulated, making verbal content more subject to alteration. Nonverbal signs, however, are usually truthful as they directly relate to the unconscious, reflecting suppressed attitudes and therefore are less controlled.

Therefore, movement is linked to deeper layers of the psyche, making expressive movement the best way to channel unconscious psychic content, which then takes visible form and is released. Movement is the primary medium the therapist uses for observation, assessment, exploration, therapeutic interaction, and intervention.

APPLICATION OF DIFFERENT DANCE STYLES ACCORDING TO THERAPEUTIC EFFECTS

For physical health and fitness:

- zumba, hip-hop, afro dance – high intensity, excellent for burning calories and strengthening the heart.
- ballet – develops strength, flexibility, posture, and balance.
- contemporary dance / modern dance – dynamic and varied, strengthens the entire body.

For emotional expression and mental health:

- contemporary dance, improvisation – allows freedom of expression and emotional release.
- argentine tango – has therapeutic effects, especially for depression, anxiety, and loss of sexual energy.
- dance therapy – used in clinical psychology to work with trauma and emotional issues.

For social connection:

- salsa, bachata, kizomba – sensual partner dances that develop communication, trust, and intimacy.
- folk dances – connect participants with tradition, community, and culture**.**

For the brain and cognitive development:

- standard and latin-american dances (competitive dance**s)** – require precise steps and coordination with a partner.
- ballroom dancing for older adults – proven to improve memory and reduce the risk of dementia

CONCLUSION

Dance, due to its holistic impact, significantly contributes to the balance of mental and motor abilities and promotes a positive mood. It both stimulates and soothes emotions, which is why it is also used for therapeutic purposes. In dance therapy, patients are given the opportunity to exercise, reducing muscle tension and improving bodily system functions, which has a positive effect on both physical and mental health. Considering dance as a human need—manifesting the desire for pleasure, recreation, and happiness, as well as the pursuit of spontaneous activity and freedom of movement—it becomes evident why dance can be applied for therapeutic purposes. If dance can, through dance therapy, help humanity, then it holds complete meaning, especially today in the times we live in.

Due to the highly effective effects of dance and dance movements on physical, mental, emotional, social, and spiritual health, a relatively young field in psychotherapy has emerged, known as movement and dance therapy, often referred to as dance-movement therapy.

Dance/Movement Therapy (DMT) is a form of psychotherapy that uses movement, the body, and dance as primary means of expression and communication. It developed in the 1940s in the United States. This therapy is based on the idea that the body, emotions, and mind form an integrated whole—everything that happens in the psyche is reflected in the body, and vice versa. It is used with a wide range of individuals, especially those for whom traditional verbal forms of therapy are insufficient or challenging. The main goal of this therapy is not to "teach someone to dance," but to enable self-expression through movement and to raise awareness of one's internal state through the body. Dance therapies help individuals to better feel and understand their emotions, express what cannot be put into words, develop self-confidence and body awareness, and improve communication in relationships with others.

Therapy sessions can be individual or group-based and are led by a dance therapist, following various structures (warm-up, main part, reflection, and integration), using different techniques (movement improvisation, mirroring, dance meditation).

It can be used to treat a range of physical and mental health issues, including anxiety, arthritis, chronic pain, dementia, depression, multiple sclerosis, autism, Parkinson's disease, PTSD, and more. Dance/movement therapy utilizes movement and nonverbal communication, alongside talk therapy, to address psychological and behavioral issues that words alone cannot resolve. It is about finding an inner

space that we may not know exists or have chosen to deny, and giving voice to those experiences and emotions.

"Dance is the language of the soul—a movement that transcends words. It not only strengthens the body but heals the mind, releases emotions, and connects us to our own truth. In the rhythm of music, one finds a freedom that everyday life often conceals." So, let us dance!

REFERENCES

1. American Dance Therapy Assosiation. Službena web-stranica. Dostupno na: https://adta.org/marian-chace-biography/
2. Barnes, R. (2010). Step Change: Dance therapy for individuals with Down syndrome. *Journal of Dance Therapy, 32*(2), 123-135.
3. Blagojević, M. (2016). Plesna terapija kao oblik somatske psihoterapije. *Ples i terapija: Novi pristupi* (str. 105-114). Izdavačka kuća Psihopolis.
4. Bradt, J., & Dileo, C. (2019). Dance/movement therapy for trauma survivors: Theoretical and practical considerations. *Journal of Dance/Movement Therapy*, 41(1), 16-30.
5. Buškulić, M. (2024). Zdravstveni aspekti primjene plesa i pokreta, Diplomski rad, Sveučilište u Splitu Filozofski fakultet - odsjek za rani i predškolski odgoj i obrazovanje.
6. Centar Terpsichore – službena web-starnica. Dostupno na: https://www.centarterpsichore.hr/edukacija-psihoterapija-pokretom-i-plesom/
7. Ečimović Nemarnik, R. (2019). Zdravstveni učinci društvenih plesova i njihova uloga u prevenciji kroničnih bolesti. Hrvatski športskomedicinski vjesnik, 34(1), 5-13.
8. Federman, D. J. (2011). Kinesthetic ability and the development of empathy in dance movement therapy. Journal of applied arts & health, 2 (2), 137-154.
9. Gillan, W. (1992). Dance movement therapy and communication in children. *Journal of Dance Therapy, 15*(1), 45-60.
10. Hećimović I., Martinec R., Runjić T. (2014). Utjecaj terapije pokretom i plesom na sliku tijela adolescentica sa slabovidnošću. Hrvatska revija za rehabilitacijska istraživanja, 2014; 50(1), str. 13-25.
11. Jeong, Y. H., Kim, J. H., & Lee, S. H. (2005). The effect of a therapeutic program on the concentration of serotonin and dopamine in adolescents with mild depression. *Journal of Clinical Psychology, 61*(4), 505-514.
12. Jovanović, A. (2020). Somatski pristupi u terapiji pokretom: Ples, telo i emocije. *Somatska terapija u Srbiji*, 11(2), 134-142.
13. Kattenstroth, M. (2013). The effects of dancing on the memory and cognitive abilities of older adults. *Frontiers in Aging Neuroscience, 5*, 10. doi:10.3389/fnagi.2013.00010
14. Kim, H. M., Park, J. W., Lee, H. S. i Kim, J. H. (2014). The Effects of the Community Dance Program on Socialization and Emotional Competency in Individuals with Intellectual Disabilities. Korean Journal of Adapted Physical Activity, 22 (1), 39-53.
15. Koch, S. C., Fuchs, T., & Kilian, R. (2007). The joy dance: Specific effects of a single dance intervention on psychiatric patients with depression. *Psychiatry Research*, 150(2), 101-108.
16. Kovačić, I., & Matijaš, I. (2016). Plesna terapija kao alat u lečenju trauma. *Terapijski pristupi u umetnosti*, 10(1), 99-107.
17. Mandić, M. (2018). Plesna terapija u radu sa decom sa posebnim potrebama. *Kreativne terapije*, 25(2), 73-80.
18. Martinec, R., Šiškov, T., Pinjatela, R., Stijačić, D. (2014). Primjena psihoterapije pokretom plesom u osoba s depresijom. Socijalna psihijatrija, 42 (3), 145-154.
19. Milić, J. (2019). Plesna terapija i njen uticaj na emocionalno zdravlje adolescenata. *Psihoterapija i umetnost*, 16(3), 95-104
20. Musicant, S. (1994). Authentic movement and dance therapy. American journal of dance therapy, 16 (2), 91-106.
21. Petrović, J., & Mandić, I. (2019). Ples i pokret u terapiji za osobe sa invaliditetom. *Revija za terapijske umetnosti*, 30(2), 119-126.
22. Ristić, J. (2017). Ples kao metoda u terapiji i rehabilitaciji. *Psihološke studije*, 14(3), 58-66.
23. Trkanjec Z. (2019). Tjelesna aktivnost i Parkinsonova bolest. Medicus, 28(2): str. 213- 217.
24. Tsimaras, V. K., Giamouridou, G. A., Kokaridas, D. G., Sidiropoulou, M. P., i Patsiaouras, A. I. (2012). The effect of a traditional dance training program on dynamic balance of individuals with intellectual disability. Journal of Strength Conditioning Research, (26), 192 -198.

TERAPIJA POKRETOM I PLESOM

Ćeremidžić Tatjana, Ćeremidžić Dejan

Sažetak: *Ples se, od ljudske praistorije koristio u terapijske svrhe te je na toj osnovi koncipirana terapija plesom i pokretom koja se s vremenom razvila u zasebni (psiho)terapijski pristup. Psihoterapija pokretom i plesom (PPP), ponekad se skraćeno zove „plesna terapija", razvila se 40-ih godina u SAD-u, da bi u Evropu stigla 70-ih godina prošlog vijeka. Plesna terapija je tjelesno orijentisana terapija koja se temelji na primjeni plesa i pokreta kao kreativnog procesa, a cilj je integrisati emocionalne, kognitivne, socijalne i tjelesne karakteristike svakog pojedinca, odnosno povezati tijelo, um i duh. Ova vrsta terapije uključuje terapijsko korištenje pokreta i psihomotornu ekspresiju kao glavni način analize i intervencije. Osim fokusa na način kretanja i tjelesno držanje, važnost se pridaje i drugim neverbalnim znakovima, kao što su disanje, gestikulacija, mimika, tonus mišića, ritam izvođenja pokreta, način korištenja prostora i dr. Terapija pokretom i plesom pokazala se izrazito korisna kod različitih grupa ljudi i namjenjena je svim uzrastima. Ova terapija može se izvoditi individualno, u paru ili grupi. Analizom dolazimo do zaključka da ovaj poseban oblik terapije ciljano kristi pokret i ples radi izliječenja i unapređenja zdravlja, te djeluje na opšte kognitivno funkcionisanje, ponajviše pamćenje, poboljšanje neverbalne komunikacijske vještine i smanjenje nivoa stresa te uticaja na afektivne procese kod ljudi. Spontana improvizacija u pokretu omogućava klijentima isprobavanje novih načina bivanja i novo iskustvo samog sebe, odnosno razmišljanja i osjećanja.*

Klučne riječi: *ples, pokret, terapija.*

UTICAJ SUPLEMENTACIJE NA SNAGU I TJELESNU KOMPOZICIJU KOD REKREATIVACA

Kovač Stevan[1], Bjelica Bojan[1], Cicović Borislav[1], Pržulj Radomir[1], Aksović Nikola[2], Cicović Vanja[1], Hajder Đorđe[1], Bubanj Saša[3]

[1]Fakultet fizičkog vaspitanja i sporta, Univerzitet u Istočnom Sarajevu, Republika Srpska, BiH
[2]Fakultet za sport i fizičko vaspitanje, Univerzitet u Prištini, Leposavić, Srbija
[3]Fakultet sporta i fizičkog vaspitanja, Univerzitet u Nišu, Srbija

ORIGINAL SCIENTIFIC ARTICLE
DOI: 10.5937/ATAVPA25111K

Sažetak: *Suplementacija, kao moderan pristup poboljšanju fizičkih performansi, postala je integralni dio sportske prakse širom svijeta. Danas se na tržištu nalaze brojni dodaci ishrani koji ciljaju na povećanje mišićne mase, smanjenje umora ili optimizaciju oporavka. Cilj ovog istraživanja je ispitati uticaj kreatina na parametre mišićne snage i tjelesne kompozicije u specifičnim uslovima treninga. Uzorak za istraživanje sačinjen je od 19 rekreativaca podijeljenih na eksperimentalnu (n=12) i kontrolnu (n=7) grupu. Eksperimentalna grupa je suplementirana sa 5gr kreatin monohidrata, dok je kontrolna-placebo grupa kao dodatak dobijala 5gr dekstroze. Ekperimentalni program je sproveden u trajanju od 8 sedmica sa učestalosti od 4 treninga nedeljno. Praćeni su efekti eksperimentalnog tretmana na tjelesnu kompoziciju (3 varijable) i snagu (3 testa). Na osnovu rezultatat istraživanja, može se konstatovati da eksperimentalni tretman ima pozitivne efekte na snagu ispitanika, povećanje mišićne mase, dok kod procenta masti i tjelesne vode nije bilo statistički značajnih razlika. Fitnes programi predstavljaju efikasno sredstvo za poboljšanje tjelesne kompozicije i snage žena. Bilo bi poželjno utvrditi efekte treninga na još neke motoričke parametre i parcijalne dijelove tijela kada je u pitanju tjelesna kompozicija.*

Ključne riječi: *1RM, Bench press, Strengh, Leg press, exercise, program*

UVOD

Ljudi su od davnina tražili načine da unaprijede fizičke sposobnosti, koristeći dostupne resurse za postizanje boljih rezultata u aktivnostima koje zahtijevaju snagu, izdržljivost i brzinu. Historijski zapisi, poput onih vezanih za drevne Olimpijske igre u antičkoj Grčkoj, ukazuju na upotrebu različitih metoda za poboljšanje performansi, uključujući i specifičnu ishranu i rituale (Maughan, & Burke, 2012). Suplementacija, kao moderan pristup poboljšanju fizičkih performansi, postala je integralni dio sportske prakse širom svijeta. Danas se na tržištu nalaze brojni dodaci ishrani koji ciljaju na povećanje mišićne mase, smanjenje umora ili optimizaciju oporavka.

Među najpopularnijim suplementima ističe se kreatin, organsko jedinjenje koje se prirodno nalazi u mišićima i ima ključnu ulogu u regeneraciji adenozin-trifosfata (ATP), osnovnog izvora energije za intenzivne aktivnosti kratkog trajanja (Buford et al., 2007). Unos kreatina može značajno povećati njegove rezerve u skeletnim mišićima, doprinoseći boljem performansu tokom vježbanja i ubrzavajući oporavak nakon napora (Cooper et al., 2012). Kreatin se može pronaći u hrani poput crvenog mesa i ribe, ali se njegova konzumacija u obliku suplemenata pokazala efikasnijom za povećanje fosfokreatinskih rezervi (Rawson, & Venezia, 2011). Kreatin se, osim u sportskoj praksi, sve više istražuje i u kontekstu kliničkih populacija, gdje pokazuje potencijalne koristi za neurološke i metaboličke poremećaje. Takođe, njegovo djelovanje na povećanje intramuskularne hidratacije može doprinijeti poboljšanju anaboličkih procesa, čineći ga korisnim za osobe koje teže povećanju mišićne mase. Važno je naglasiti da kreatin nema trenutni efekat na izdržljivost ili aerobne aktivnosti, već je njegova primarna uloga povezana s anaerobnim performansama. Iako postoje individualne varijacije u odgovorima na suplementaciju kreatinom, većina korisnika doživljava benefite u relativno kratkom vremenskom periodu.

Istraživanja ukazuju na značajan uticaj kreatina na povećanje mišićne mase, snage i eksplozivnosti, dok njegova uloga u promjenama tjelesne kompozicije ostaje predmet brojnih naučnih diskusija (Branch, 2003; Jagim et al., 2012). Uz to, protokoli suplementacije uključuju fazu "punjenja" i fazu održavanja, pri čemu se preporučene doze prilagođavaju individualnim potrebama sportista. Važno je naglasiti da je kreatin jedan od najistraživanijih i najsigurnijih suplemenata, uz brojne dokaze o njegovim koristima za različite vrste fizičkih aktivnosti (Kreider et al., 2017). Buduća istraživanja trebala bi se fokusirati na

dugoročne efekte suplementacije, kao i na mogućnost kombinovanja kreatina s drugim ergogenim sredstvima za postizanje optimalnih rezultata.

Cilj ovog istraživanja je ispitati uticaj kreatina na parametre mišićne snage i tjelesne kompozicije u specifičnim uslovima treninga.

METOD

Ispitanici i protokol testiranja

Istraživanjem je obuhvaćeno 19 ispitanika podjeljenih na dva subuzorka: N=12 ispitanika koji su konzumirali CR, prosječne težine 83,2kg i visine 180,4cm, N=7 ispitanika koji su predstavljali Placebo grupu PG, prosječne težine 84,1kg i visine 181,3cm. Starosna kategorija ispitanika je iznosila 27±3 mjeseci. Svi ispitanici su bili napredni rekreativci u oblasti body building-a sa aktivnim učešćem od 6 mjeseci u procesu vježbanja (3-5 puta u toku nedelje). Tokom vježbanja subjekti nisu konzumirali ni jedan vid suplemenata ili nedozvoljenih supstanci. Svi ispitanici su dobrovoljno pristali da učestvuju u istraživanju.

Dva dana prije početka eksperimentalnog protokola (EP) sprovedeno je inicijalno testiranje. Testiranje je započeto u jutarnjim satima (8:00) i obuhvatalo je analizu tjelesne kompozicije svih učesnika, nakon čega je svako od njih pojedinačno prošao procjenu snage. Analiza tjelesne kompozicije vršena je korištenjem uređaja za bioelektričnu impedansu TANITA, model BC-545n, proizvedenog u Japanu. Iz ovog segmenta prikupljeni su sljedeći parametri: tjelesna masa (kg), mišićna masa (kg), procentualni udio masti (%) i procenat vode (%), prema standardizovanom protokolu (Macfarlane, Chan, Tse, Joe, 2016). Snaga je procjenjivana kroz tri testa: Bench Press (maksimalno jedno ponavljanje – 1RM), Leg Press (1RM), i Barbell Biceps Scott, gdje se mjerio maksimalan broj ponavljanja s težinom od 15 kg (uključujući težinu šipke). Prije procjene snage, učesnici su se zagrijavali deset minuta, aktivirajući sve mišićne grupe, a potom su izvodili probne serije zadatih testova s progresivnim povećanjem težine (3–4 pokušaja) dok se nije odredio maksimalni kapacitet za 1RM.

Eksperimentalni protokol trajao je 8 sedmica i uključivao ukupno 32 treninga, raspoređenih na 4 sedmična termina: ponedjeljak, srijeda, petak i subota. Svaki trening je trajao 75 minuta. Utorak, četvrtak i nedjelja bili su dani za odmor i oporavak. Svaka sesija započinjala je zajedničkim dinamičkim zagrijavanjem u trajanju od 10 minuta, koje je uključivalo vježbe mobilnosti, istezanja i lakog kardio opterećenja.

Trening je bio baziran na kružnom principu, s fokusom na različite mišićne grupe svakog dana. Učesnici su izvodili 6–8 različitih vježbi po treningu, u 4 serije s 12–15 ponavljanja, održavajući intenzitet od 65–75% 1RM. Pauze između serija bile su 60 sekundi, dok su pauze između vježbi trajale do 2 minute. Vježbe za core regiju uključivale su intervalni rad od 30–45 sekundi, s pauzama od 30 sekundi između serija.

Eksperimentalni protokol je sproveden u teretani "Sparta" u Palama. Treninzi su počinjali u 18:00 sati, čime su omogućavali učesnicima optimalan period za oporavak tokom dana. Tokom osam sedmica, plan treninga bio je sljedeći:

- **Ponedjeljak (Leđa + Biceps)**: Vježbe su uključivale mrtvo dizanje, zgibove (široki hvat), povlačenje na lat mašini, veslanje na mašini, biceps pregib s šipkom, čekić pregib i pregib s bučicama u sjedećem položaju.
- **Srijeda (Grudi + Triceps)**: Uključene vježbe su bile bench press (ravna klupa), kosi bench press, flys s bučicama, crossover na kablovima, triceps ekstenzije na sajli, propadanja i francuski potisak.
- **Petak (Noge + Ramena)**: Čučnjevi s opterećenjem, nožni potisak, iskoraci, ekstenzije nogu na mašini, sjedeći potisak za ramena, lateralna podizanja s bučicama i povlačenje na sajli za zadnji dio ramena.
- **Subota (Kardio + Core)**: Kardio segment uključivao je vožnju bicikla ili brzo hodanje na traci u trajanju od 15 minuta. Vježbe za core obuhvatale su plank, bočni plank, medicinska lopta twist, podizanje nogu i mountain climbers.

Obrada podataka

Data was obtained using the statistical data-processing package SPSS 20. Basic statistical parameters were presented for both groups of participants (CR and Placebo), and differences between the groups were assessed using the ANOVA test of repeated measures. All the results were presented as mean values.

REZULTATI SA DISKUSIJOM

Grupa koja je koristila kreatin zabeležila je značajno povećanje telesne mase (+4.3 kg), dok je placebo grupa imala minimalne promene (+0.5 kg). Udeo telesne masti ostao je praktično isti u obe grupe, što ukazuje da je dobitak mase kod kreatinske grupe bio rezultat povećanja mišićne mase i vode, a ne masti. Ovo je u skladu sa prethodnim studijama koje pokazuju da kreatin povećava telesnu masu prvenstveno kroz retenciju vode u mišićima i sintezu proteina (Vandenberghe et al., 1997; Kreider et al., 2003).

Tabela 1 Tjelesna kompozicija – inicijalno/finalno stanje KR/PG

	Pre-test (kg)	Post-test (kg)	Pre-test Body Fat (%)	Post-test Body Fat (%)	Pre-test Body Water (%)	Post-test Body Water (%)
KR	85.3	89.6**	14.5	14.3	61.8	62.0
PG	83.7	84.2	14.2	14.1	61.5	61.7

Povećanje telesne vode u obe grupe sugeriše da je trening imao ulogu u poboljšanju hidratacije. Kreatin, međutim, dodatno doprinosi intramuskularnoj retenciji vode, što je u skladu sa nalazima Branch (2003), koji navodi da kreatin dovodi do povećanja ukupne telesne mase kroz povećanje intracelularne hidratacije.

Grupa koja je koristila kreatin pokazala je značajna poboljšanja u maksimalnoj snazi na Bench Pressu (+11.2 kg) i Leg Pressu (+12.8 kg), dok su poboljšanja u placebo grupi bila minimalna (+4.1 kg i +3.3 kg). Ovo potvrđuje da kreatin poboljšava performanse u vežbama snage, što je u skladu sa istraživanjima Volek et al. (1997) i Earnest et al. (1995), koji su takođe pronašli poboljšanja u 1RM nakon kreatinske suplementacije.

Tabela 2

	Pre-test Bench Press (1RM kg)	Post-test Bench Press (1RM kg)	Pre-test Leg Press (1RM kg)	Post-test Leg Press (1RM kg)
KR	97.2	108.4*	94.5	107.3*
PG	96.1	100.2	92.8	96.1

Jedan od glavnih mehanizama kojim kreatin poboljšava snagu jeste povećanje rezerve fosfokreatina u mišićima, što omogućava bržu resintezu ATP-a tokom visokointenzivnih napora (Hultman et al., 1996). Dodatno, istraživanja su pokazala da kreatin može povećati mišićnu hipertrofiju (Cribb & Hayes, 2006), što dodatno doprinosi povećanju snage.

U placebo grupi je takođe došlo do određenih poboljšanja, što se može pripisati samom treningu, ali bez značajnog doprinosa kreatina, poboljšanja su bila značajno manja.

Kreatin monohidrat je jedan od najistraživanijih suplemenata u sportu i naučno je potvrđeno da ima pozitivan efekat na snagu, mišićnu masu i sportsku izdržljivost. Njegov glavni mehanizam delovanja je povećanje intramuskularnih rezervi fosfokreatina, što omogućava bržu resintezu ATP-a i poboljšava sposobnost izvođenja visokointenzivnih pokreta. Studije su pokazale da se suplementacija kreatinom povezuje sa povećanjem telesne mase, pri čemu je taj dobitak uglavnom rezultat povećanja mišićne mase i intracelularne retencije vode, a ne nakupljanja masti.

U istraživanju koje je analizirano, grupa koja je koristila kreatin imala je značajno povećanje telesne mase u poređenju sa placebo grupom, dok razlika u procentu telesne masti nije bila statistički značajna. Ovakvi rezultati su u skladu sa prethodnim studijama koje su pokazale da suplementacija kreatinom doprinosi povećanju mišićne mase bez značajne promene u telesnoj masti. Takođe, utvrđeno je da kreatin

može doprineti povećanju sadržaja vode u organizmu, ali se to uglavnom odnosi na povećanje unutar mišićnih ćelija, što može pozitivno uticati na anaboličke procese. Pored promene telesne kompozicije, efekti kreatina su vidljivi i u poboljšanju maksimalne snage, što je potvrđeno u testovima Bench Pressa i Leg Pressa. Grupa koja je koristila kreatin pokazala je značajno veće poboljšanje u ovim testovima u poređenju sa placebo grupom, što sugeriše da suplementacija može doprineti većem adaptivnom odgovoru na trening snage. Mnoge studije su pokazale da redovna upotreba kreatina može povećati maksimalnu snagu za 5-15% u periodu od nekoliko nedelja intenzivnog treninga.

Jedan od razloga za poboljšanja u snazi može biti sposobnost kreatina da poveća radni kapacitet mišića, čime se omogućava izvođenje većeg broja ponavljanja pre zamora. Ovaj efekat može dovesti do većeg ukupnog opterećenja tokom treninga, što može dodatno stimulisati mišićni rast i povećanje snage. Takođe, povećana dostupnost kreatina može ubrzati oporavak između serija, što omogućava sportistima da održe viši intenzitet tokom treninga. Važno je napomenuti da, iako kreatin pokazuje značajne benefite kod većine korisnika, postoje individualne razlike u odgovoru na suplementaciju. Oko 20-30% ljudi ima manji ili nikakav odgovor na kreatin, što može biti povezano sa već prirodno visokim nivoima kreatina u mišićima. Uprkos tome, kod većine sportista i rekreativaca, kreatin ostaje jedan od najsigurnijih i najefikasnijih suplemenata za poboljšanje sportskih performansi.

ZAKLJUČAK

Rezultati ove studije potvrđuju da suplementacija kreatinom može imati značajan pozitivan efekat na telesnu kompoziciju i snagu kod osoba koje se bave treningom snage. Uočeno je povećanje telesne mase u kreatinskoj grupi, pri čemu nije došlo do promene u procentu telesne masti, što potvrđuje da je dobitak mase pre svega rezultat povećanja mišićne mase i povećane intramuskularne hidratacije. Takođe, značajna poboljšanja su primećena u testovima maksimalne snage na Bench Pressu i Leg Pressu, što dodatno podržava efikasnost kreatina u poboljšanju performansi. Preporučena doza kreatina u ovoj studiji pratila je standardni protokol suplementacije, koji se sastoji iz dve faze. Prva faza je faza punjenja, tokom koje su učesnici unosili 20 g kreatina dnevno (podeljeno u četiri doze od po 5 g) tokom prvih 5-7 dana. Nakon toga su prešli na fazu održavanja, gde su svakodnevno unosili 3-5 g kreatina do kraja osmonedeljnog programa. Ovaj protokol je u skladu sa prethodnim istraživanjima i pokazuje se kao najefikasniji način za brzo povećanje nivoa kreatina u mišićima.

Trenažni program korišćen u istraživanju trajao je 8 nedelja i sastojao se od četiri treninga nedeljno, sa fokusom na vežbe snage. Trening je bio organizovan po principu kombinovanja većih i manjih mišićnih grupa u istom treningu. Učesnici su radili 8-10 ponavljanja po vežbi, u 5 serija, sa pauzama od 90 sekundi između serija i 3 minuta između vežbi. Ovaj pristup je bio usmeren na povećanje mišićne mase i snage i pokazao se kao efikasan. Iako su rezultati pokazali značajne benefite, moguće su određene nadogradnje programa za još bolje rezultate.

LITERATURA

1. Becque, M. D., Lochmann, J. D., & Melrose, D. R. (2000). Effects of oral creatine supplementation on muscular strength and body composition. *Sports Science,* 32(3), 654-658.
2. Branch, J. D. (2003). Effect of creatine supplementation on body composition and performance: A meta-analysis. *International Journal of Sport Nutrition and Exercise Metabolism*, 13(2), 198-226.
3. Branch, J. D. (2003). Effect of creatine supplementation on body composition and performance: A meta-analysis. *International Journal of Sport Nutrition,* 13(2), 198-226.
4. Buford, T. W., Kreider, R. B., Stout, J. R., Greenwood, M., Campbell, B., Spano, M., ... & Antonio, J. (2007). International Society of Sports Nutrition position stand: Creatine supplementation and exercise. *Journal of the International Society of Sports Nutrition*, 4(1), 6.
5. Cooper, R., Naclerio, F., Allgrove, J., & Jimenez, A. (2012). Creatine supplementation with specific view to exercise/sports performance: An update. *Journal of the International Society of Sports Nutrition*, 9(1), 33.
6. Earnest, C. P., Snell, P. G., Rodriguez, R., Almada, A. L., & Mitchell, T. L. (1995). The effect of creatine monohydrate ingestion on anaerobic power indices, muscular strength, and body composition. *Acta Physiologica Scandinavica,* 153(2), 207-209.
7. Hultman, E., Söderlund, K., Timmons, J. A., Cederblad, G., & Greenhaff, P. L. (1996). Muscle creatine loading in men. *Journal of Applied Physiology*, 81(1), 232-237.

8. Jagim, A. R., Wright, G. A., Kisiolek, J., & Jones, M. T. (2012). The safety and efficacy of creatine supplementation in exercise, sport, and medicine. *Nutrition,* 28(7-8), 607-617.
9. Kreider, R. B., Ferreira, M., Wilson, M., Grindstaff, P., Plisk, S., Reinhardy, J., & Almada, A. L. (1998). Effects of creatine supplementation on body composition, strength, and sprint performance. *Medicine & Science in Sports & Exercise*, 30(1), 73-82.
10. Kreider, R. B., Kalman, D. S., Antonio, J., Ziegenfuss, T. N., Wildman, R., Collins, R., ... & Lopez, H. L. (2017). International Society of Sports Nutrition position stand: Safety and efficacy of creatine supplementation in exercise, sport, and medicine. *Journal of the International Society of Sports Nutrition*, 14(1), 18.
11. Maughan, R. J., & Burke, L. M. (2012). *Practical nutritional recommendations for the athlete.* Nestle Nutrition Institute Workshop Series, 69, 131-149.
12. Rawson, E. S., & Venezia, A. C. (2011). Use of creatine in the elderly and evidence for effects on cognitive function in young and old. *Amino Acids,* 40(5), 1349-1362.
13. Vandenberghe, K., Goris, M., Van Hecke, P., Van Leemputte, M., Vangerven, L., & Hespel, P. (1997). Long-term creatine intake is beneficial to muscle performance during resistance training. *Journal of Applied Physiology*, 83(6), 2055-2063.

THE EFFECT OF SUPPLEMENTATION ON STRENGHT AND BODY COMPOSITION IN RECREATIONAL ATHLETES

Kovač Stevan, Bjelica Bojan, Cicović Borislav, Pržulj Radomir, Aksović Nikola, Cicović Vanja, Hajder Đorđe, Bubanj Saša

Abstract: *Supplementation, as a modern approach to improving physical performance, has become an integral part of sports practice worldwide. Today, there are numerous nutritional supplements on the market that aim to increase muscle mass, reduce fatigue or optimize recovery. The aim of this study is to examine the impact of creatine on muscle strength and body composition parameters under specific training conditions. The research sample consisted of 19 recreational athletes divided into an experimental (n=12) and a control (n=7) group. The experimental group was supplemented with 5g of creatine monohydrate, while the control-placebo group received 5g of dextrose as a supplement. The experimental program was conducted for 8 weeks with a frequency of 4 training sessions per week. The effects of the experimental treatment on body composition (3 variables) and strength (3 tests) were monitored. Based on the results of the study, it can be concluded that the experimental treatment has positive effects on the strength of the subjects, an increase in muscle mass, while there were no statistically significant differences in the percentage of fat and body water. Fitness programs are an effective tool for improving the body composition and strength of women. It would be desirable to determine the effects of training on some other motor parameters and partial body parts when it comes to body composition.*
Key words: *1RM, Bench press, Strength, Leg press, exercise, program.*

EFFECTS OF THE EXPERIMENTAL BASKETBALL PROGRAM ON THE MOTOR ABILITIES OF YOUNGER SCHOOL-AGE CHILDREN

Roković Milica[1], Aksović Nikola[2], Babović Dragana[3], Joksimović Aleksandar[4], Joksimović Dina[4], Miljković Miljan[5], Dobrescu Tatiana[6], Stanković Veroljub[2]

[1]Branksome Hall Asia, Republic of Korea
[2]Faculty of Sport and Physical Education, University of Priština in Kosovska Mitrovica, Serbia
[3]Faculty of Physical Education and Sport, University of East Sarajevo, Republic of Srpska, B&H
[4]Fatima College of Health Sciences (FCHS) - IAT, Abu Dhabi, UAE
[5]Teacher education Faculty, University of Priština-Kosovska Mitrovica, Serbia
[6]Faculty of Movement, Sport and Health Sciences, Vasile Alecsandr University of Bacau, Romania

ORIGINAL SCIENTIFIC ARTICLE
DOI: 10.5937/ATAVPA25116R

Abstract: *The study was conducted with the aim of determining the effects of an experimental basketball program on explosive strength and sprinting speed in younger school-aged girls. The research was carried out on a sample of 65 participants, members of the "Bears" basketball school from South Korea, attending the "Branksome Hall Asia" international girls' school on Jeju Island, South Korea, in 2017. To assess motor abilities, the following variables were applied: 10m sprint from a standing start, 20m sprint from a standing start, 30m sprint from a standing start, 60m sprint from a standing start, standing long jump, standing triple jump, and Sargent's jump test. The results of the MANCOVA and ANCOVA analyses indicate statistically significant effects of the intervention on the following variables: 10 m, 30 m, and 60 m sprints from a standing start, and standing triple jump, in favor of the experimental group. Based on the obtained results, it can be concluded that the experimental basketball program lasting 3 months has positive effects on the sprinting speed and explosive strength of the lower extremities.*
Key words: *team sport, experimental treatment, influence, sprint, explosive strength.*

INTRODUCTION

Basketball is one of the most widespread team sports in the modern world, governed by the International Basketball Federation (FIBA), which includes 213 national federations. The game is played between two teams of five players each, with the main objective of scoring by shooting the ball into the opponent's basket while preventing the opposing team from doing the same, all in accordance with the official rules. In basketball, points are scored rather than baskets, so the score difference is measured in points—two, three, five, or more—but not by the number of baskets (Kocić, Aksović, & Berić, 2024).

Within the group of team sports, basketball stands out as a highly complex game characterized by specific structural and functional features. Basketball experts classify the sport according to three main criteria: based on structural complexity, basketball is considered a complex sport that involves groups of both simple and complex movements performed in cooperative conditions among team members; based on the dominance of energy processes, basketball is primarily an anaerobic sport; and based on the dominance of specific abilities, it is a sport that requires coordination, strength, speed, and accuracy (Borović, Rupčić, Matković, Garafolić, & Dadić, 2016; Král, 2024).

The course of play consists of short, high-intensity (maximal and submaximal) activities that continuously alternate with periods of active and passive rest. Since the game unfolds within a specific spatial and temporal framework, basketball belongs to the group of polystructural sports in which complex polystructural movements predominate (Altavilla, & Raiola, 2015). Game analysis in basketball leads to the conclusion that the aforementioned motor abilities are of fundamental importance. Basketball players are highly mobile—though to varying degrees depending on their level of motor skill development. These abilities are expressed through movements performed both with and without the ball. To properly analyze basketball motor abilities and assess the degree to which they have been acquired, it is necessary to examine the structure of players' movements (Conte et al., 2015). Therefore, the most suitable classification is the division into movements with and without the ball, provided that the direction, speed, and duration of those movements are not specifically considered. It can also be concluded that all movements in basketball are of a locomotor and manipulative nature (Wang et al.,

2025).

In addition to its positive impact on motor abilities, basketball also exerts a beneficial influence on psychological characteristics, the socialization of children, and the development of healthy interpersonal relationships (Sushko et al., 2019). It enhances body and self-awareness, fosters a sense of responsibility, and helps resolve issues related to authority, which in the context of basketball is based on cooperation (Alleimon, 2019). At a younger school age, children are still developing, and their motor control is not yet stable, which makes it difficult to accurately assess their motor abilities and the level of their manifestation. During this developmental stage, the human body demonstrates the highest capacity for adaptation to external influences—primarily physical activity (Wilson, & Hyde, 2013). A particularly important aspect of this period is the strong interconnection between motor, cognitive, and conative domains in children, which is explained by Ismail's well-known theory of integral development (Peltekova, & Houech, 2025). This theory suggests that children of this age group respond to physical activity through their intellectual and conative capacities. Therefore, physical exercise at this stage can significantly influence the overall development of a child's personality (Aksović & Berić, 2017).

By examining the motor abiliies of younger school-aged children, it can be concluded that insufficient attention is generally given to this age group. Therefore, the study was conducted with the aim of determining the effects of an experimental basketball program on explosive strength and sprinting speed in younger school-aged girls. Based on the defined aim, it was hypothesized that there is a significant difference between the two measurements of motor abilities in young female basketball players attending a basketball school and female students who do not participate in sports.

MATERIALS AND METHODS

Sample of Participants

The assessment of motor abilities was conducted on a sample of 65 participants, including 42 girls who regularly attend training sessions at the "Bears" Basketball School and 23 girls enrolled at Branksome Hall Asia International School in South Korea who do not participate in sports activities. All participants were between 8 and 9 years of age. The basketball school participants had been training for up to one year, with a frequency of two to three sessions per week. All subjects were of similar socioeconomic status, in good health, and without visible physical deformities. The non-athlete group also shared a comparable socioeconomic background, attended the same school, and were in good overall health.

Sample of Variables

To assess running speed and explosive strength, the following variables were applied: 10 meters sprint from a standing start (s); 20 meters sprint from a standing start (s); 30 meters sprint from a standing start (s); 60 meters sprint from a standing start (s); Standing long jump (cm); Standing triple jump (cm); Sargent jump test (cm).

Procedures

At the beginning of the school year, questionnaires were distributed to the children at Branksome Hall Asia International School, following ethical principles and with parental consent, which authorized the assessment of their motor abilities. The experimental motor tests were conducted on this sample of participants on two occasions.

The initial assessment of motor abilities was carried out in September 2017, while the final measurement took place in November 2017. These assessments were conducted at the "Bears" Basketball School during basketball training sessions on Jeju Island, South Korea. Motor ability assessments for the non-athlete girls were conducted in the physical education hall of Branksome Hall Asia, International School for Girls, also on Jeju Island, South Korea. The measurements were performed by the author, with the participation of the school's physical education teacher and the assistance of coaches from the basketball school.

Experimental Program

Considering the age of the young female basketball players and their familiarity with the structure of the game, the three-month training program at the basketball school focused on technical skills within general physical preparation, with particular emphasis on developing speed, accuracy, coordination, and explosiveness. For players aged 7 to 11, physical preparation is largely centered on teaching the technical aspects of basketball. Training focused on fundamental skills, including mastering various passing techniques both with and without the ball, stationary and in light movement, as well as proper shooting technique from designated spots and free throws. Ball-handling skills were developed with both hands, incorporating basic changes of direction while dribbling, and training included fundamental elements combined with dribbling, such as the two-step and jump shot. Small-sided games on two baskets were also incorporated to reinforce these skills. The principle followed was that a well-trained player controls the ball, while a poorly trained player is controlled by it.

In the development of motor abilities, emphasis was placed on walking and running forward and backward with changes of direction, running with acceleration, and sprint exercises designed to touch specific lines and return repeatedly. Agility drills, such as zig-zag running, were included, along with flexibility exercises applied at every training session. Coordination, reaction speed, and muscular strength were trained through basic exercises, and an additional corrective physical preparation program was integrated to support overall athletic development. The experimental program was conducted in accordance with the recommendations of previous studies (Kozinc, Smajla, & Šarabon, 2021; Kocić et al., 2024; Peltekova, & Houech, 2025).

Statistical Analysis

The data obtained through the previously described procedure were processed using the statistical software SPSS 25 (Statistical Package for the Social Sciences, v25.0, SPSS Inc., Chicago, IL, USA). The statistical analysis of the data included the calculation of descriptive statistics for all motor variables, including the mean (Mean), standard deviation (SD), minimum (Min) and maximum (Max) values of the measurements, and the coefficient of variation (CV). These analyses provided essential information on whether statistically significant differences existed between the two measurements in the given sample of participants, both among young basketball players and among students who do not engage in sports. The Kolmogorov-Smirnov test (K-S sig) was used to assess the normality of the distribution.

To evaluate the effect of the training program between the two testing points, multivariate analysis of covariance (MANCOVA) was used, providing information on whether statistically significant differences existed between the initial and final measurements in the sample of younger school-aged students. For identifying individual differences, univariate analysis of covariance (ANCOVA) was applied. The level of significance was set at $p \leq 0.05$.

RESULTS

Tables 1 and 2 present the descriptive parameters of motor abilities at the initial and final measurements.

The analysis of the coefficient of variation (CV) (Tables 1 and 2) indicates a high degree of homogeneity in the results of participants in both the experimental and control groups for six out of the seven analyzed variables, at both the initial and final measurements. Increased homogeneity was observed in the variables for 20 m, 30 m, and 60 m sprints from a standing start in both groups at both measurement points. Relative homogeneity was present in the standing long jump, standing triple jump, and Sargent jump test. Greater variability was observed only in the 10 m sprint from a standing start. Differences between the initial and final measurements were noted in both groups based on the means. Based on the significance values of the Kolmogorov-Smirnov test, it can be concluded that the distributions of the analyzed variables do not deviate significantly from the theoretical distribution (K-S sig; $p > 0.05$) at either the initial or final measurement in both pre-formed subgroups.

Table 1 Descriptive parameters of the experimental and control groups at the initial measurement

Variables	Group	Min	Max	Mean	SD	CV (%)	K-S sig
10 m sprint	EXP	2.99	3.28	3.10	.08	25.80	0.59
	CON	2.85	3.33	3.12	.09	28.84	0.97
20 m sprint	EXP	3.65	5.51	4.46	.53	11.88	0.26
	CON	3.62	5.10	4.35	.37	8.51	0.93
30 m sprint	EXP	6.68	7.82	7.03	.23	3.27	0.53
	CON	6.66	8.65	7.25	.49	6.76	0.06
60 m sprint	EXP	12.67	14.84	13.81	.53	3.84	0.26
	CON	13.29	16.35	14.60	.74	5.07	0.98
Standing long jump	EXP	101	159	138.82	12.19	8.81	0.55
	CON	110	171	143.33	13.99	9.76	0.78
Standing triple jump	EXP	305	445	371.74	28.83	7.76	0.80
	CON	250	400	344.65	39.57	11.48	0.53
Sargent jump test	EXP	18	41	29.91	4.83	16.53	0.80
	CON	520	42	30.55	5.62	18.40	0.76

Legend: EXP – experimental group; CON – control group; Mean – mean; SD – standard deviation; Min – minimum values; Max – maximum values; CV – coefficient of variation; < K-S sig – level of significance according to the Kolmogorov-Smirnov test.

Table 2 Descriptive parameters of the experimental and control groups at the final measurement

Variables	Group	Min	Max	Mean	SD	CV (%)	K-S sig
10 m sprint	EXP	2.90	3.25	3.05	.09	29.51	0.79
	CON	2.90	3.33	3.14	.09	28.66	0.85
20 m sprint	EXP	3.87	5.64	4.49	.47	10.47	0.25
	CON	3.62	5.12	4.40	.39	8.86	0.57
30 m sprint	EXP	6.28	7.80	6.71	.28	4.17	0.28
	CON	6.56	8.55	7.24	.47	6.49	0.16
60 m sprint	EXP	12.47	14.56	13.62	.54	3.96	0.75
	CON	13.22	16.75	14.67	.79	5.39	0.48
Standing long jump	EXP	110	165	140.97	12.87	9.13	0.87
	CON	115	160	142.40	11.08	7.78	0.57
Standing triple jump	EXP	320	460	386.03	29.22	7.57	0.77
	CON	252	401	343.52	40.93	11.91	0.61
Sargent jump test	EXP	19	42	30.13	4.71	15.63	0.88
	CON	21	44	30.85	5.29	17.14	0.86

Table 3 Univariate analysis of covariance of the experimental and control groups for motor ability variables

Variables	Adj. Mean EXP	Adj. Mean CON	F	p
10 m sprint	3.06	3.13	22.67	**0.00****
20 m sprint	4.44	4.45	0.01	0.99
30 m sprint	6.80	7.16	59.13	**0.00****
60 m sprint	14.01	14.29	26.47	**0.00****
Standing long jump	142.03	141.39	.05	.83
Standing triple jump	372.70	356.19	41.40	**0.00****
Sargent jump test	30.78	30.23	1.23	.27

Legend: Adj. Mean – adjusted mean values, F – F-test value, p – level of significance, significance of differences ** ≤ 0.01, * ≤ 0.05

To determine the effects of the experimental treatment, multivariate and univariate analyses of covariance (MANCOVA and ANCOVA) were performed. The results of the multivariate analysis of covariance indicate that there are statistically significant differences (p = 0.00) between participants in the experimental and control groups in terms of leg explosive strength and sprinting speed, as reflected by the Wilks' test value F = 14.27.

After controlling for pre-treatment differences and examining individual variables, it can be concluded that significant differences were present in four out of the seven tested variables. Significant improvements were observed in the experimental group for the 10 m sprint from a standing start (p = 0.00) and the standing triple jump (p = 0.00), as well as for sprinting speed, specifically in the 30 m sprint (p = 0.00) and 60 m sprint from a standing start (p = 0.00). In the remaining three variables—20 m sprint from a standing start, standing long jump, and Sargent jump test—improvements were noted in the experimental group, but these changes were not significant (p > 0.05). This is likely because participants in the control group also showed progress in their motor abilities, possibly due to growth and natural development, which were not considered as variables in this study and may be regarded as external factors influencing the results at the final measurement. Finally, it is interesting to compare the adjusted mean values of the experimental and control groups (Figure 1).

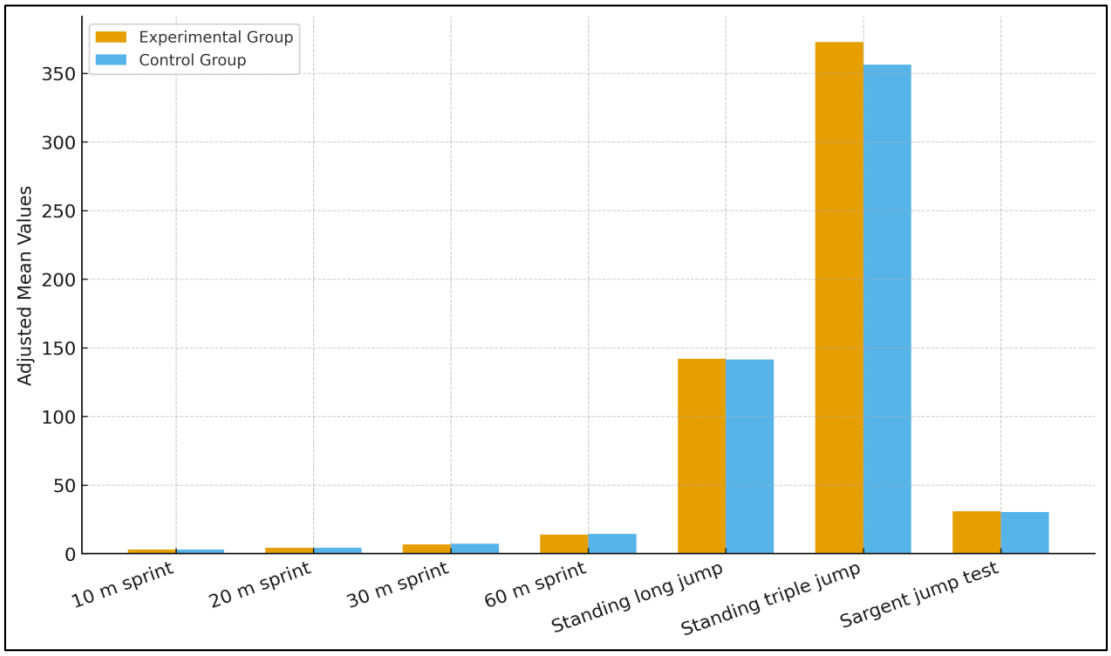


Figure 1 Adjusted mean values of motor ability variables between the experimental and control groups

DISCUSSION

The primary purpose of this study was to examine the effects of a three-month experimental basketball program on explosive strength and sprinting speed in younger school-aged girls. The main results of the study clearly indicate that the experimental basketball program had significant effects on the variables assessing explosive strength (standing triple jump) and sprinting speed (10 m, 30 m, and 60 m sprints from a standing start). Therefore, this training intervention can be characterized as effective and appropriate for the examined sample and age group. These findings confirm the hypothesis stated in the introduction, suggesting that participation in basketball training positively influences the development of explosive strength and sprint performance in young girls.

The significant effects of the basketball experimental program on the variables assessing explosive strength and sprinting speed can be explained by the nature and structure of the training process itself. Basketball as a sport involves a large number of fast, dynamic, and explosive movements—short sprints, jumps, sudden changes of direction, and accelerations (Aksović, Bjelica, Milanović, Jovanović, &

Zelenović, 2021). Throughout the experimental period, the children repeatedly engaged in training activities (such as acceleration drills, jumping exercises, changes of direction, two-basket games, and dribbling or shooting in motion) that specifically activated the muscle groups responsible for explosive lower-body strength. This type of activity stimulates adaptive processes within the neuromuscular system by increasing neural conduction speed, improving the efficiency of motor unit activation, and enhancing the ability to generate force in a short time interval (Gottlieb, Shalom, & Calleja-Gonzalez, 2021). As a result, improvements were observed in tests such as the standing triple jump and the 10 m, 30 m, and 60 m sprints from a standing start. Additionally, basketball training is characterized by a high frequency of rhythm and intensity changes, which contributes to the development of reaction speed and coordination, thereby indirectly improving sprint performance. In younger school-age children, such activities further stimulate the development of basic motor abilities, as this age represents a period of rapid growth and heightened neuromuscular plasticity (Silva et al., 2010). Taken together, these findings explain why the experimental basketball program produced significant positive effects on the variables requiring explosive strength and sprinting speed.

On the other hand, Sargent jump, standing long jump, and 20 m sprint from a standing start require maximal explosive strength from a static position, meaning that the muscles must generate high force rapidly without any prior momentum (Haugen, Breitschädel, & Seiler, 2019). In younger girls, both muscular development and neuromuscular coordination are not yet sufficiently matured to perform these actions efficiently. The basketball program, on the other hand, primarily enhances dynamic movements, repeated jumps, and sprints with prior motion, and thus does not directly stimulate this type of explosive strength and sprint speed (Davis, Rossi, Langdon, & McMillan, 2012).

Despite the robust methodology, the obtained results should be interpreted with certain limitations. Younger girls are in a phase of rapid neuromuscular and muscular development, which may limit the interpretation of the program's effects on explosive strength and sprint speed. In addition, the measurements were limited to seven motor variables, which do not reflect all aspects of motor abilities expressed in basketball. Future research should include a broader range of motor abilities, such as agility, change-of-direction speed, endurance, coordination, or additional variables for a more precise assessment of the effects on explosive strength and sprinting speed. Furthermore, future research of a similar type should be conducted on a larger sample of children, taking into account that the general motor factor still has a significant influence on the motor abilities of children aged 8–9 years.

CONCLUSION

The experimental basketball school program had significant effects on the development of motor abilities, explosive strength, and sprinting speed in younger school-aged children in South Korea. Significant improvements were observed in the 10 m, 30 m, and 60 m sprints from a standing start, as well as in the standing triple jump, confirming the effectiveness of the program and supporting the research hypothesis. The practical significance of these results is reflected in the enhancement of physical education classes through organized, varied, and dynamic activities, as well as in the planning of training sessions in sports clubs. Knowledge of school-aged children's motor abilities enables teachers and coaches to plan physical education lessons, sports sections, and training sessions more effectively, select appropriate methods and exercises, and more precisely define the goals of physical education. Specifically, the results can be valuable for basketball clubs in the early selection of talented children and in designing training programs that promote the development of key motor abilities essential for the sport.

REFERENCES

1. Aksović, N., & Berić, D. (2017). Differences in explosive power between basketball players of different age. *Fizička kultura*, *71*(1), 36-42.
2. Aksović, N., Bjelıca, B., Milanović, F., Jovanović, N., & Zelenović, M. (2021). Plyometric training effects on explosive power, sprint and direction change speed in basketball: A review. *Turkish Journal of Kinesiology*, *7*(2), 73-79.

3. Alleimon, S. (2019). Relationship between the level of social psychological factors and sport performance among basketball players. *Journal of Physical Education and Sport*, *19*, 925-930.
4. Altavilla, G., & Raiola, G. (2015). Sports game tactic in basketball. *Sport Science*, *8*, 43-46.
5. Borović, I., Rupčić, T., Matković, R., Garafolić, H., & Dadić, M. (2016). Anthropological profile of U16 basketball players. *Acta Kinesiologica*, *10*(1), 71-77.
6. Conte, D., Favero, T. G., Lupo, C., Francioni, F. M., Capranica, L., & Tessitore, A. (2015). Time-motion analysis of Italian elite women's basketball games: individual and team analyses. *The Journal of Strength & Conditioning Research*, *29*(1), 144-150.
7. Davis, K., Rossi, S., Langdon, J., & McMillan, J. (2012). The relationship between jumping and sprinting performance in collegiate ultimate athletes. *Journal of Coaching Education*, *5*(2), 24-37.
8. Gottlieb, R., Shalom, A., & Calleja-Gonzalez, J. (2021). Physiology of basketball–field tests. Review Article. *Journal of Human Kinetics*, *77*, 159.
9. Haugen, T. A., Breitschädel, F., & Seiler, S. (2019). Sprint mechanical properties in handball and basketball players. *International Journal of Sports Physiology and Performance*, *14*(10), 1388-1394.
10. Král, R. (2024). Analysis of game statistics and their impact on match results at the 2022. *Biology of Sport*, *35*, 137-143.
11. Kocić, M., Aksović, N., & Berić, D. (2024). *Basketball (Košarka)*. Niš: Faculty of Sport and Physical Education, University of Niš. In Serbian
12. Kozinc, Ž., Smajla, D., & Šarabon, N. (2021). The relationship between lower limb maximal and explosive strength and change of direction ability: Comparison of basketball and tennis players, and long-distance runners. *PLoS One*, *16*(8), e0256347.
13. Peltekova, I., & Houech, I. V. (2025). Relationships between basketball and improving some physical and health indicators in young people. *Trakia Journal of Sciences, 23*(Supplement 1), 6.
14. Silva, M. J., Carvalho, H. M., Gonçalves, C. E., Figueiredo, A. J., Elferink-Gemser, M. T., Philippaerts, R. M., & Malina, R. M. (2010). Growth, maturation, functional capacities and sport-specific skills in 12-13 year-old-basketball players. *Journal of Sports Medicine and Physical Fitness*, *50*(2), 174-181.
15. Sushko, R., Vysochina, N., Vorobiova, A., Doroshenko, E., Pastuhova, V., & Vysochin, F. (2019). Psychological selection in game sports on the basketball example. *Journal of Physical Education and Sport*, *19*(7), 1708-1714.
16. Wang, Z., Chen, N., Cao, S., Gao, L., Geok, S. K., & Liu, J. (2025). The effects of balance training on physical fitness and skill-related performance in basketball players: a systematic review. *BMC Sports Science, Medicine and Rehabilitation*, *17*(1), 1-14.
17. Wilson, P. H., & Hyde, C. (2013). The development of rapid online control in children aged 6–12 years: Reaching performance. *Human Movement Science*, *32*(5), 1138-1150.

EFEKTI EKSPERIMENTALNOG PROGRAMA KOŠARKE NA MOTORIČKE SPOSOBNOSTI DECE MLAĐEG ŠKOLSKOG UZRASTA

Roković Milica, Aksović Nikola, Babović Dragana, Joksimović Aleksandar, Joksimović Dina, Miljković Miljan, Dobrescu Tatiana, Stanković Veroljub

Sažetak: *Istraživanje je sprovedeno sa ciljem je da se utvrde razlike u eksplozivnoj snazi i kratkom sprintu između polaznika škole košarke i devojčica koje se ne bave sportom. Istraživanje je sprovedeno na uzorku od 65 ispitanika, polazika škole košarke „Bears„ iz Južne Koreje, koje pohađaju „Branksome Hall Asia„ internacionalnu školu za devojčice- Jeju Island, Južna Koreja 2017. godine. Za procenu motoričkih sposobnosti primenjene su sledeće varijable: sprint 10m iz visokog starta, sprint 20m iz visokog starta, sprint 30m iz visokog starta, sprint 60m iz visokog starta, skok udalj iz mesta, troskok iz mesta, Sardžentov test za procenu skočnosti (cm). Rezultati MANCOVE ukazuju na statistički značajne razlike nakon primene tretmana u sledećim varijablama: sprint 10m iz visokog starta, troskok iz mesta i sprint 60m iz visokog starta u korist eksperimentalne grupe. Dakle, na osnovu dobijenih rezultata može se zaključiti da eksperimentalni tretman košarke u trajanju od 3 meseca ostvaruje pozitivne efekte na kratki sprint i ekspolozivnu snagu donjih ekstremiteta.*
Ključne reči: *timski sport, eksperimentalni tretman, uticaj, sprint, eksplozivna snaga.*

THE EFFECTS OF EXERCISE PROGRAMS ON THE CORRECTION OF KYPHOSIS: A SYSTEMATIC REVIEW

Perić Vladimir[1], Ademović Valida[2], Ademović Imer[2], Đorđević Stefan[1], Jorgić Bojan[1]
[1]Faculty of Sport and Physical Education, University of Niš, Serbia
[2]Technical school, Tutin, Serbia

REVIEW ARTICLE
DOI: 10.5937/ATAVPA25123P

Abstract: *The term kyphosis is used to describe a spinal curvature that results in an abnormal curvature of the back. Kyphosis can develop due to trauma, developmental abnormalities, degenerative disc disease, as well as inflammatory and infectious diseases. Kyphosis adversely affects both children and the elderly and makes it impossible for them to carry out the normal duties of daily living. In this regard, this systematic review aims to find and determine, based on previous research, the application and effects of various forms of exercise programs on kyphosis correction. All peer-reviewed and analyzed scientific papers were collected and selected using the Internet database of electronic editions of scientific journals: Google Scholar, NCBI, PubMed, PLOS, SCIndeks. The works were searched in the time period from 2000 to 2024. The keywords used to search the database are kyphosis, hyperkyphosis, effects of an exercise program, and Scheuermann's disease (kyphosis). When selecting papers in this study, the criteria by which papers were considered and selected were as follows: examining the effects of various exercise programs on kyphosis, then on strengthening and stretching the muscles of the chest, back, shoulders and neck and reducing the angle of kyphosis. Based on these criteria, 15 papers were included in the final analysis. The best effects on kyphosis corrections, the final analysis found, were having workouts that included stretching and strength exercise programs, lasting a minimum of 4 weeks, with a weekly frequency of 3 workouts of 60 minutes.*
Key words: *kyphosis, hyper-kyphosis, effects, exercise programs*

INTRODUCTION

Spinal deformities are defined as deviations from the normal spinal curvature observed in either the frontal or sagittal plane. Poor muscle development, combined with insufficient physical activity and non-physiological forces acting on the musculoskeletal system, often lead to improper posture (Biševac, Mahmutović, Mekić & Dolićanin, 2021). Spinal deformities can result in symptoms such as pain, weakness, numbness, tingling, loss of function, as well as pulmonary and cardiac complications (Frost, Camarero-Espinosa & Foster, 2019). One of the most common deformities is hyperkyphosis, which Sheehan and Grayhack (2017) define as an exaggerated rounding deformity of the thoracic or thoracolumbar spine, measuring more than 40 degrees using the Cobb angle technique. Similarly, Yaman and Dalbayrak (2014) describe hyperkyphosis as a spinal curvature that results in an abnormal rounding of the back. Kyphosis may develop due to trauma, developmental anomalies, degenerative disc disease, as well as inflammatory and infectious conditions. Hyperkyphosis can be characterized as an excessive thoracic curvature (>40°–45°), and it is among the most prevalent disorders of the spine, as well as a significant etiological factor in upper back pathologies, ranging from shoulder pain to vertebral compression fractures. The prevalence of hyperkyphosis has been reported to be 15.3% in 11-year-old children, 38% in adults aged 20 to 50, and 35% in adults aged 20 to 64. Hyperkyphosis may also develop as a result of muscular and neuromuscular diseases. Conditions such as cerebral palsy, muscular dystrophy, spinal muscular atrophy, spina bifida, neurofibromatosis, connective tissue disorders, Paget's disease, tumors, and spinal surgeries are also known to cause kyphosis (Yaman & Dalbayrak, 2014). From an age-related perspective, it has been established that the kyphotic angle tends to increase with age, leading to age-associated hyperkyphosis. Although increased kyphosis is a typical consequence of osteoporosis, studies have shown that up to 70% of patients with age-related hyperkyphosis do not suffer from reduced bone mineral density (Perriman, Scarvell, Hughes, Lueck, Dear, Smith, 2012). The exact proportion of patients with non-osteoporotic hyperkyphosis remains unknown; however, estimates suggest that 10% to 45% of individuals over the age of 50 are diagnosed with non-osteoporotic hyperkyphosis. In terms of gender, the prevalence of thoracic hyperkyphosis increases to 50% in men and 65% in women over the age of 65 (Bartynski, Heller, Grahovac, Rothfus & Kurs-Lasky, 2005). Various

methods are used to correct hyperkyphosis, including corrective exercises, manual therapy, postural strengthening exercises, taping, and orthotic devices (Seidia, Rajabi, Ebrahimi, Alizadeh & Minoonejad, 2014). Based on this, the aim of the present study is to determine, through a systematic review of existing research, the effects of implementing exercise programs in the treatment and correction of kyphosis.

METHODS

To collect data on the effects of exercise programs on the correction of kyphosis, scientific articles were gathered and analyzed by searching online databases of peer-reviewed journals, including Google Scholar, NCBI, PubMed, PLOS, and SCIndeks. The reviewed studies were published between 2000 and 2023. The keywords used for database searches included: *kyphosis*, *hyperkyphosis*, *hyper-kyphosis*, *effects of exercise on kyphosis/hyperkyphosis*, and *Scheuermann's kyphosis*. The inclusion criteria for selecting research studies were as follows: investigation of the effects of exercise on the reduction of pain and the degree of kyphosis, as well as improvement in spinal function and mobility (flexibility).

RESULTS

Figure 1 illustrates the process of data collection, analysis, and exclusion of identified studies. A large number of studies were initially found through database searches. The majority of studies were excluded based on their abstracts, titles, and publication dates, with only studies published between 2000 and 2024 considered for inclusion. Based on the fulfillment of the established criteria, the number of studies was narrowed down to 15, which were included in the final analysis.

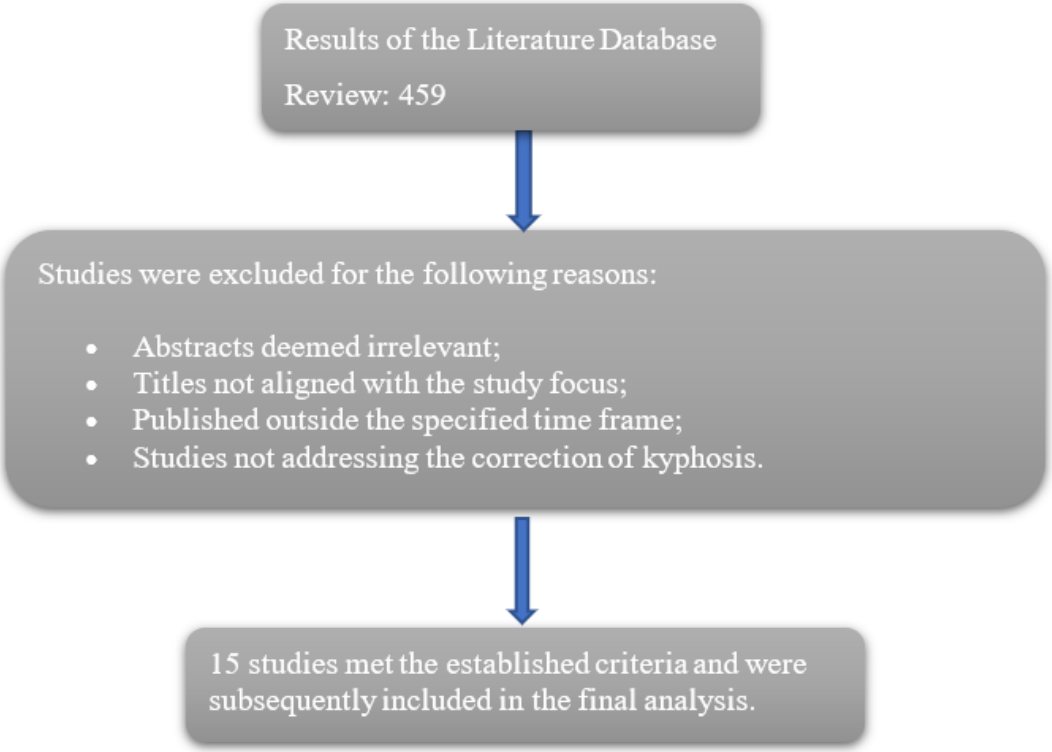


Figure 1 Process of Data Collection, Analysis, and Exclusion of Identified Studies

From the data presented in the table 1, it can be observed that the sample was mixed-gender in five studies, including both male and female participants. In another five studies, the samples consisted solely of female participants, while the remaining five studies included only male participants.

Table 1 Analysis of articles

References	Study Sample N	Groups EG/CG	Experimental Program		Measurement Instruments and Results
			Frequency and Duration	Exercise Program	
Bišević et al. (2021)	n=110 M: 63 F: 47 MA: 6.6±2.4	EGk1 (n=6) EGs2 (n=11) EGl3 (n=1)	TD: 6 months WF: 4 times SD: 90 min	Corrective exercises consisted of strengthening weakened muscles and stretching shortened muscles.	The study results demonstrate that corrective exercises produce sig.↑ in spinal deformities when comparing the (IA) to the (FA).
Ahmadnezhad et al. (2015)	n=30 F: 30 MA: 12.16±3	EG(n=15) CG(n=15)	TD: 8 weeks WF: 3 times	Exercise program consisted of 9 corrective exercise games aimed at strengthening weakened and stretching shortened muscles.	EG showed sig.↑ better results compared to CG; these exercise games may contribute to kyphosis correction.
Yazici et al. (2017)	n=40 M: 40 MA: 17.24 ±2.84	EG(n=20) CG(n=20)	TD: 8 weeks WF: 3 times SD: 60 min	Combined program of PNF stretching and strengthening of abdominal and erector spinae muscles.	An eight-week corrective exercise program demonstrated effective reduction of the kyphosis angle in the experimental group (EG).
Obayashi et al. (2012)	n=26 EG:8m и 5f CG:8m и 5f MA: 16.85±1.2	EG(n=13) CG(n=13)	TD: 4 weeks WF: 3 times SD: 10 min	The experimental group (EG) performed respiratory-muscular exercises using the SpiroTiger device.	The experimental group (EG) achieved sig.↑ between pre- and post-testing.
Rahimi et al. (2020)	n=52 M: 52 MA: 20.65±1.29	EG(n=26) CG(n=26)	TD: 6 weeks WF: 6 times	The experimental group (EG) performed Dynamic Neuromuscular Stabilization (DNS) breathing exercises in varying postures each week, aiming to strengthen spinal stabilizer muscles, improve posture, and reduce the kyphotic angle.	A sig.↑ and reduction of the lumbar angle was observed in the EG after testing and compared to the CG. Results indicate that home-based exercises can also contribute to better posture and a reduced kyphotic angle.
Hamidiyeh et al. (2021)	n=24 M: 24 MA: 60±4	EG(n=12) CG(n=12)	TD: 8 weeks WF: 3 times SD: 60 min	The experimental group (EG) utilized the TRX (Total Resistance Exercises) training method, targeting the strengthening of the erector spinae muscles.	The results indicated that properly structured total resistance training **sig.↑** strengthens stabilizing muscles and contributes to a reduction in the kyphotic angle in middle-aged individuals.
Azizi (2011)	n=10 F: 10 MA: 19-23	EG(n=10)	TD: 6 weeks WF: 3 times SD: 30 min	The hydrotherapy program consisted of warm-up, range of motion and flexibility exercises, strengthening and stabilization, endurance training, as well as coordination and balance exercises.	Results showed a significant difference between pre-test and post-test measurements.

Gaber (2014)	n=30 F: 30 MA: 13.2±3.79	EG1(on land) EG2(in water)	TD: 6 weeks WF: 3 times SD: 30 min	EG1 performed static and dynamic strengthening exercises along with stretching aimed at elongating and restoring the pectoral muscles to their natural position. EG2 followed the same exercises, adapted for aquatic training.	Both EG1 and EG2 significantly reduced the kyphosis angle and strengthened the trunk and back muscles, with negligible differences between the two groups.
Ahmadi et al. (2019)	n=30 M: 30 MA: 18-22	EG(n=14) CG(n=16)	TD: 8 weeks WF: 3 times SD: 60 min	The exercise program for the experimental group (EG) consisted of three phases, including aquatic training with myofascial release of tight muscles and breathing exercises.	Results showed that corrective aquatic exercises significantly reduce postural deformities and neck and shoulder pain in students.
Naderi et al. (2019)	n=24 M: 24 MA: 68.75±2.67	EG(n=12) CG(n=12)	TD: 12 weeks WF: 3 times	Exercises included spinal mobility, stretching of the suboccipital muscles, pectoralis muscle stretching, strengthening of the cervical flexor muscles, and strengthening of the scapular retractor muscles.	The EG achieved **sig.↑** compared to the CG, indicating enhanced posture and a reduction in kyphosis among older adults.
Seidi et al. (2014)	n=60 M: 30 F: 30 MA: 20.84±1.69	EG1 (n=20) EG2 (n=20) CG (n=20)	TD: 12 weeks WF: 3 times	In this study, EG1 utilized the Local Corrective Exercise Program (LCEP), while EG2 followed the Comprehensive Corrective Exercise Program (CCEP).	Based on the results after 12 weeks, both LCEP and CCEP groups demonstrated a significant reduction in thoracic kyphosis angle. However, considering the effect sizes (CCEP = 5.08; LCEP = 1.42), it can be concluded that CCEP is a more effective program than LCEP.
Vaughn et al. (2007)	n=71 M: 23 F: 48 MA: 39.8±13.2	EG(n=32) CG(n=39)	TD: 13 weeks	The seven prescribed exercises in this study combined strengthening, stretching, and self-mobilization activities performed at home. These exercises targeted the erector spinae muscles. Each exercise included a defined progression in repetitions and resistance, utilizing Theraband™ elastic bands.	The EG demonstrated **sig.↑** ($p < 0.05$) between pre- and post-assessments, indicating that home-based exercises can yield positive outcomes.

Ball et al. (2009)	n=35 F: 35 MA: 50-59	EG(n=35)	TD: 1 year WF: 3 times	Nine extensor muscle strengthening exercises were used. Participants were instructed to keep a WHOQOL-BREF exercise diary and were subsequently assessed on their adherence during follow-up evaluations.	In addition to reducing the kyphosis angle and restoring the spine to its natural alignment, a significant increase in height was also observed among the participants.
Sawdon-Bea (2010)	n=44 F: 44	EG(n=23) CG(n=21)	TD: 10 weeks WF: 3 times	The EG followed a 10-week exercise program consisting of stretching, postural strengthening exercises, breathing exercises, upper and mid-back training, as well as weight training for the upper extremities.	This study demonstrated that a home-based exercise program is feasible, safe, and effective for a significant reduction in thoracic kyphosis and significant strengthening of the back extensor muscles in women.
Katzman et al. (2017)	n=99 M: 28 F: 71 MA: 70.6±0.6	EG(n=50) CG(n=49)	TD: 6 months WF: 3 times SD: 1 hour	The experimental group's exercise program consisted of spine muscle strengthening and postural training under therapist supervision.	The EG demonstrated a significant decrease in kyphosis angle at pre- and post assessment, as well as improved postural alignment.

Legend: GS – TD - Training Duration; WF - Weekly Frequency; SD - Session Duration; M – Male participants; F – Female participants; MA – Mean age; sig.↑ – Statistically significant improvement in results; n – Number of participants; EG1 – Experimental Group 1; EG2 – Experimental Group 2; EG3 – Experimental Group 3; CG – Control Group; TD – Total duration of the intervention/program; WF – Weekly frequency of sessions; ST – Duration of each training session; I – Intensity; WHOQOL-BREF – Quality of life assessment instrument developed by the World Health Organization

The largest sample size was reported by Biševac et al. (2021), comprising 110 participants. The smallest sample size was found in the study by Azizi (2011), which included only 10 participants. The youngest sample was represented in the study by Biševac et al., 2021 where the mean age of participants was 6.6 ± 2.4 years. In contrast, the oldest participants were included in the study by Katzman et al. (2017), with a mean age of 70.6 ± 0.6 years, while the study by Vaughn et al. (2007) exhibited the greatest range in mean age (39.8 ± 13.2 years). The study by Sawdon-Bea, J. (2010) did not provide clear data regarding the average age of participants.

The majority of studies (10 in total) included one experimental group and one control group (Ahmadnezhad et al., 2015; Yazici et al., 2017; Obayashi et al., 2012; Rahimi et al., 2020; Hamidiyeh et al., 2021; Ahmadi et al., 2019; Naderi et al., 2019; Vaughn et al., 2007; Sawdon-Bea, 2010; Katzman et al., 2017), while only the study by Seidi et al. (2014) featured two experimental groups and one control group. There were also studies that included only experimental groups: Ball et al. (2009) with one experimental group; Azizi (2011) with one experimental group; Gaber (2014) with two experimental groups; and Biševac et al. (2021) with three experimental groups.

The duration of the studies ranged from 4 weeks (Obayashi et al., 2012), which was the shortest, to one year (Ball et al., 2009), which was the longest study. The most common total duration of the exercise programs was 8 weeks, reported in four studies (Ahmadi et al., 2019; Hamidiyeh et al., 2021; Yazici et al., 2017; Ahmadnezhad et al., 2015). The most frequent weekly training/treatment frequency was three sessions per week, reported in 12 studies, whereas the study by Vaughn et al. 2007 did not provide this information.

The longest treatment/corrective exercise sessions were conducted with the experimental groups in the study by Biševac et al. (2021), lasting 90 minutes. In addition to having the longest treatment duration, this study also had the largest sample size (110 participants) and the youngest average age of participants (6.6 ± 2.4 years). The authors aimed to determine whether regular performance of

corrective exercises—designed to stretch shortened muscles and strengthen weakened muscles—could improve posture in preschool and school-aged children.

Exercises for kyphosis were primarily performed in the prone position, while exercises for lordosis were conducted in the supine position. Exercises targeting scoliosis required special attention, as physiotherapists needed to carefully consider the direction of spinal deviation during training to specifically strengthen weakened muscles and stretch shortened muscles.

DISCUSSION

This systematic review included five studies with exclusively male participants, five with exclusively female participants, and five with an equal representation of both genders. Other studies also demonstrate that the prevalence of kyphosis is nearly equal in men and women, although there is a slight increase in kyphosis incidence among women over 60 years of age.

Research indicates that kyphosis affects both younger and older populations, which can be associated with a sedentary lifestyle, decreased physical activity, and increased use of modern technology.
According to the results of Seidi et al. (2014), after 12 weeks, both the Local Corrective Exercise Program (LCEP) and the Comprehensive Corrective Exercise Program (CCEP) groups showed a statistically significant reduction in the thoracic kyphosis angle. However, considering the effect size (LCEP = 5.08; CCEP = 1.42) and the mean reduction in kyphosis angle (CCEP = −12.25°; LCEP = −5.04°), the CCEP was more effective than the LCEP. Theoretically, there is a close relationship among various deviations such as hyperkyphotic deformity and abnormalities of the head and shoulders in the upper body. From this, it is concluded that correcting each deformity separately, as performed in the LCEP, lacks sufficient scientific justification and is believed to be less effective than the CCEP in reducing the thoracic curvature in patients with hyperkyphosis. In contrast, the CCEP exercises are designed so that most muscles and joints of the head, neck, trunk, and upper extremities are actively and simultaneously engaged in every movement. This approach not only positively influences the postural alignment of the upper body but also distributes the exercise load, avoids focusing on isolated muscles, and delays fatigue.

Since the Cobb angle gradually progresses with age, at a rate of less than 1° per year on average, even a small reduction in kyphosis may be clinically significant, particularly if treatment effects are maintained over time, as highlighted by Katzman et al. (2017). Changes in kyphosis measured by the kyphometer align with previous studies reporting improvements in clinical kyphosis measures following targeted spinal strengthening. An improvement of 0.43 points (95% CI 0.24, 0.61) in the self-image domain of the SRS-30 is comparable to changes observed after scoliosis surgery. Moreover, the authors note that self-image is a component of self-efficacy, which can have long-term benefits and contribute to higher levels of physical functioning, performance, and adherence to exercise in patients with arthritis and other chronic conditions. The authors conclude that such exercise programs also benefit significantly older patients.

In the study by Sawdon-Bea (2010), twenty-three participants in the experimental group performed a strengthening exercise program consisting of eight exercises, conducted three times per week over a 10-week period. Twenty-one participants served as the control group. Using MANOVA, the authors compared the kyphosis index, peak expiratory flow, forced vital capacity, maximal inspiratory pressure, 6-minute walk test, and back extensor strength measured before and after the exercise intervention. Univariate ANOVA tests revealed a significant group-by-time interaction for both the kyphosis index and back extensor strength. Subsequent post-hoc tests identified significant improvements in the kyphosis index and back extensor strength in the exercise group, with no improvements observed in the control group. This study demonstrated that a home-based exercise program is feasible, safe, and effective in significantly reducing thoracic kyphosis and substantially strengthening back extensor muscles in postmenopausal women with osteoporosis.

The study by Ball et al. (2009) lasted a full year. In their cross-sectional study, they observed a steady increase in cervical depth and thoracic curvature among women aged 40 to 70 years, without compression fractures. The greatest change in thoracic curvature was noted between participants aged 50 and 70 years. Cervical depth (kyphosis) increased linearly from 50 to 59 years of age. Based on these observations, the authors investigated the effect of spinal extension exercises on the progression of

kyphotic changes over one year. The greatest improvements reported in this study were achieved through stretching exercises targeting the thoracic curvature.

In the study by Rahimi et al. (2020), the weekly training frequency was six sessions, with three sessions conducted at home and three sessions in designated indoor facilities under professional supervision. The duration of individual training sessions ranged from 10 to 90 minutes. The experimental group performed Dynamic Neuromuscular Stabilization (DNS) breathing exercises with different postures each week, aimed at strengthening spinal stabilizer muscles to improve posture and reduce the kyphosis angle.

In the study by Obayashi et al. (2012), the experimental group performed respiratory muscle exercises lasting 10 minutes, three times per week, over a total program duration of four weeks. As explained by Obayashi and colleagues, respiratory muscle training is not only used in the rehabilitation of patients with respiratory diseases but also in endurance training for athletes. During respiration, the back and abdominal muscles are engaged, which contribute to the maintenance of proper spinal posture.

In the study by Ahmadnezhad et al. (2015), the kyphosis angle was measured using a flexible ruler, a reliable and non-invasive method. Participants were in a relaxed position during measurements. The flexible ruler was placed over the spinous processes from T2 to T12 to obtain the spinal curvature angle. In the study by Yazici et al. (2017), a spinal mouse was used to assess the kyphosis and lordosis angles. The exercise program consisted of PNF (Proprioceptive Neuromuscular Facilitation) stretching (targeting the chest, groin, hamstrings, and gluteus muscles), strengthening of the abdominal muscles (variations of crunches and plank holds), hip flexor and extensor exercises, and Williams exercises aimed at strengthening the spinal muscles.

Azizi (2011) employed a hydrotherapy exercise program to reduce the kyphosis angle. Before testing, kyphosis angle, back muscle strength, spinal muscle flexibility, and shoulder range of motion were measured. The experimental group showed significant improvements at post-testing in back muscle strength (sig. $\uparrow \leq 0.05$), shoulder abduction (sig. $\uparrow \leq 0.05$), spinal flexibility, and thoracic expansion (sig. $\uparrow \leq 0.05$), leading to the conclusion that strengthening these muscles improves posture and consequently reduces the kyphosis angle.

In the study by Ahmadi et al. (2019), the exercise program consisted of three phases: 1) normalization of peripheral structures; 2) restoration of muscular balance; and 3) enhancement of sensory systems and motor skills through training. Exercises were conducted in an aquatic environment. In the first phase, muscle trigger points were released by water massage, and myofascial release of stiff muscles was induced by foam rolling. The second phase involved static stretching exercises combined with corrective breathing pattern exercises. Finally, strengthening exercises and aquatic games were performed with an emphasis on maintaining correct posture.

CONCLUSION

Based on the results of the conducted systematic review, various exercise programs aimed at stretching and strengthening the muscles of the chest, back, shoulders, and neck can be effectively applied in the management of kyphosis. Most of the studies included in this review utilized different forms of stretching and strengthening exercise programs. The chest muscles (pectoralis major and minor) are typically shortened and tight, thus targeted with stretching exercises, while the back, shoulder, and neck muscles (trapezius, latissimus dorsi, and rhomboids) tend to be weakened and elongated, requiring strengthening exercises. Research has shown that exercise programs performed both in aquatic environments and home settings are equally effective and beneficial alongside conventional methods for correcting kyphosis. Among the commonly used exercise aids are elastic bands, foam rollers, and weights. Analyzing the studies reviewed in this work, it is concluded that priority should be given to exercise programs focused on strengthening and stretching weakened and overstrained musculature, conducted for a minimum duration of four weeks, with a frequency of three training sessions per week.

REFERENCES

1. Ahmadi, H., Yalfani, A., & Gandomi, F. (2019). The Effect of Eight-Week Water-Based Corrective Exercises on Forward Head, Rounded Shoulder, Thoracic Hyperkyphosis Posture, and Neck Pain: A Randomized Controlled Trial. *Research Square,* https://doi.org/10.21203/rs.2.18600/v1
2. Ahmadnezhad, L., Ebrahimi Atri, A., Khoshraftar Yazdi, N., & Sokhangoei, Y. (2015). The effect of eight-weeks corrective games on kyphosis angle and postural control in mentally retarded children having kyphosis. *Journal of Research and Health,* 5(2), 178-183.
3. Azizi, M. (2011). The effect of hydrotherapy on some of the selected parameters related to Kyphosis in Kyphotic girls. *Procedia-Social and Behavioral Sciences,* 15, 1595-1599.
4. Ball, J. M., Cagle, P., Johnson, B. E., Lucasey, C., & Lukert, B. P. (2009). Spinal extension exercises prevent natural progression of kyphosis. *Osteoporosis International,* 20, 481-489.,
5. Biševac, E., Mahmutović, E., Mekić, R., & Dolićanin, Z. (2021). Efekat korektivnih vežbi na funkcionalne deformitete kičmenog stuba kod dece predškolskog i školskog uzrasta. *Specijalna edukacija i rehabilitacija, 20*(1), 51-63.
6. Frost, B. A., Camarero-Espinosa, S., & Foster, E. J. (2019). Materials for the spine: anatomy, problems, and solutions. *Materials, 12*(2), 253.
7. Gaber Mohamed, W. (2014). The Effect of a Specific Short-Term Training Program on Correcting the Curvature Angle of Kyphosis in Female Young Gymnasts. *Journal of Applied Sports Science,* 4(2), 32-38.
8. Hamidiyeh, M., Naserpour, H., & Chogan, M. (2021). Change in Erector Spinae Muscle Strength and Kyphosis Angle Following an Eight Weeks TRX Training in middle-age Men. *International Journal of Aging Health and Movement,* 3(1), 13-20.
9. Katzman, W. B., Vittinghoff, E., Lin, F., Schafer, A., Long, R. K., Wong, S., ... & Lane, N. E. (2017). Targeted spine strengthening exercise and posture training program to reduce hyperkyphosis in older adults: results from the study of hyperkyphosis, exercise, and function (SHEAF) randomized controlled trial. *Osteoporosis International,* 28, 2831-2841.
10. Katzman, W. B., Wanek, L., Shepherd, J. A., & Sellmeyer, D. E. (2010). Age-related hyperkyphosis: its causes, consequences, and management. *Journal of Orthopaedic & Sports Physical Therapy*, 40(6), 352-360.
11. Rahimi, N.M., Mahdavinejad, R., Attarzadeh Hosseini, S. R., & Negahban, H. (2020). Efficacy of dynamic neuromuscular stabilization breathing exercises on chest mobility, trunk muscles, and thoracic kyphosis: a randomized controlled 6-Week trial. Iranian Rehabilitation Journal, 18(3), 329-336.
12. Naderi, A., Rezvani, M. H., Shaabani, F., & Bagheri, S. (2019). Effect of kyphosis exercises on physical function, postural control and quality of life in elderly men with hyperkyphosis. *Iranian Journal of Ageing,* 13(4), 464-479.
13. Obayashi, H., Urabe, Y., Yamanaka, Y., & Okuma, R. (2012). Effects of respiratory-muscle exercise on spinal curvature. *Journal of sport rehabilitation,* 21(1), 63-68.
14. Perriman, D. M., Scarvell, J. M., Hughes, A. R., Lueck, C. J., Dear, K. B., & Smith, P. N. (2012). Thoracic hyperkyphosis: a survey of Australian physiotherapists. *Physiotherapy Research International,* 17(3), 167-178.
15. Sawdon-Bea, J. (2010). *Effects of a 10-week exercise intervention on thoracic kyphosis, pulmonary function, endurance, back extensor strength, and quality of life in women with osteoporosis.* Doctoral dissertation, Texas Woman's University.
16. Seidi, F., Rajabi, R., Ebrahimi, I., Alizadeh, M. H., & Minoonejad, H. (2014). The efficiency of corrective exercise interventions on thoracic hyper-kyphosis angle. *Journal of back and musculoskeletal rehabilitation,* 27(1), 7-16.
17. Sheehan, D. D., & Grayhack, J. (2017). Pediatric scoliosis and kyphosis: an overview of diagnosis, management, and surgical treatment. *Pediatric annals,* 46(12), e472-e480.
18. Vaughn, D. W., & Brown, E. W. (2007). The influence of an in-home based therapeutic exercise program on thoracic kyphosis angles. *Journal of Back and Musculoskeletal Rehabilitation,* 20(4), 155-165.
19. Yaman, O., & Dalbayrak, S. (2014). Idiopathic scoliosis. *Turkish neurosurgery*, 24(5). 646-657.
20. Yazici, A. G., & Mohammadi, M. (2017). The effect of corrective exercises on the thoracic kyphosis and lumbar lordosis of boy students. *Turkish Journal of Sport and Exercise,* 19(2), 177-181.

EFEKTI PROGRAMA VEŽBANJA NA KOREKCIJU KIFOZE: SISTEMATSKO PREGLEDNO ISTRAŽIVANJE

Perić Vladimir, Ademović Valida, Ademović Imer, Đorđević Stefan, Jorgić Bojan

***Sažetak**: Termin kifoza se koristi za opisivanje kičmene krivine koja dovodi do abnormalne zaobljenosti leđa. Kifoza se može razviti zbog traume, razvojnih anomalija, degenerativnih bolesti diska, kao i inflamatornih i zaraznih bolesti. Kifoza utiče nepovoljno kako na decu tako i na starije i onemogućava normalano obavljanje svakodnevnih životnih obaveza. S tim u vezi ovo sistematsko pregledno istraživanje ima za cilj pronaći i utvrditi na osnovu dosadašnjih istraživanja, primenu i efekte raznih oblika programa vežbanja na korekciju kifoze. Svi pregledani i analizirani naučni radovi su prikupljeni i selektovani korišćenjem internet baza podataka elektronskih izdanja naučnih časopisa: Google Scholar, NCBI, PubMed, PLOS, SCIndeks. Radovi su pretraživani u vremenskom periodu od 2000. do 2023. godine. Ključne reči koje su korišćene za pretraživanje baze podataka su kifoza, hiperkifoza, efekti programa vežbanja i Šojermanova bolest (kifoza). Pri odabiru radova u ovom istraživanju, kriterijumi na osnovu kojih su radovi bili razmatrani i odabirani su sledeći: ispitivanje uticaja različitih programa vežbanja na kifozu, zatim na jačanje i rastezanje mišića grudi, leđa, ramena i vrata i smanjenje ugla kifoze. Na osnovu pomenutih kriterijuma u konačnu analizu je ušlo 15 radova. Najbolje efekte na korekcije kifoze, konačnom analizom je utvrđeno, da imanju radovi koji su sadržali programe vežbi rastezanja i snage, u trajanju od minimum 4 nedelje, sa nedeljnom učestalošću od 3 treninga po 60 minuta.*

***Ključne reči**: kifoza, hiperkifoza, efekti, programi vežbanja*

UTICAJ RAZLIČITE SPORTSKE SPECIJALIZACIJE NA MORFOLOSKE KARAKTERISTIKE U MLAĐEM UZRASTU

Marković Milan[1], Toskić Lazar[1,2], Arsenijević Radenko[1], Aksović Nikola[1]
[1]Fakultet sporta i fizičkog vaspitanja, Univerzitet u Prištini – Kosovska Mitrovica, Leposavić, Srbija
[2]Fakultet za sport, Univerzitet ''Union – Nikola Tesla'', Beograd, Srbija

ORIGINAL SCIENTIFIC ARTICLE
DOI: 10.5937/ATAVPA25132M

Sažetak: *Pored sportova čija specifičnost tradicionalno naleže rano angažovanje, sve veća popularnosti za bavljenje sportom podstakla je i rano uključivanje u sportske aktivnosti. Samim tim, i proces specijalizacije počinje ranije, delimično spontano u želji poboljšanja kvaliteta treninga, ali i radi što bržih uspeha. Rana sportska specijalizacija može imati značajan uticaj kako na motoričke tako i na morfološke karakteristike. Predmet ovog rada su morfološke karakteristike mladih sportista. Cilj ovog istraživanja je da se izvrši uporedna analiza mladih sportista različitog uzrastsa, sa aspekta morfoloških karakteristika, a u funkciji definisanja uticaja rane sportske specijalizacije na strukturu tela. Istraživanjem je obuhaćeno 105 ispitanika od 8 do 11 godina, od toga 56 dečaka i 49 devojaka, koji se bave borilačkim sportom (Džudo, Rvanje) ili plivanjem. Procedura testiranja je obuhvatala merenje telesne visine i analiza telesnog sastava (InBody 270). Primenjenim analizama mogu se uočiti značajne razlike, između ispitivanih uzrastnih grupa za većinu ispitivanih varijabli unutar definisanih sportova. Utvrđene razlike definišu kumulativne efekte rasta i razvoja, kao i opšte efekte fizičke aktivnosti, ali i specifične efekte datog sporta. Ipak glavni fokus u ovom radu bio je na definisanju razlika rane specijalizacije različitih sportova, pri čemu su utvrđene značajne razlike samo u najmlađoj grupi dečaka i to u visini, količini vode u organizmu, proteinima, mišićnoj masi, i masi bezmasne komponente, na nivou p = 0.002-0.005. Dok u uzrastu od 9 do 11 godina kod dečaka, kao i u svim uzrasnim grupama kod devojčica nisu utvrđene statistički značajne razlike između sportova na nivou ispitivanih morfoloških karakteristika. Na osnovu dobijenih rezultata može se zaključiti da je visina tela predstavljala jedan od faktora u selekciji najmlađih ispitanika, a da rana sportska specijalizacija ne pravi značajne efekte na morfološke karakteristike u uzrastu od 8 do 11 godina, ali možemo pretpostaviti da mnogo veći efekat ima na motoričke sposobnosti, koje bi svakako trebale da budu ključne u selekciji.*
Ključne reči: *selekcija, adaptacija, pioniri, motoričke sposobnosti.*

UVOD

Morfološke karakteristike dece predstavljaju jedan od ključnih pokazatelja njihovog biološkog razvoja i adaptacije na specifične motoričke i trenažne zahteve (Malacko et al., 2015). Veoma je važno proučiti antropometrijske profile dece koja su već u ranoj fazi sportskog razvoja, jer se tada formira osnovni somatski obrazac koji može imati dugoročni uticaj na sportski uspeh i sposobnosti adaptacije na trening (Malina et al., 2004).

Period predpuberteta, obično između 8. i 11. godine života, karakteriše ubrzan ali relativno stabilan rast i diferencijacija telesnih komponenata, pre svega povećanje telesne visine, progresivno povećanje nemasne mase i postepene promene u distribuciji masnog tkiva (Malina et al., 2015; Malina & Rogol, 2020). Ove promene uslovljene su kombinacijom genetskih i faktora sredine, uključujući i sistematsku fizičku aktivnost, koja može dovesti do jasnijeg morfološkog profila specifičnog sporta u odnosu na opštu populaciju vršnjaka.

Telesni sastav i antropometrijske mere posebno su važni u sportskom kontekstu, jer utiču na biomehaničku efikasnost, motorički potencijal i buduću sportsku specijalizaciju (Lloyd & Oliver, 2012; Lloyd et al., 2015). Tako se deca koja se uključuju u organizovani sportski trening često razvijaju prema obrascima karakterističnim specifičnom sportu, pri čemu se već u predpubertetu mogu uočiti određene razlike u telesnom profilu zavisno od vrste sporta, intenziteta i učestalosti trenažnog procesa (Towlson et al., 2021).

Borilački sportovi kao što su džudo i rvanje zahtevaju visok nivo neuromišićne snage, mišićne mase, eksplozivnosti i stabilizacije, što se u literaturi dovodi u vezu sa povećanom nemasnom masom, većim BMI, robustnijim somatskim karakteristikama i izraženijim razvojem mišićnog tkiva kod dece koja se ovim sportovima bave (Franchini et al., 2012; Kons et al., 2018; Alvarez et al., 2019). Za razliku od toga,

plivanje predstavlja sport s dominantnim aerobnim komponentama i kontinuiranim aktiviranjem velikih mišićnih grupa u sredini smanjene gravitacije, što se povezuje sa nižim vrednostima masnog tkiva, stabilnijim linearnim rastom i ujednačenijim razvojem mišićne mase u odnosu na sportove sa visokim mehaničkim opterećenjem (Pyne et al., 2014; Costa et al., 2022).

Razlike između polova u ovom uzrasnom periodu obično su slabo izražene, budući da većina hormonski posredovanih promena još nije započela (Malina et al., 2015). Ipak, postoje dokazi da dečaci mogu brže reagovati na trenažne stimuluse, posebno na one koji podstiču razvoj mišićne mase i neuromišićne snage, dok su kod devojčica adaptacije u ovom periodu često umerenije (Agostinete et al., 2017; Rodriguez et al., 2018).

S obzirom na navedeno, proučavanje morfoloških karakteristika mladih sportista u različitim sportovima i različitim uzrastima omogućava bolje razumevanje razvojnih obrazaca i uticaja specifičnih sportskih stimulusa u predpubertetskom period, što i predstavlja cilj ovog rada. Upoređivanje džudista/rvača i plivača po uzrastima i polu može pružiti uvid u to kako kombinovani efekti prirodnog rasta i treninga oblikuju morfološki profil, kao i da li se sportska diferencijacija može uočiti već u ranom detinjstvu. Takva istraživanja imaju praktičnu vrednost u procesu sportske selekcije, planiranju treninga i praćenju razvoja mladih sportista u periodu intenzivnih bioloških promena.

METODE

Uzorak ispitanika

Ovim istraživanjem testirano je 105 devojčica i dečaka uzrasta od 8 do 11 godina (Tabela 1), od toga 66 se bavi borilačkim sportovima (džudo i rvanje), tj. 35 dečaka i 31 devojčica, dok je **39** bilo iz plivačke selekcije, tj. 21 dečak i 18 devojčica. Svi učesnici imali su najmanje godinu dana iskustva u treniranju svog sporta, uz redovne trenažne procese od minimalno tri puta nedeljno. Roditelji ili staratelji potpisali su saglasnost za učešće dece u istraživanju, a svi postupci merenja sprovedeni su u skladu sa etičkim standardima Deklaracije iz Helsinkija (World Medical Association, 2013).

Tabela 1 Prikaz broja ispitanika po sportu, polu i uzrastu

Sport	Pol	Uzrast				Ukupno	
		8	9	10	11		
Džudo+Rvanje	Dečaci	10	7	10	8	35	66
	Devojčice	5	5	9	12	31	
Plivanje	Dečaci	5	6	5	5	21	39
	Devojčice	3	4	5	6	18	
Ukupno		23	22	29	31	105	

Procedura merenje

Testiranja su sprovođena u jutarnjim časovima, u prostorijama matičnih klubova ispitanika. Svi ispitanici su bili obavešteni o proceduri koji su morali da ispoštuju pre testiranja, tj. da izbegavaju fizičku aktivnost najmanje 24 h pre merenja, ali i da ne konzumiraju hranu tog jutra kao i umereno unošenje tečnosti (Dopsaj et al., 2013). Testiranje telesne kompozicije je izvršeno pomoću bioelektrične impedance (bioimpedance – In Body 270; Biospace Co., Soul, Korea), čemu je prethodilo merenje telesne visine (antropometar po Martinu). Pre svakog merenja ispitanici su obrisali ruke i stopala antibakterijskim rastvorom radi osiguravanja provodljivosti. Uređaj je automatski generisao rezultate nakon približno 15 sekundi stajanja u zadatom položaju.

Varijable

Na osnovu izmerenih podataka, u analizu su uključene sledeće morfološke varijable:

- Telesna visina - Body Height – BH, izraženo u cm,
- Telesna masa - Body Weight – BW, izraženo u kg,
- Indeks telesne mase - Body Mass Index – BMI, izraženo u kg/m^2,
- Ukupna telesna voda - Total Body Water – TBW, izraženo u L.

- Proteini - Protein, izraženo u kg,
- Minerali - Minerals, izraženo u kg,
- Masa masnog tkiva - Body Fat Mass – BFM, izraženo u kg,
- Masa bez masti - Free Fat Mass – FFM, izraženo u kg,
- Skeletna mišićna masa - Skeletal Muscle Mass – SMM, izraženo u kg,
- Procenat masnog tkiva - Percent Body Fat – PBF, izraženo u %,
- Procenat skeletne mišićne mase - Percent Skeletal Muscle Mass – PSMM, izraženo u %,
- Odnos struk–kuk - Waist–Hip Ratio – WHR,
- InBody rezultat - Inbody Score.

Sve varijable preuzete su direktno iz standardnog InBody izveštaja.

Statističke analize

Sve analize su sprovedene korišćenjem statističkog paketa za društvene nauke (IBM, SPSS 20.0, Chicago, IL, USA)). Za sve varijable izračunati su osnovni deskriptivni parametri. Da bi se utvrdile razlike između grupa korišćena je ANOVA, dok su rezlike između parova pojedinačnih varijabli analizirane T testom. Nivo statističke značajnosti je definisan sa 95%, a vrednosti verovatnoće su $p < 0,05$ (Hair *et al*., 1998).

REZULTATI

Rezultati prikazani u Tabeli 2 ukazuju na statistički značajne razlike u morfološkim karakteristikama između uzrasta unutar sportskih grupa. Kod dečaka su utvrđene statistički značajne razlike između uzrasta bez obzira na sport i to na nivou $p = 0.001$ za borilačke sportove (džudo+rvanje) i na nivou $p = 0.006$ kod plivača. Kod devojčica, značajne razlike su pronađene unutar grupe džudo+rvanje ($p = 0.001$), dok razlike unutar uzrasta kod plivačica nisu dostigle statističku značajnost ($p = 0.131$).

Tabela 2 Razlike između uzrasnih grupa u funkciji pola i sportske specijalizacije

Effect	Pol	Sport	Value	F	Hypothesis df	Error df	**Sig.**	Partial Eta Squared	Noncent. Parameter	Observed Power[e]
Wilks' Lambda	Dečaci	Džudo+Rvanje	0.102	2.552	30.000	65.250	**0.001**	0.532	74.203	0.998
		Plivanje	0.012	2.810	30.000	24.158	**0.006**	0.770	80.836	0.979
	Devojčice	Džudo+Rvanje	0.063	2.795	30.000	53.510	**0.001**	0.602	81.082	0.999
		Plivanje	0.013	1.721	30.000	15.352	**0.131**	0.763	49.543	0.690

Prema podacima iz Tabele 3, ispitivane relacije između sportskih disciplina, nisu dostigle nivo statistički značajnih razlika ($p = 0.054$-0.973), bez obzira na pol i uzrast.

Tabela 3 Razlike između sportova, u funkciji pola i uzrasta

Relation	Pol	Uzrast	Value	F	Hypothesis df	Error df	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[d]
Džudo+Rvanje / Plivanje	Dečaci	8	0.173	1.911	10.000	4.000	0.279	0.827	19.109	0.256
		9	0.056	3.372	10.000	2.000	0.250	0.944	33.716	0.200
		10	0.382	0.647	10.000	4.000	0.738	0.618	6.468	0.112
		11	0.153	1.110	10.000	2.000	0.563	0.847	11.099	0.102
	Devojčice	8	0.586	0.118	6.000	1.000	0.973	0.414	0.706	0.053
		9	0.001	204.209	7.000	1.000	0.054	0.999	1429.465	0.648
		10	0.265	0.831	10.000	3.000	0.642	0.735	8.312	0.111
		11	0.650	0.377	10.000	7.000	0.921	0.350	3.766	0.104

Rezultati prikazani u Tabeli 4 ukazuju na postojanje statistički značajnih razlika između sportskih grupa (džudo/rvanje i plivanje) kod dečaka, ali samo u najmlađem uzrastu (8 godina). U ovom uzrastu

utvrđene su značajne razlike u BH (F = 15.794; p = 0.002), TBW (F = 12.833; p = 0.003), Protein (F = 11.277; p = 0.005), SMM (F = 11.497; p = 0.005) i FFM (F = 11.853; p = 0.004). U uzrastima 9, 10 i 11 godina nisu utvrđene statistički značajne razlike ni u jednoj od posmatranih morfoloških varijabli (p > 0.05), dok kod devojčica nisu utvrđene statistički značajne razlike ni u jednoj uzrasnoj grupi.

Tabela 4 Deskriptivna statistika i rezlike džudista i plivača muškog pola u funkciji uzrasta

Uzrast	**8**			**9**			**10**			**11**		
Variable	Mean		F	Mean		F	Mean		F	Mean		**F**
	Dž+R	P		Dž+R	P		Dž+R	P		Dž+R	P	
BH	131.3	140.6	15.794*	140.4	142.2	0.595	154.5	148.2	1.633	160.1	156.0	0.438
BW	29.1	29.9	0.108	41.1	36.9	1.376	48.7	38.6	2.155	53.8	44.4	2.239
BMI	16.8	15.1	2.019	20.9	18.3	1.629	20.0	17.7	1.248	20.8	18.2	2.170
TBW	17.0	19.5	12.833*	21.0	21.0	0.000	26.6	23.6	1.052	30.5	26.8	1.001
Protein	4.5	5.2	11.277*	5.7	5.6	0.045	7.1	6.3	1.067	8.2	7.2	1.097
Minerals	1.6	1.8	2.533	1.9	1.9	0.040	2.6	2.2	1.455	3.0	2.6	1.093
BFM	5.9	3.4	1.586	12.5	8.4	1.366	12.5	6.6	2.988	12.1	7.8	1.477
SMM	11.7	13.7	11.497*	15.0	15.0	0.019	19.4	17.0	1.050	22.7	19.7	1.043
FFM	23.1	26.4	11.853*	28.6	28.6	0.003	36.2	32.1	1.085	41.7	36.6	1.023
PBF	19.0	11.0	2.580	28.0	22.4	0.809	23.8	16.7	2.521	21.6	17.6	0.581
PSMM	39.6	37.2	0.474	39.3	42.9	1.571	43.1	44.6	0.353	44.1	42.3	0.854
WHR	0.8	0.8	0.238	0.8	0.8	0.642	0.8	0.8	3.965	0.8	0.8	0.219
InBody Score	76.8	76.2	0.139	72.9	76.2	1.020	72.9	76.6	2.335	73.1	76.4	0.903

Legenda : Dž+R - Džudo+Rvanje, P - Plivanje; * - Statistička značajnost na nivou p ≤ 0.05

Generalno, analiza Tabele 5 ukazuje da kod devojčica uzrasta 8–11 godina razlike između sportova postoje na deskriptivnom nivou, naročito kada su u pitanju komponente masnog i nemasnog tkiva, ali da statistička značajnost izostaje. Ovakav obrazac sugeriše da je u predpubertetskom uzrastu uticaj specifičnog sportskog treninga slabije izražen kod devojčica nego kod dečaka, verovatno zbog slabijeg intenziteta trenažnih stimulusa, nižeg nivoa hormonski posredovanog mišićnog rasta i izraženijih individualnih varijacija. Ovi rezultati potvrđuju da su polne razlike i sportska diferencijacija u ovom razvojnom periodu kod devojčica generalno suptilnije i manje konzistentne.

Tabela 5 Deskriptivna statistika i rezlike džudista i plivača ženskog pola u funkciji uzrasta

Uzrast	**8**			**9**			**10**			**11**		
Variable	Mean		F	Mean		F	Mean		F	Mean		F
	Dž+R	P		Dž+R	P		Dž+R	P		Dž+R	P	
BH	132.8	136.5	0.893	142.8	144.1	0.321	147.2	150.8	0.778	156.6	156.3	0.007
BW	31.7	33.4	0.222	38.9	33.3	1.859	37.1	38.9	0.151	46.8	45.1	0.096
BMI	18.0	17.8	0.011	19.0	16.1	2.229	17.0	17.0	0.000	18.9	18.4	0.067
TBW	16.6	17.2	0.255	19.8	19.0	0.907	20.7	22.7	0.810	26.4	26.0	0.047
Protein	4.4	4.6	0.378	5.3	5.0	1.709	5.5	6.0	0.880	7.1	6.9	0.081
Minerals	1.6	1.7	0.139	1.9	1.9	0.327	2.1	2.2	0.276	2.5	2.5	0.025
BFM	9.0	9.9	0.103	11.9	7.4	2.190	8.8	8.1	0.087	10.9	9.7	0.111
SMM	11.4	11.8	0.273	14.0	13.2	1.131	14.7	16.3	0.857	19.3	18.9	0.063
FFM	22.7	23.4	0.279	27.0	25.9	0.801	28.3	30.9	0.788	36.0	35.4	0.053
PBF	27.8	28.9	0.034	29.2	22.1	2.021	22.5	20.3	0.212	21.2	21.1	0.001
PSMM	37.5	35.3	0.627	42.4	43.3	0.674	37.6	42.6	4.636	39.5	42.0	1.182
WHR	0.8	0.8	1.864	0.8	0.8	0.338	0.8	0.8	0.248	0.8	0.8	0.114
InBody Score	74.8	74.3	0.034	73.6	74.8	0.312	73.8	74.0	0.007	74.5	75.5	0.192

Legenda : Dž+R - Džudo+Rvanje, P - Plivanje; * - Statistička značajnost na nivou p ≤ 0.05

DISKUSIJA

Nalazi istraživanja pokazuju da period od 8 do 11 godina predstavlja fazu intenzivnih promena morfoloških karakteristika, koje su rezultat kombinovanih efekata rasta, biološkog sazrevanja i specifičnih sportskih opterećenja. Statistički značajne razlike unutar sportskih grupa prikazane u Tabeli 2 kod dečaka u oba sporta i kod devojčica u džudou/rvanju potvrđuju da se somatske komponente u ovom periodu razvijaju ubrzano, što je u skladu sa nalazima Maline i saradnika (2015) i Maline i Rogola (2020), koji ukazuju da je predpubertetski period karakterisan linearnim ali ubrzanim razvojnim progresijama. Slične razvojne tendencije uočene su i u istraživanjima Barace i saradnika (2021), koji su istakli da uzrast predstavlja ključni moderator promene mišićne mase, telesne visine i proporcionalnosti.

Rezultati prikazani u Tabeli 3 pokazuju da između sportova nisu utvrđene statistički značajne razlike ni u jednom uzrastu bez obzira na pol, što ukazuje da u periodu od 8 do 11 godina dominantnu ulogu u oblikovanju morfoloških karakteristika i dalje ima prirodan rast, a ne specifičan sportski trening. Ovakav nalaz je očekivan s obzirom na visoku individualnu variabilnost u predpubertetu i relativno slabije izražene adaptacije na trening u ovom razvojnom periodu, posebno kod devojčica (Malina et al., 2015; Agostinete et al., 2017).

Rezultati ovog istraživanja ukazuju na jasno diferencirane obrasce morfološkog razvoja između sportova i polova u uzrasnom periodu od 8 do 11 godina. Kod dečaka su razlike između džudo/rvanja i plivanja najizraženije u najmlađem analiziranom uzrastu (8 godina), gde su telesna visina, ukupna telesna voda, proteinska masa, skeletna mišićna masa i ukupna nemasna masa bile statistički značajno veće kod džudista i rvača. Ovi nalazi potvrđuju da borilački sportovi u ranoj fazi treninga podstiču brži razvoj komponenti nemasne mase, što je već dokumentovano u istraživanjima koja ukazuju da intenzivni izometrički i dinamički napori, česti oblici borbenog kontakta i zahtevi za stabilizacijom tela vode ka ranijem neuromišićnom razvoju i povećanju mišićne mase kod dece uključenih u ove sportove (Franchini et al., 2012; Kons et al., 2018; Alvarez et al., 2019). S druge strane, plivanje kao sport manje opterećenja, sa kontinuiranim aerobnim radom u sredini smanjene gravitacije, ne podstiče ubrzan porast mišićne mase u najranijem uzrastu, iako doprinosi efikasnijoj regulaciji telesne kompozicije, što je u skladu sa prethodnim istraživanjima (Pynea et al., 2014; Coste et al., 2022).

Međutim, u uzrastima 9, 10 i 11 godina razlike između sportova kod dečaka više nisu dostizale statističku značajnost, što sugeriše da prirodni rast i razvoj postepeno nadjačavaju efekat specifičnog sportskog opterećenja. Ovaj trend je u skladu sa nalazima Maline i Rogola (2020), koji ističu da je biološka variabilnost u predpubertetskom periodu visoka, što može zamaskirati trenažne efekte, posebno u sportovima gde se adaptacija razvija postepeno. Takođe, moguće je da se tokom ovih godina intenzitet i volumen treninga kod mladih sportista ne razlikuju dovoljno između disciplina da bi se razlike u morfološkim komponentama dodatno produbile.

Za razliku od dečaka, kod devojčica nijedna analizirana morfološka varijabla nije dostigla nivo statističke značajnosti u poređenju džudo/rvanja i plivanja, iako su deskriptivne razlike vidljive, posebno kod PBF, SMM i TBW u nekim uzrastima. Ovaj obrazac jasno odražava činjenicu da se kod devojčica u uzrastu 8–11 godina trenažne adaptacije javljaju sporije i manje intenzivno, što je potvrđeno u prethodnim istraživanjima (Agostinetea et al., 2017; Rodriguez et al., 2018). Biološki gledano, prepubertetske devojčice ne doživljavaju hormonalne promene koje bi ubrzale razvoj mišićne mase (posebno anaboličkih efekata testosterona), zbog čega sportski stimulusi ostaju slabije izraženi u njihovom morfološkom profilu (Malina et al., 2015). Takođe, intenzitet trenažnih programa kod devojčica često je niži u poređenju sa dečacima, što dodatno doprinosi odsustvu značajnih razlika između sportova.

Ipak, deskriptivni podaci ukazuju na određenu prirodnu diferencijaciju: džudistkinje u proseku pokazuju veće vrednosti nemasnih komponenti (SMM, FFM), dok plivačice, kao i kod dečaka, imaju niži procenat masnog tkiva, što je u skladu sa specifičnostima sportova. Plivanje, zbog visokog energetskog zahteva i niskog opterećenja zglobova, često dovodi do boljeg odnosa masnog i nemasnog tkiva, dok borilački sportovi više stimulišu razvoj mišićne mase (Costa et al., 2022; Pyne et al., 2014). Ovi obrasci, iako statistički neznačajni, pokazuju tendenciju koja bi se mogla izrazitije manifestovati ulaskom u pubertet, kada hormonski faktori dodatno pojačavaju diferencijaciju sportske adaptacije (Towlsona et al., 2021).

Ukupno posmatrano, rezultati iz ANOVA analize za muški pol i deskriptivne analize za ženski pol upućuju na to da kombinacija prirodnog rasta i specifičnog sportskog opterećenja oblikuje morfološke karakteristike kod dece, ali sa jasnim razlikama u intenzitetu i vremenu pojavljivanja efekata. Kod dečaka su razlike vidljive ranije i izraženije, dok se kod devojčica morfološke razlike između sportova tek naznačavaju, ali bez statističke potvrde. To ukazuje da se sportska diferencijacija morfoloških karakteristika u predpubertetskom periodu odvija polno specifično, zavisno od bioloških, hormonalnih i trenažnih faktora.

ZAKLJUČAK

Rezultati istraživanja pokazuju da uzrast od 8 do 11 godina predstavlja kritičan period promena morfoloških karakteristika pod uticajem rasta, razvoja i sportskog angažmana. Borilački sportovi (džudo i rvanje) podstiču veći razvoj mišićne mase, FFM-a i BMI-a, dok plivanje doprinosi ujednačenijem linearnom rastu i nižim vrednostima masnih komponenti. Razlike između sportova izraženije su kod dečaka, dok su kod devojčica manje naglašene i nisu statistički značajne. Ovi nalazi ukazuju na potrebu individualizovanog planiranja treninga, praćenja morfološkog razvoja i primene sportskih stimulusa koji su usklađeni sa biološkom zrelošću deteta. Takođe, se može zaključiti da visina tela predstavljala jedan od faktora u selekciji najmlađih ispitanika, a da rana sportska specijalizacija ne pravi značajne efekte na morfološke karakteristike u uzrastu od 8 do 11 godina, ali možemo pretpostaviti da mnogo veći efekat ima na motoričke sposobnosti, koje bi svakako trebale da budu ključne u selekciji.

LITERATURA

1. Agostinete, R. R., Costa, R. R., & Santos, M. A. (2017). Growth and body composition in prepubertal boys and girls. *Journal of Sports Sciences, 35*(6), 567–575.
2. Alvarez, P. R., Carvalho, H. M., & Castilho, P. (2019). Body composition and neuromuscular performance in young judo athletes. *Journal of Strength and Conditioning Research, 33*(2), 327–334.
3. Barace, A., D'Hondt, E., & Lenoir, M. (2021). Somatic growth patterns in childhood. *Pediatric Exercise Science, 33*(4), 212–220.
4. Costa, M. J., Marinho, D. A., & Silva, A. J. (2022). Variation in swimming performance and body composition in youth swimmers. *European Journal of Sport Science, 22*(4), 512–520.
5. Dopsaj, M., Todorov, I., Vuković, M., & Radovanović, D. (2013). Various morphological indicators in elite judo athletes defined by multifrequency bioelectrical impedance analysis. *Serbian Journal of Sports Sciences, 7*(3), 129–141.
6. Franchini, E., Brito, C. J., & Artioli, G. G. (2012). Physiological profiles of elite judo athletes. *Sports Medicine, 42*(3), 231–250.
7. Hair, J. F., Anderson, R. E., Tatham, R. L., & Black, W. C. (1998). *Multivariate data analysis* (5th ed.). Prentice Hall.
8. Kons, R. L., Fernandes da Silva, J., & Branco, B. H. M. (2018). Anthropometric and physical performance characteristics in judo athletes. *Archives of Budo, 14*, 227–235.
9. Lloyd, R. S., & Oliver, J. L. (2012). The youth physical development model. *Strength and Conditioning Journal, 34*(3), 61–72.
10. Lloyd, R. S., Oliver, J. L., Faigenbaum, A. D., Howard, R., De Ste Croix, M., Williams, C. A., Best, T. M., & Myer, G. D. (2015). Long-term athletic development. *Journal of Strength and Conditioning Research, 29*(6), 1439–1450.
11. Malacko, J., Rađo, I., & Doder, D. (2015). *Teorija treninga: Antropološki aspekti sporta*. Fakultet sporta i fizičkog vaspitanja.
12. Malina, R. M., & Rogol, A. D. (2020). Assessment of growth and maturation in children. *Sports Medicine, 50*(12), 1997–2016.
13. Malina, R. M., Bouchard, C., & Bar-Or, O. (2004). *Growth, maturation, and physical activity* (2nd ed.). Human Kinetics.
14. Malina, R. M., Rogol, A. D., Cumming, S. P., Bar-Or, O., & Eisenmann, J. C. (2015). Growth and maturation of children engaged in sports. *British Journal of Sports Medicine, 49*(13), 852–857.
15. Pyne, D. B., Anderson, M., & Hopkins, W. G. (2014). Body composition and swimming performance in youth athletes. *International Journal of Sports Physiology and Performance, 9*(3), 324–331.
16. Rodriguez, F., Sansone, M., & Bishop, D. (2018). Sex differences in response to training during preadolescence. *Journal of Strength and Conditioning Research, 32*(12), 3458–3465.

17. Towlson, C., Cobley, S., & Till, K. (2021). Growth and maturation in youth athletes: Implications for training. *Sports Medicine, 51*(6), 1141–1154.
18. World Medical Association. (2013). *WMA Declaration of Helsinki: Ethical principles for medical research involving human subjects*. https://www.wma.net/policies-post/wma-declaration-of-helsinki-ethical-principles-for-medical-research-involving-human-subjects/

THE INFLUENCE OF DIFFERENT SPORTS SPECIALIZATION ON MORPHOLOGICAL CHARACTERISTICS AT YOUNG AGE

Marković Milan, Toskić Lazar, Arsenijević Radenko, Aksović Nikola

Abstract: *In addition to sports whose specificity traditionally lies in early engagement, the growing popularity of sports has also encouraged early involvement in sports activities. Therefore, the process of specialization begins earlier, partly spontaneously in the desire to improve the quality of training, but also for the sake of faster success. Early sports specialization can have a significant impact on both motor and morphological characteristics. The subject of this paper is the morphological characteristics of young athletes. The aim of this research is to perform a comparative analysis of young athletes of different ages, from the aspect of morphological characteristics, and in the function of defining the impact of early sports specialization on body structure. The study included 105 respondents aged 8 to 11, of which 56 boys and 49 girls, who practice martial arts (Judo, Wrestling) or swimming. The testing procedure includes measuring body height and analyzing body composition (InBody 270). The applied analyses can be observed significant differences between the examined age groups for most of the examined variables within the defined sports. The established differences define the cumulative effects of growth and development, as well as the general effects of physical activity, but also the specific effects of a given sport. However, the main focus of this work was on defining the differences in early specialization of different sports, with significant differences only in the group of the youngest children, namely in body height, total body water, protein, skeletal muscle mass, and the fat free mass, at the level of p = 0.002-0.005. While in the age group of 9 to 11 years in boys, as well as in all age groups in girls, no statistically significant differences were found between sports at the level of the examined morphological characteristics. Based on the obtained results, it can be concluded that body height was one of the factors in the selection of the youngest respondents, and that early sports specialization does not have significant effects on morphological characteristics at the age of 8 to 11 years, but we can assume that it has a much greater effect on motor skills, which should definitely be key in selection.*

Key words*: selection, adaptation, pioneers, motor skills.*

IMPACT OF PREVENTIVE EXERCISE PROGRAMS ON SCOLIOSIS

Veselinović Zorana[1], Hajder Đorđe[1], Bjelica Bojan[1], Pržulj Radomir[1], Aksović Nikola[2], Dobrescu Tatiana[3], Bubanj Saša[4]

[1]Faculty of Physical Education and Sports, University of East Sarajevo, Republika Srpska, Bosnia & Herzegovina
[2]Faculty of Sports and Physical Education, University of Priština-Kosovska Mitrovica, Leposavić, Serbia
[3]Faculty of Movement, Sport and Health Sciences, Vasile Alecsandri University, Bacau, Romania
[4]Faculty of Sport and Physical Education, University of Niš, Serbia

REVIEW ARTICLE
DOI: 10.5937/ATAVPA25139V

Abstract: *The aim of the study was to determine the effect of various corrective and preventive programs on scoliosis, one of the most common postural disorders in children and young people. Electronic databases such as PubMed, Web of Science, Scopus, MEDLINE, ERIC and Google Scholar were used in the literature review. Based on predefined criteria, ten studies that met quality standards were analyzed. The results of the study indicate that preventive programs that include specialized exercises, corrective gymnastics and individually tailored interventions significantly contribute to reducing the angle of spinal curvature and improving postural condition. It has also been shown that regular application of such programs has a positive effect on the functional abilities and psychophysical health of participants. Future research should focus on the long-term effects of preventive programs, including their application in different age groups and degrees of scoliosis. It is also recommended to examine the effectiveness of programs that combine corrective exercises with modern technological solutions, such as posture monitoring sensors and virtual reality. In addition, it is important to expand the samples to populations from different settings so that the results can be generalized and applied in a broader context.*

Key words: *Corrective gymnastics, exercises, rehabilitation, postural disorders.*

INTRODUCTION

Specific deformation caused by poor posture is not just one of the disorders, but includes several deformations, caused by active muscle tension. Poor posture is only one of the characteristics of weakness of the whole body and especially the joint-muscular apparatus, caused by weakness of other parts of the locomotor system (Bogdanović, 2005; Hajder, 2023). The period of growing up from 9-12 years, or the rapid transition from childhood to adolescence, causes significant changes in morphological characteristics and motor abilities that can indirectly affect postural status (Wojtys, 1987). Obesity and increased body weight in children lead to increased difficulties in movement and maintaining statistical balance (Shumway-Cook, 2001). Postural stability, sensory and motor systems in the period from 4-6 years go through a transitional period until they reach adult maturity at 7-10 years (Forssberg & Nashner, 1982; Shumway-Cook & Woollacott, 1985).

Reduced physical activity, school bags, excessive body weight, inappropriate school furniture are just some of the external influences that contribute to the development of spinal deformities in adolescents and primary school children during the growth period (Bunnell, 1986; Wiggins, 2003; Boos, 2008; Ha et al., 2015). In the last 15 years, the statistical percentage of deformities has increased significantly, especially idiopathic scoliosis deformities, which have increased in boys from 0.25% to 2.25% and in girls from 0.93% to 1.37% (Schlenk, 2003; Bogdanović, 2008; Altaf, 2013; Ailon, 2015). Spinal deformities, in addition to impairing and making motor skills difficult, can cause serious health problems such as disorders of the cardiorespiratory and locomotor systems due to a narrow and asymmetrical chest (Aebi, 2005; Youssef, 2013; Diebo, 2019). A deformity like this is accompanied by a decrease in physical activity, back pain, increased forced posture, the appearance of depression, fatigue, and a decrease in work capacity (Janicki, 2007; Berdishevsky, 2016; Gámiz-Bermúdez, Obrero-Gaitán, Zagalaz-Anula, & Lomas-Vega 2022). The above symptoms are most pronounced in adolescents and occur even in school-age children. In response to this problem, it is necessary to apply adequate corrective gymnastics exercises that will strengthen weakened muscles and bring the spine to a normal-correct state. In addition to corrective exercises, time plays a key role (Fusco et al., 2011). Disorders discovered in time while the spine is still functional are much easier to eliminate or correct than disorders that

progress or have already turned into deformity, where recovery is much more difficult and takes longer.

Therefore, the aim of this systematic review was to determine the effect of various corrective and preventive exercise programs on scoliosis, one of the most common postural disorders in children and young people.

MATHERIAL AND METHODS

Search Strategy

The literature review used electronic databases such as Scholar Google, PubMed, MEDLINE, relevant journals in the field of sports and medical sciences, as well as scientific publications that could answer the problem posed. Keywords for the electronic search included: "corrective gymnastics", "exercises", rehabilitation", "postural disorders".

Study selection

EndNote citation management software was utilized for literature screening, while duplicate detection was performed using Mendeley reference management software (v. 2.111.0, Copyright © 2024 Elsevier Ltd., Barcelona, Spain). The selection of papers was determined based on title, keywords and relevance to the topic, and the electronic databases PubMed, Web of Science, Scopus, MEDLINE, ERIC and Google Scholar were searched. Two criteria were set for the selection of papers. The first criterion refers to research that analyzes the effects of preventive and corrective programs, with an emphasis on physical exercises and therapeutic approaches aimed at improving postural status and alleviating scoliosis symptoms. The second criterion includes the time frame of the analysis, whereby papers published between 2012 and 2021 were considered, in order to ensure the relevance and timeliness of the data. Based on the defined criteria, ten scientific papers were selected that met the requirements for further analysis and were close to the subject of the research.

All disagreements were resolved through agreement between two researchers or with the help of a third. Two authors (A.N. and B.B.) independently reviewed and selected the searched papers. Selected papers were then cross-checked by the same two authors. The final decision for included papers was made by a third author (H.Đ.).

Methodological quality of studies

Methodological quality assessment of the included studies were performed independently according to the Physical Therapy Database (PEDro) scale, which involves 11 items. These items were displayed and rated as (+ or -), although numbers (1 or 0) can also be used. If the included study has six or more, then the quality of the study is considered high, results of 4-5 mean studies of moderate quality, while results of less than 4 correspond to studies of poor quality (Zhao et al., 2023).

RESULTS

The papers were selected from a ten-year period, taking into account those that could most closely offer solutions to the set topic. The analyzed articles provide an overview of the impact of corrective gymnastics physical exercise programs on postural disorders, with a special emphasis on the deformity of scoliosis. The analysis of the papers included in the review reveals a significant contribution of research in the field of preventive treatment programs for scoliosis. The presented papers focus on various aspects of analysis, rehabilitation and prevention of the development of deformities with a focus on the deformity scoliosis.

A total of 150 articles were identified through the database search. After removing duplicates and screening the articles based on their title, abstract, and other criteria 35 studies remained. Two researchers independently evaluated these 35 studies. Following the final screening, 10 studies met the set criteria and conditions and were included in the systematic review. The procedure for the collection, analysis, and elimination of the papers is shown in Figure 1.

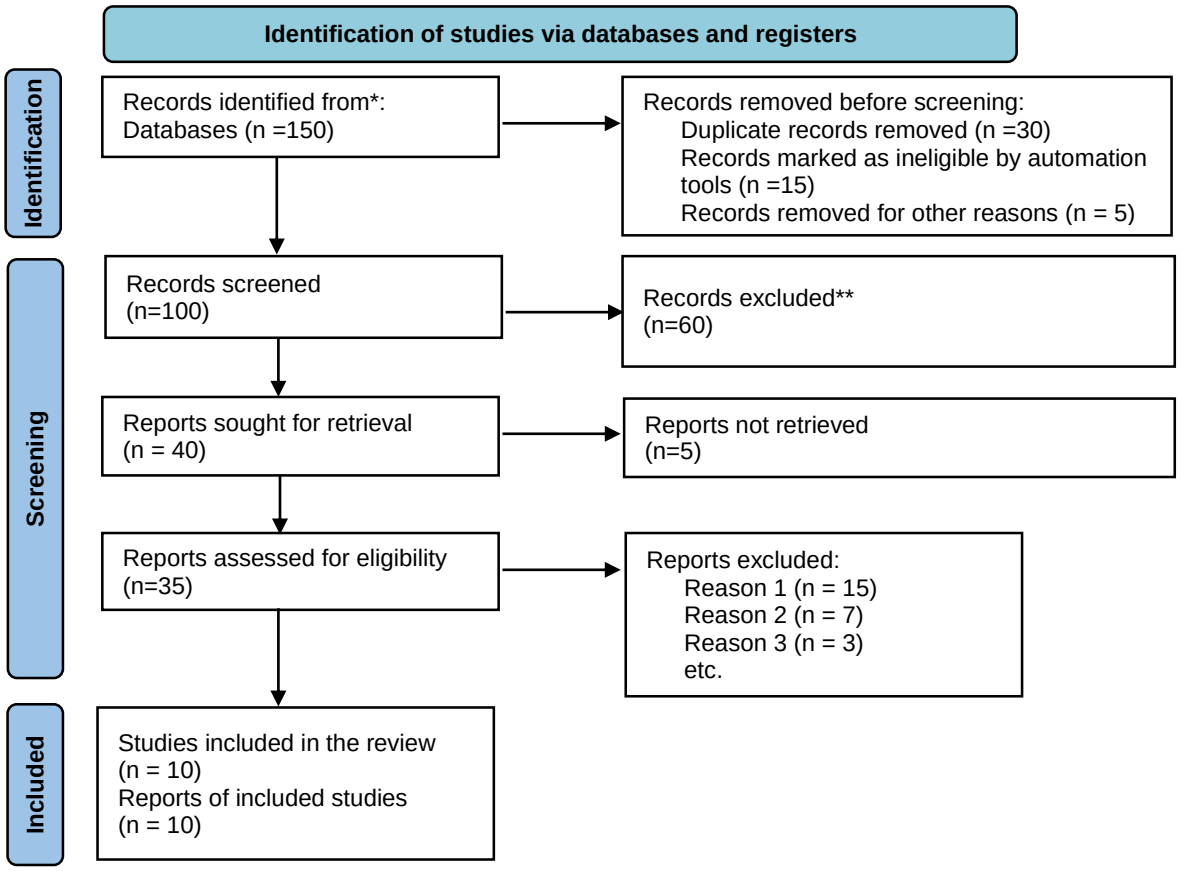


Figure 1 Diagram of included studies (Page et al., 2021)

The data extracted from the selected studies included the following: References, number of respodents, average age, program time, program type, and research results (see Table 1).

Table 1 Systematic review of the impact of preventive programs on spinal deformities with a focus on scoliosis

Authors	Number of respondents	Age	Program time	Program type	Research results
Monticone et al. (2014)	N=110 G1- 55 (control group); G2-55 (stabilization group).	12.45 ± 1.1	12 months	G1- Cobb's angle; TRA, SRS-22	Training in the experimental group led to a significant reduction in radiological deformity (Cobb angle >5), while the control group remained stable.
Kumar et al. (2017)	N= 36 G1- 18 (control group); G2- 18 (postural group for self-correlation).	11.8 ± 1.1	12 months	G1- Cobb's angle, FVC, FEV1, VC; G2-PEF	Post-intervention results showed significantly higher values of FVC (p=0.001), FEV1 (p=0.01) and VC (p=0.002) in the experimental group compared to the control group, with a greater reduction in Cobb angle (p=0.001) in the experimental group.

Zapata et al. (2015)	N= 24 G1- 17 (control group); G2- 17 (uncontrolled stabilization group).	14.9 ± 1.4	8 weeks	G1-NPRS, PSFS; G2- OSW, PDLRT	The supervised group showed significantly greater pain reduction and functional improvements (P < .01), while there were no differences between groups in back muscle endurance, as analyzed by the results of the Oswestry questionnaire or the Global Rating of Change.
Schreiber et al. (2016)	N= 50 G1- 25 (Schroth group); G2- 25 (control group).	13.4 ± 0.7	6 months	G1- Major curve; G2- Sum of curves;	After six months, the Schroth group had a significantly lower maximum angle of curvature (-3.5°, p = 0.006) and a lower Sum of Curves (-0.40°, p = 0.046) compared to the control group, with the difference increasing with the severity of the condition, while the per-protocol analysis showed even larger differences in the maximum angle of curvature (-4.1°, p = 0.002) and Sum of Curves (-0.8° to 0.2°, p = 0.006).
Diab et al. (2012)	N= 76 G1- 25 (control group); G2- 25(postural self-correction group).	13.9 ± 1.3	10 weeks 3 months	G1- Craniovertebral angle, trunk inclination, lordosis, kyphosis, imbalance, lateral deviation, pelvic torsion and rotation, FRI.	After 10 weeks, significant differences were recorded in the study group in several parameters, including craniovertebral angle (p = 0.006), trunk tilt (p = 0.005), lordosis (p = 0.01), kyphosis (p = 0.001), trunk imbalance (p = 0.001), lateral deviation (p = 0.001), pelvic torsion (p = 0.004), and surface rotation (p = 0.013), and these differences remained significant after three months, while there was no significant difference in the functional index after 10 weeks (p = 0.8), but a significant difference was achieved after three months (p = 0.001).
Zheng et al. (2018)	N=53 G1- 24 (control group); G2- 29 (experimental group).	12.4 ± 0.9	52 weeks 1 session 40 minutes	G1- Orthosis; G2-SEAS.	Both interventions, bracing and exercise, showed significant efficacy in the treatment of AIS, with the bracing group achieving better results in correcting spinal curvature (Cobb angle, P = 0.039) as well as improving shoulder balance (P < 0.005), while the exercise group had significantly greater improvements in quality of life, including functional status (P < 0.001), mental health (P < 0.001), and total score (P < 0.001), with significant improvements within both groups in parameters of spinal curvature and body symmetry.
Gao et al. (2019)	N=55 G1- 22 (control group); G2- 23 (experimental group).	12.15±1	24 weeks 7 sessions 10-15 minutes	G1- Orthosis; G2- SEAS + Orthosis.	After 6 months of the program, the group that used the orthosis in combination with exercise showed significantly better correction of the Cobb angle, improved back muscle endurance and lung function, while the group with orthotic intervention recorded a decrease in back muscle endurance and lung function.Significant differences were observed in back muscle endurance time and lung function parameters at the 6-month follow-up.

de Assis et al. (2021)	N=156 G1-78 (control group); G2- 78 (experimental group).	13±9	261 weeks	Adams test, Life habits, IPAQ, Rebolh questionnaire, postural habits, physical activity, scoliosis.	42.9% of participants were considered to be irregularly active, and only 33.3% practiced physical activity regularly. After bivariate analysis and conditional logistic regression, low physical activity was shown to be a risk factor for scoliosis (p = 0.041; OR: 2.81; 95% CI: 1.04–7.57), while the postural habits assessed in this study did not show a statistical association with scoliosis.
Scaturro et al. (2021)	N=428	11.76	2 school years (80 weeks)	Adams test, Bunnell inclinometer,Pre-intervention questionnaire.	Clinical assessment using the Adams test and Bunnell inclinometer indicated an association between suspected adolescent idiopathic scoliosis (AIS) and high-risk sports ($p < 0.05$), weekly physical activity longer than 3 hours ($p < 0.05$), low back pain ($p < 0.001$), postural disorders ($p < 0.01$), and lack of contact with a doctor ($p < 0.01$). In addition, high-risk sports (adj OR = 1.83; CI 95% 1.11–4.76) and postural disorders (adj OR = 1.67; CI 95% 1.12–3.60) showed a significant association with a confirmed diagnosis of AIS, defined by a Cobb angle ≥ 10° on X-ray.
Kocaman et al. (2021)	N=28G1-14 (schroth group); G2-14 (basic group).	14.14±2.28	10 weeks; 3 days a week	Basic strength training, Schroth exercises/Conventional therapy, Cobb angle.	Patients in the Schroth group showed greater improvement in Cobb angles, thoracic trunk rotation angle, aesthetic trunk deformity, spinal mobility, and quality of life than those in the baseline group ($p<0.05$), except for lumbar trunk rotation angle. Peripheral improvement in muscle strength was greater in the baseline group than in the Schroth.

Legend: group (G), statistical value (p), trunk rotation angle (TRA), Scoliosis Research Society Patient Outcomes questionnaire 22 (SRS-22), forced vital capacity (FVC), forced expiratory volume in 1 second (FEV1), vital capacity (VC), peak expiratory flow (PEF), Numeric Pain Rating Scale (NPRS), Global Rating of Change (GROC), Oswestry Low Back Pain Disability Questionnaire (OSW), Patient-Specific Functional Scale (PSFS), Functional Rating Index (FRI), Scientific Exercise Approach to Scoliosis (SEAS), entire simple (N), International Physical Activity Questionnaire (IPAQ).

The methodological quality assessment of the included studies

According to the PEDro scale, seven included studies (n=7) were of high quality, three studies (n=3) were of moderate quality, and no low-quality studies were included in this systematic review (Table 2).

Table 2 Physiotherapy Evidence Database (PEDro) score of the included studies

References	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Monticone et al. (2014)	+	+	+	+	-	-	-	-	-	+	+	6
Kumar et al. (2017)	+	+	-	-	-	-	-	+	-	+	+	5
Zapata et al. (2015)	+	+	-	-	-	-	-	-	+	+	+	5
Schreiber et al. (2016)	+	+	-	+	-	+	-	-	-	+	+	6
Diab et al. (2012)	+	+	-	+	+	-	-	+	-	+	+	7
Zheng et al. (2018)	+	+	+	+	-	-	-	-	-	+	+	6
Gao et al. (2019)	+	+	+	-	-	-	-	+	-	+	+	6
de Assis et al. (2021)	+	+	+	+	-	+	-	-	-	+	+	7
Scaturro et al. (2021)	+	+	-	+	-	-	-	+	-	+	+	6
Kocaman et al. (2021)	+	+	-	-	-	-	-	+	-	-	+	4

Legend: + indicates one point, - indicates no point. (1) Eligibility criteria, (2) Radomization, (3) Concealment of allocation, (4) Between-group homogeneity, (5) Blinded of subjects, (6) Blinded trainers, (7) Blinded testers, (8) Dropout rate < 15%, (9) Intention-to-treat, (10) Statistical between-group comparisons, (11) Point and variability estimates, (12) total scores.

DISCUSSION

The primary purpose of the study was to determine the effects of various corrective and preventive programs on scoliosis, one of the most common postural disorders in children and young people. The results obtained clearly indicate significant differences between the experimental and control groups, with the interventions implemented in the experimental groups leading to significant improvements (de Assis et al. 2021; Scaturro et al., 2021; Kocaman et al., 2021) in multiple dimensions, including reduction of radiological deformities (Cobb angle >5°) and improvements in physiological functions. The reduction in Cobb angle in the experimental groups, while the condition in the control groups remained stable, suggests that targeted interventions are crucial for modifying structural spinal deformities. This study is in line with previous research highlighting that conservative therapies, such as specific corrective exercises, can reduce the progression of scoliosis (Monticone et al., 2014).

Post-intervention data further indicate the benefits of interventions in the experimental groups, which showed significant improvements in pulmonary functions, including FVC ($p=0.001$), FEV1 ($p=0.01$) and VC ($p=0.002$). These results suggest that the increase in lung capacity is likely associated with the correction of thoracic spine deformities, which allows for a larger lung volume and improved ventilation. On the other hand, the control group did not show such changes, which emphasizes the importance of an active therapeutic approach, rather than relying on passive methods or lack of intervention. Analysis of long-term effects shows that significant improvements were maintained after six months. The Schroth group, which focuses on a three-dimensional corrective approach, showed a significant reduction in the maximum angle of curvature (-3.5°, $p=0.006$) and the Sum of Curves (-0.40°, $p=0.046$) compared to the control group. These results are even more pronounced when considering the per-protocol analysis, which showed an additional reduction in the maximum angle of curvature (-4.1°, $p=0.002$). These findings indicate the key role of precisely structured and supervised exercises in the treatment of adolescent idiopathic scoliosis, especially in patients with more severe deformities. Interestingly, the supervised group showed a significant reduction in pain and functional improvements ($p < 0.001$), while there were no differences in back muscle endurance between the groups. This study opens up a discussion about how interventions primarily affect subjective factors (such as pain), while objective factors, such as muscle endurance, require a longer period to achieve visible changes.

These results are consistent with research by Čuk et al. (2020), who state that pain reduction can be an early indicator of the effectiveness of interventions, while changes in muscle strength are a longer-term process. A particularly significant aspect of this study is the comparative analysis of different approaches. The group using orthoses showed better results in Cobb angle correction ($p=0.039$) and shoulder balance ($p<0.005$), while the exercise group showed greater improvement in quality of life, including mental health and functional status ($p<0.001$). These results highlight the different goals and effects of interventions – while orthoses may provide faster correction of deformities, exercise brings broader benefits to the overall health and quality of life of patients. The combination of orthosis and exercise produced significantly positive results and led to significant improvements in Cobb angle correction, back muscle endurance, and lung function. On the other hand, the isolated use of orthosis was associated with a decline in muscle endurance and lung function, indicating the potential negative effects of lack of physical activity.

These findings are in line with the literature that emphasizes the need for a holistic approach to the treatment of AIS (Negrini et al., 2018). When we analyze the broader aspects of these results, it is clear that targeted therapeutic exercises, such as the Schroth method, have significant potential for long-term reduction of deformity and improvement of functional capacity. These programs not only affect physiological parameters, but also psychological aspects, improving the quality of life of patients. Given that AIS often affects adolescents, timely and effective intervention can have lasting effects on their physical and mental health, reducing the risk of further complications in adulthood.

However, the results obtained should be interpreted with certain limitations. This systematic review analyzed only ten studies. Another limitation of the study is that the authors made general conclusions without examining whether scoliosis is more common in children or adolescents, or in boys or girls. Therefore, a recommendation for future researchers would be to examine whether there are differences in the incidence of scoliosis in boys and girls, or whether scoliosis is more common in children or

adolescents. It would also be interesting to conduct a meta-analysis in order to fully interpret the results obtained. It would also be interesting to further investigate individual factors that may influence the success of interventions, as well as to develop standardized protocols that will enable wider application of these methods in clinical practice.

CONCLUSION

The results of this study clearly indicate the importance of well-structured and targeted interventions in the treatment of adolescent idiopathic scoliosis. Experimental groups that applied specific therapeutic exercises, including the Schroth method, showed significant improvements in Cobb angle reduction, functional lung capacity, as well as subjective factors such as pain reduction and improved quality of life. In contrast, control groups did not record similar positive changes, which further confirms the effectiveness of the active therapeutic approach. Comparison between different treatment methods showed that orthoses were effective in correcting spinal deformities and balancing the shoulders, while exercises provided broader benefits, including significant improvements in functional status, mental health and quality of life. The combination of orthoses and exercise stood out as the most effective approach, ensuring comprehensive improvements in both structural deformities and functional abilities and general health of patients. Long-term analysis confirms the sustainability of these results, with the improvements achieved with the Schroth method and combined therapies remaining significant even after six months. At the same time, the negative effects of isolated orthosis use on functional parameters, such as muscle endurance and pulmonary function, emphasize the need for a multidisciplinary approach that also includes physical activity.

In conclusion, the results of this study confirm the importance of integrated therapeutic approaches in the treatment of adolescent idiopathic scoliosis. While isolated methods, such as orthosis, provide certain advantages in deformity correction, combined therapies provide much broader benefits, including functional and psychological improvements.

REFERENCES

1. Abdelaal, A., Munigangaiah, S., Trivedi, J., & Davidson, N. (2020). Magnetically controlled growing rods in the treatment of early onset scoliosis: a single centre experience of 44 patients with mean follow-up of 4.1 years. *Bone & Joint Open, 1*(7), 405–414.
2. Adam, C., & Dougherty, G. (2011). Applications of medical image processing in the diagnosis and treatment of spinal deformity. In Medical Image Processing: Techniques and Applications (pp. 227-248). New York, NY: Springer New York.
3. Aebi, M. (2005). The adult scoliosis. *European Spine Journal, 14,* 925-948.
4. Ailon, T., Smith, J. S., Shaffrey, C. I., Lenke, L. G., Brodke, D., Harrop, J. S., ... & Ames, C. P. (2015). Degenerative spinal deformity. *Neurosurgery, 77*, S75-S91.
5. Altaf, F., Gibson, A., Dannawi, Z., & Noordeen, H. (2013). Adolescent idiopathic scoliosis*. Bmj,* 346.
6. Berdishevsky, H., Lebel, V. A., Bettany-Saltikov, J., Rigo, M., Lebel, A., Hennes, A., ... & Durmala, J. (2016). Physiotherapy scoliosis-specific exercises–a comprehensive review of seven major schools. *Scoliosis and Spinal Disorders, 11,* 1-52.
7. Bogdanovic, Z. (2005), The impact of a programmed corrective gymnastics on postural status of primary school students. *PhD Thesis*, Nis. In Serbian
8. Bogdanovic, Z. (2008). [Spinal deformities in the sagital plane - prevention and correction]. *Monografija,* State University of Novi Pazar, Novi Pazar. In Serbian
9. Boos, N. (2008). *Spinal disorders: fundamentals of diagnosis and treatment* (Vol. 1165). M. Aebi (Ed.). Berlin: Springer.
10. Bunnell W. P. (1986). Spinal deformity. *Pediatric Clinics of North America, 33*(6), 1475–1487.
11. de Assis, S. J. C., Sanchis, G. J. B., de Souza, C. G., & Roncalli, A. G. (2021). Influence of physical activity and postural habits in schoolchildren with scoliosis. *Archives of Public Health*, *79*(1), 63.
12. Diab A. A. (2012). The role of forward head correction in management of adolescent idiopathic scoliotic patients: a randomized controlled trial. *Clinical Rehabilitation, 26*(12), 1123–1132.
13. Diebo, B. G., Shah, N. V., Boachie-Adjei, O., Zhu, F., Rothenfluh, D. A., Paulino, C. B., ... & Lafage, V. (2019). Adult spinal deformity. *The Lancet, 394*(10193), 160-172.

14. Forssberg, H., & Nashner, L. M. (1982). Ontogenetic development of postural control in man: adaptation to altered support and visual conditions during stance. *Journal of Neuroscience*, *2*(5), 545-552.
15. Fusco, C., Zaina, F., Atanasio, S., Romano, M., Negrini, A., & Negrini, S. (2011). Physical exercises in the treatment of adolescent idiopathic scoliosis: an updated systematic review. *Physiotherapy Theory and Practice, 27*(1), 80-114.
16. Gámiz-Bermúdez, F., Obrero-Gaitán, E., Zagalaz-Anula, N., & Lomas-Vega, R. (2022). Corrective exercise-based therapy for adolescent idiopathic scoliosis: Systematic review and meta-analysis. *Clinical Rehabilitation, 36*(5), 597-608.
17. Gao, C., Zheng, Y., Fan, C., Yang, Y., He, C., & Wong, M. (2019). Could the Clinical Effectiveness Be Improved Under the Integration of Orthotic Intervention and Scoliosis-Specific Exercise in Managing Adolescent Idiopathic Scoliosis?: A Randomized Controlled Trial Study. *American Journal of Physical Medicine & Rehabilitation, 98*(8), 642–648.
18. Goldberg, C. J., Moore, D. P., Fogarty, E. E., & Dowling, F. E. (2008). Scoliosis: a review. *Pediatric Surgery International, 24,* 129-144.
19. Ha, Y., Oh, J. K., Smith, J. S., Ailon, T., Fehlings, M. G., Shaffrey, C. I., & Ames, C. P. (2015). Impact of Movement Disorders on Management of Spinal Deformity in the Elderly. *Neurosurgery, 77* Suppl 4, S173–S185.
20. Hajder, D. (2023). Nutrition And Lifestyle Habits. *International Journal of Academic and Applied Research, 7*(2), 95-101.
21. Janicki, J. A., & Alman, B. (2007). Scoliosis: Review of diagnosis and treatment. *Pediatrics & Child Health, 12*(9), 771-776.
22. Kocaman, H., Bek, N., Kaya, M. H., Büyükturan, B., Yetiş, M., & Büyükturan, Ö. (2021). The effectiveness of two different exercise approaches in adolescent idiopathic scoliosis: A single-blind, randomized-controlled trial. *PloS One, 16*(4), e0249492.
23. Kumar, A., Kumar, S., Sharma, V., Srivastava, R. N., Gupta, A. K., Parihar, A., Verma, V., & Kumar, D. (2017). Efficacy of Task Oriented Exercise Program Based on Ergonomics on Cobb's Angle and Pulmonary Function Improvement in Adolescent Idiopathic Scoliosis- A Randomized Control Trial. *Journal of Clinical and Diagnostic Research 11*(8), YC01–YC04.
24. Monticone, M., Ambrosini, E., Cazzaniga, D., Rocca, B., & Ferrante, S. (2014). Active self-correction and task-oriented exercises reduce spinal deformity and improve quality of life in subjects with mild adolescent idiopathic scoliosis. Results of a randomised controlled trial. *European Spine Journal*, *23*, 1204-1214.
25. Scaturro, D., Costantino, C., Terrana, P., Vitagliani, F., Falco, V., Cuntrera, D., ... & Letizia Mauro, G. (2021). Risk factors, lifestyle and prevention among adolescents with idiopathic juvenile scoliosis: a cross sectional study in eleven first-grade secondary schools of Palermo province, Italy. *International Journal of Environmental Research and Public Health, 18*(23), 12335.
26. Schlenk, R. P., Kowalski, R. J., & Benzel, E. C. (2003). Biomechanics of spinal deformity. *Neurosurgical Focus, 14*(1), 1-15.
27. Schreiber, S., Parent, E. C., Khodayari Moez, E., Hedden, D. M., Hill, D. L., Moreau, M., Lou, E., Watkins, E. M., & Southon, S. C. (2016). Schroth Physiotherapeutic Scoliosis-Specific Exercises Added to the Standard of Care Lead to Better Cobb Angle Outcomes in Adolescents with Idiopathic Scoliosis - an Assessor and Statistician Blinded Randomized Controlled Trial. *PloS One, 11*(12), e0168746.
28. Shumway-Cook, A., & Woollacott, M. H. (1985). The growth of stability: postural control from a developmental perspective. *Journal of Motor Behavior*, *17*(2), 131-147.
29. Shumway-Cook, A. (2001). Motor control. *Theory and practical applications*.
30. Wiggins, G. C., Shaffrey, C. I., Abel, M. F., & Menezes, A. H. (2003). Pediatric spinal deformities. *Neurosurgical Focus, 14*(1), e3.
31. Wojtys EM, (1987), Section of Orthopaedic Surgery, University of Michigan, Ann Arbor. *The Orthopedic Clinics of North America,18*(4),689-708.
32. Woollacott, M., Inglin, B., & Manchester, D. (1988). Response preparation and posture control. Neuromuscular changes in the older adult. *Annals of the New York Academy of Sciences*, *515*, 42-53.
33. Youssef, J. A., Orndorff, D. O., Patty, C. A., Scott, M. A., Price, H. L., Hamlin, L. F., ... & Deviren, V. (2013). Current status of adult spinal deformity. *Global Spine Journal, 3*(1), 051-062.
34. Zapata, K. A., Wang-Price, S. S., Sucato, D. J., Thompson, M., Trudelle-Jackson, E., & Lovelace-Chandler, V. (2015). Spinal stabilization exercise effectiveness for low back pain in adolescent idiopathic scoliosis: a randomized trial. *Pediatric Physical Therapy*, *27*(4), 396-402.
35. Zhao, H., Teng, J., Song, G., Fu, X., Pan, X., Shen, S., ... & Liu, C. (2023). The optimal exercise parameters of Tai Chi on the effect of glucose and lipid metabolism in patients with type 2 diabetes mellitus: A meta-analysis. *Complementary Therapies in Medicine,* 102995.

36. Zheng, Y., Dang, Y., Yang, Y., Li, H., Zhang, L., Lou, E. H. M., He, C., & Wong, M. (2018). Whether Orthotic Management and Exercise are Equally Effective to the Patients With Adolescent Idiopathic Scoliosis in Mainland China?: A Randomized Controlled Trial Study. *Spine, 43*(9), E494–E503.

UTICAJ PREVENTIVNIH PROGRAMA VJEŽBANJA NA SKOLIOZU

Veselinović Zorana, Hajder Đorđe, Bjelica Bojan, Pržulj Radomir, Aksović Nikola, Dobrescu Tatiana, Bubanj Saša

Sažetak: *Cilj istraživanja bio je da se utvrdi efekat različitih korektivnih i preventivnih programa na skoliozu, kao jedan od najčešćih posturalnih poremećaja kod djece i mladih. U pregledu literature korištene su elektronske baze podataka kao što su PubMed, Web of Science, Scopus, MEDLINE, ERIC i Google Scholar. Na osnovu unaprijed definisanih kriterijuma, analizirano je sedam studija koje su zadovoljile standarde kvaliteta. Rezultati istraživanja ukazuju na to da preventivni programi koji uključuju specijalizovane vježbe, korektivnu gimnastiku i individualno prilagođene intervencije značajno doprinose smanjenju ugla iskrivljenja kičme i poboljšanju posturalnog stanja. Takođe, pokazano je da redovna primjena ovakvih programa pozitivno utiče na funkcionalne sposobnosti i psihofizičko zdravlje učesnika. Naredna istraživanja trebala bi staviti fokus na dugoročne efekte preventivnih programa, uključujući njihovu primjenu u različitim uzrasnim grupama i stepenima skolioze. Takođe, preporučuje se ispitivanje efikasnosti programa koji kombinuju korektivne vježbe sa modernim tehnološkim rješenjima, kao što su senzori za praćenje držanja i virtuelna stvarnost. Pored toga, važno je proširiti uzorke na populacije iz različitih okruženja kako bi se rezultati mogli generalizovati i primjeniti u širem kontekstu.*
Ključne riječi: *Korektivna gimnastika, vježbe, rehabilitacija, posturalni poremećaji.*

ВАЛИДНОСТ ДВА ТИПА ОМРОН ВАГА ЗА ПРОЦЕНУ ТЕЛЕСНЕ КОМПОЗИЦИЈЕ КОД КАРАТИСТА

Арсенијевић Раденко[1], Утвић Никола[1], Марковић Милан[1], Лилић Љубиша[1], Станковић Верољуб[1,2]

[1]Факултет за спорт и физичко васпитање, Универзитета у Приштини-Косовска Митровица, Србија
[2]Факултет физичког васпитања и спорта, Универзитета у Источном Сарајеву, Пале, БиХ

ORIGINAL SCIENTIFIC ARTICLE
DOI: 10.5937/ATAVPA25148A

Сажетак: *Циљ овог истраживања био је да се испита валидност два типа OMRON вага за мерење телесне композиције (BF 511 и VIVA) упоређивајући их са InBody 270 вагом, код каратиста. Мерење је обављено током летњег националног кампа ФУДО-КАН карате федерације, а узорак испитаника обухватао 20 мушкараца и 25 жена (ВН = 158 ± 0.14 цм; ВМ = 51 ± 17.65 кг), и коришћене су следеће варијабле телесне композиције: телесна маса (ВМ), проценат телесних масти (%BF) и проценат скелетне мишићне масе (%SMM), које су процењиване помоћу све три горе-поменуте ваге за процену телесне композиције. Пружени су дескриптивни подаци (Mean, SD, Min, Max, cV%) за све варијабле и у случају процењивања све три ваге, док је за утврђивање валидности коришћена Пирсонов коефицијент корелације (r) и коефицијент детерминације (r^2), обе OMRON ваге са „златним стандардом" у процењивању телесне композиције вагом InBody 270. Применом статистичких тестова r и r^2, утврђена је екстремно велика повезаност ВМ InBody са ВМ OMRON (BF 511 – r = 1.000, r^2 = 1.000; VIVA – r = 0.999, r^2 = 0.998), екстремно велика веза %BF InBody са %BF BF 511 (r = 0.927, r^2 = 0.859) и велика повезаност %BF InBody са %BF VIVA (r = 0.63, r^2 = 0.40), и на крају, велика повезаност %SMM InBody са %SMM BF 511 (r =0.652, r^2 = 0.425) и умерена негативна повезаност %SMM InBody са %SMM VIVA (r = -0.073, r^2 = 0.005). Иако на сајтовима где се продају OMRON ваге за процењивање телесне композиције тврди се да су валидне и прецизне приликом процене телесне композиције, добијени резултати јасно указују да постоје одређена одступања, поготово када говоримо о процени скелетних мишића, у случају упоређивања са InBody 270 вагом за процену телесне композиције.*

Кључне речи: *телесна маса, проценат телесних масти, проценат телесних мишића, OMRON BF 511, OMRON VIVA*

УВОД

Праћење телесног састава неопходно је у спортској науци, посебно када су у питању спортисти, јер кључни параметри попут процента телесне масти и процента масе скелетних мишића играју кључну улогу у оптимизацији извођачких перформанси и процени целокупнуих ефеката тренинга (Santos et al., 2020). Прецизно мерење ових параметара омогућава спортистима и тренерима да ефикасно прилагоде стратегије тренинга и исхране. Процена телесног састава игра значајну улогу у разумевању физиолошких адаптација током спортског тренинга (Nunes et al., 2019). Како телесни састав спортиста утиче на њихове извођачке перформансе, поседовање поузданих и приступачних алата за процену је од највеће важности (Santos et al., 2020).

За процену телесног састава користе се разне методе, укључујући мултифреквентни апарат за анализу састава тела „InBody 270" и „OMRON BF 511" и „VIVA". Иако је „InBody 270" валидиран због своје прецизности у мерењу масти и мишићне масе, његова висока цена и ограничена доступност чине га мање приемењивљијим за широку употребу (Larsen et al., 2021). Насупрот томе, „OMRON" уређаји нуде приступачнију и јефтинију алтернативу за процену састава тела, што их чини популарним алатима за спортисте и фитнес професионалце. Ови уређаји се широко рекламирају као поуздани и једноставни за коришћење, али њихова тачност/валидност у поређењу са другим уређајима захтева даљу проверу валидности у спортском контексту (Ling et al., 2011). Недавне студије су изазвале забринутост због тачности BIA уређаја, посебно код спортских популација где су прецизна мерења кључна за оптимизацију извођачких перформанси (Ciccone et al., 2020).

Уређаји за процену телесне композиције (ПТК), који користе електричну импедансу за мерење састава тела, често се рекламирају као поуздани. Функционишу тако што шаљу струју

ниског интензитета кроз тело, а отпор на који наилази ова струја користи се за предвиђање количине телесне масти и других телесних структура. Оне користе сопствене алгоритме за мерење укупне телесне масти и без-масне масе (мишића, костију и других ткива), нудећи једноставност и практичност за спортисте и здравствене раднике (Aanstad et al., 2014). Иако је то безбедна, неинвазивна, исплатива и лако преносива техника, на ову методу утиче ниво хидратације тела, због електричне проводљивости биолошких ткива (McLester, 2020). Штавише, предиктивне једначине зависне од популације могу увести систематску пристрасност, посебно када је прецизна процена састава тела неопходна (Kabiri et al., 2015).

Упркос њиховој широкој употреби, изражена је забринутост у вези са тачношћу ових уређаја у поређењу са другим уређајима за ПТК (Larsen et al., 2021). Спроведено је неколико студија ради процене валидности уређаја за процену телесне композиције, које су дале помешане резултате. На пример, студије су показале високу корелацију између уређаја за ПТК са различитим алатима за специфичне параметре као што су телесна маст и мишићна маса (Silva et al., 2018). Међутим, други налази указују на потенцијална одступања у мерењу телесне масти и потцењивање телесне масти при коришћењу уређаја з ПТК, посебно у специфичним популацијама (Stojanović et al., 2017). Ове варијације потцртавају хитну потребу за даљим истраживањима како би се валидирали уређаји за ПТК у спортској популацији, где су прецизна мерења састава тела кључна за оптимизацију извођачких перформанси. Овај нагласак на потреби за даљим истраживањем требало би да натера јавност да осети хитност и важност теме (Feng, 2024).

Без обзира на широку употребу уређаја за ПТК, на њихову тачност могу утицати фактори као што су статус хидратације, распоред оброка и физичка активност. На пример, истраживање на старијим особама показало је да вишефреквентна опрема за ПТК пружа повољне процене састава тела. Међутим, препоручено је развијање корекционих једначина како би се смањиле грешке у проценама процента телесне масти и без-масне масе (Silva et al., 2019). Студија Лиме и сар. (2020) такође је нагласила да ови уређаји могу дати мање тачне резултате код популација са широким спектром типова тела, укључујући спортисте, где се могу јавити одступања у мерењима масе масти и мишићне масе. Ови налази сугеришу да, иако су уређаји за ПТК практични за процену састава тела, треба узети у обзир њихова ограничења, посебно код спортских популација где су прецизна мерења кључна (Santos et al., 2020).

Циљ ове студије је да се процени валидност два типа OMRON анализатора за ПТК (BF 511 и VIVA) у поређењу са InBody 270 код каратиста. Претпоставља се да ће постојати значајне корелације између коришћених мерних уређаја, односно између њихових варијабли. Ова студија има за циљ да пружи увид у применљивост OMRON анализатора за ПТК у спортским условима и истражи потенцијална одступања приликом процене параметара састава тела као што су проценат телесне масти и масе скелетних мишића. Резултати ове студије, који ће бити кључни за област спортске науке, имају потенцијал да значајно утичу на употребу уређаја за ПТК у спортским условима и обезбеде поузданост података који се користе за тренинг и интервенције у исхрани (Lima et al., 2020).

МЕТОДЕ

Испитаници

Ова студија је користила јединствени трансверзални дизајн истраживања, што је реткост у студијама анализе телесног састава. Узорак, који се састојао од 45 учесника (старост = 15 ± 5.18 година; телесна висина = 158 ± 0.14 цм; телесна тежина = 51 ± 17.65 кг), пажљиво је избалансиран са 20 мушкараца и 25 жена. Сви учесници су били активно укључени у карате спорт, са искуством у тренингу и такмичењу од најмање 5 година, и сви су били здрави (без болести или повреда) и одморни приликом тестирања. Учесници су регрутовани добровољно и добили су свеобухватне информације о сврси студије, процедурама и потенцијалним ризицима. Писани информисани пристанак, камен темељац етичког истраживања, добијен је од сваког појединца, чиме се осигурава да се студија придржава највиших етичких стандарда. Студија се спроводи у складу са Хелсиншком декларацијом и етичким смерницама Факултета за спорт и физичко васпитање.

Процедуре

Валидност два „OMRON“ уређаја за ПТК (OMRON Healthcare Inc., Осака, Јапан) и њихови резултати упоређени су са онима добијеним коришћењем InBody 270 (In Body Co. Ltd., Сеул, Јужна Кореја), који је служио као референтна метода или „златни стандард“. Сваки учесник је подвргнут процени са сва три уређаја (насумично додељена) под пажљиво стандардизованим условима, осигуравајући доследност и упоредивост података.

Сва мерења су спроведена ујутру током летњег карате кампа који је организовала Фудо-Кан карате асоцијација. Антропометријска мерења су обухватала телесну висину (цм), која је добијена помоћу стандардизованог стадиометра. Мерења су обављена ујутру на празном стомаку како би се минимизирао потенцијални утицај недавног уноса хране и статуса хидратације на исходе. Учесницима је наложено да се уздрже од конзумирања алкохола или кофеина и бављења било каквом интензивном физичком активношћу најмање 24 сата пре процене како би се осигурала оптимална стандардизација и тачност прикупљених података. Сва мерења су обављена у складу са препорукама произвођача и претходним студијама (Стојановић и др., 2017; Тоскић и др., 2024). Мерења је обавили искусни истраживачи.

Статистичка анализа

Дескриптивна статистика је израчуната за све измерене варијабле, укључујући просечну вредност (Mean), стандардну девијацију (SD), минималне (Min) и максималне вредности (Max) и коефицијент варијације (cV%). Ниво валидности OMRON уређаја је одређен коришћењем Пирсоновог коефицијента корелације (r) на основу поређења са резултатима InBo-dy 270. Коефицијент детерминације (r^2) и његова једначина су такође приказани на „тачкастим дијаграмима“ како би се изразио удео заједничке варијансе између уређаја. Јачина коефицијената корелације је интерпретирана према класификацији коју су предложили Hopkins и сар. (2015): тривијална (< 0,1), мала (0,1), умерена (0,3), висока (0,5) и веома висока (0,9). Статистичка анализа је извршена у SPSS 20 (IBM, Њујорк, САД), док су графици креиране у програмском језику Python (Делавер, САД).

РЕЗУЛТАТИ

Параметри дескриптивне статистике (Mean, SD, Min, Max и cV%) за све варијабле (BM, BF и SMM), мерене су помоћу три различита уређаја за ПТК (InBody 270; Omron BF 511 и Omron Viva) и приказани су у Табели 1.

Табела 1 Резултати дескриптивне статистике три уређаја за ПТК (InBody 270, Omron BF 511, Omron VIVA) варијабли BM, BF и SMM

	Variables	Mean	SD	Min	Max	cV%
InBody 270	BM (kg)	51	17.65	26	99	34.51
	BF (%)	21	8.25	9	42	39.17
	SMM (%)	42	4.77	32	52	11.22
Omron BF 511	BM (kg)	52	17.57	27	98	33.91
	BF (%)	20	7.84	7	40	39.27
	SMM (%)	35	4.55	19	44	12.93
Omron VIVA	BM (kg)	52	17.53	26	99	33.90
	BF (%)	24	7.91	6	41	33.16
	SMM (%)	34	2.87	32	38	8.33

ПТК - процена телесне композиције; Mean - просечна вредност; SD - стандардан девијација; Min - минимална вредност; Max - максимална вредност; cV% - коефицијент варијације; BM - телесна маса; BF - маса телесних масти; SMM - маса скелетних мишића

Табела 2 и графици 1, 2 и 3 приказују резултате Пирсоновог коефицијента корелације, односно корелацију између параметара BM, BF и SMM три мерна уређаја за процену телесног састава.

Табела 2 Корелациона матрица анализираних варијабли приступљених преко различитих уређаја за процену телесне композиције

		BM Omron BF511 (kg)	BM Omron Viva (kg)	BF Omron BF511 (%)	BF Omron Viva (%)	SMM Omron BF511 (%)	SMM Omron Viva (%)
BM InBody 270 (kg)	*r*	1.000**	.999**				
	p	0.000**	0.000**				
	N	45	44				
BF InBody 270 (%)	*r*			.927**	.652**		
	p			0.000**	0.000**		
	N			44	30		
SMM InBody 270 (%)	*r*					.690**	-0.073
	p					0.000**	0.907
	N					45	5

BM InBody 270 - телесна маса мерена преко Inbody 270; BM BF511 - телесна маса мерена преко Omron BF511; BM Omron Viva - втелесна маса мерена преко Omron Viva; BF InBody 270 - маса телесних масти мерена преко Inbody 270 BCA; BF BF511 - маса телесних масти мерена преко Omron BF511 BCA; BF Omron Viva - маса телесних масти мерена преко Omron Viva; SMM InBody 270 - скелетна мишићна маса мерена преко Inbody 270 BCA; SMM BF511 - скелетна мишићна маса мерена преко Omron BF511 BCA; SMM Omron Viva - скелетна мишићна маса мерена преко Omron Viva; r - корелациони коефицијент; p - статистичка значајност; N - број података

Темељност наших метода мерења је очигледна у резултатима r, r2 и регресионе једначине мерења BM помоћу InBody 270 и Omron BF 511 и између InBody 270 и Omron Viva, приказаном на графику 1.

График 1 Повезаност телесне масе (BM) добијене преко InBody 270 са: BM добијених преко OMRON BF 511 (A), OMRON VIVA (B)

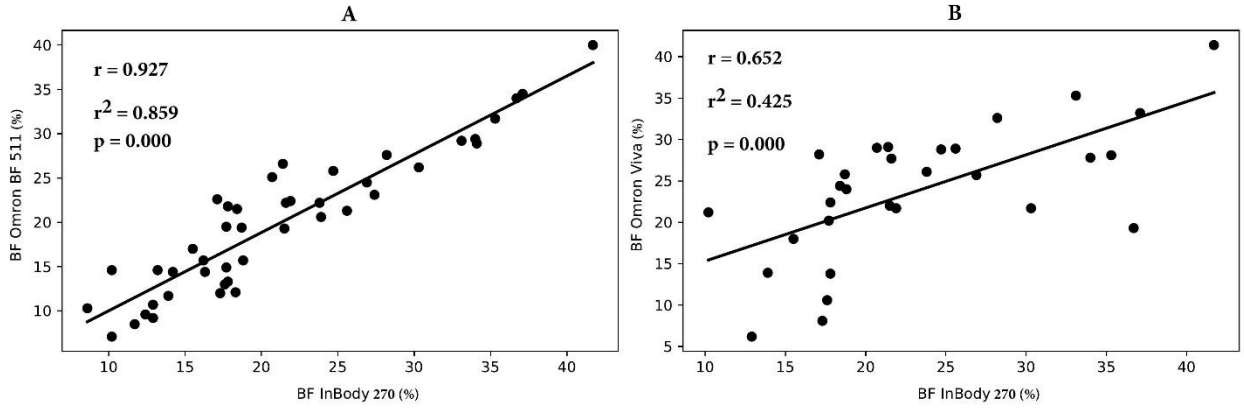
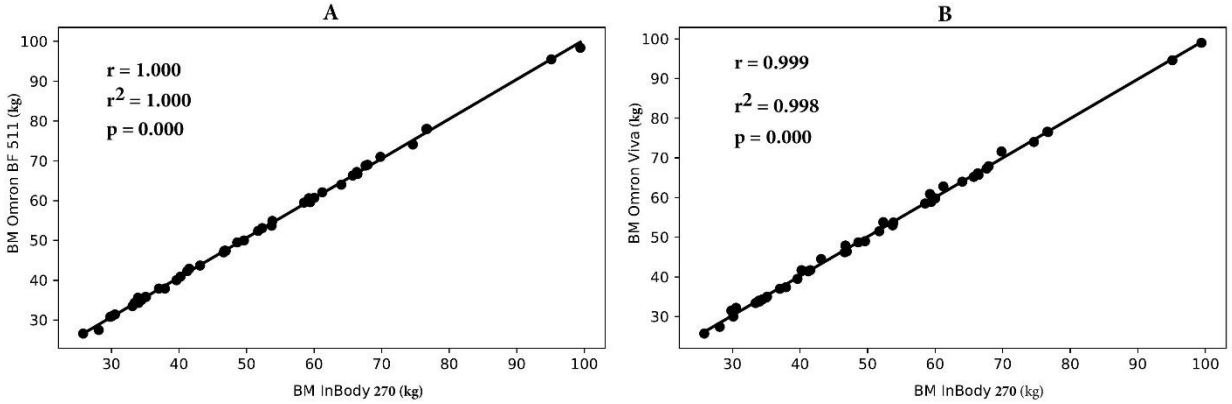


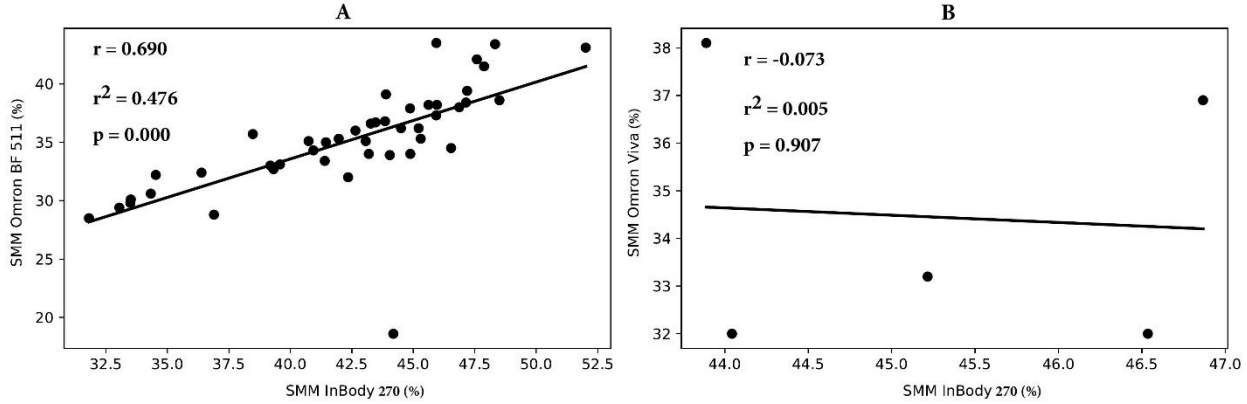
График 2 приказује резултате (r, r2 и једначину регресије) параметри који се користи за процену телесне масти (BF), која је мерена помоћу InBody 270, Omron BF 511 и Omron Viva. Вреди напоменути да је забележена висока веза између BF процењеног помоћу InBody 270 и Omron Viva, налаз који побуђује наше интересовање и позива на даља истраживања.

График 2 Повезаност масе телесних масти (BF) добијене преко InBody 270 са: BF добијених преко OMRON BF 511 (A), OMRON VIVA (B)



На крају, график 3 приказује r, r2 и једначину регресије SMM варијабле мерене помоћу InBody 270, Omron BF 511 и Omron Viva. Веза између InBody 270 и Omron BF 511 SMM вариајбле била је висока, што је значајан налаз. Подједнако интригантно је да је забележена незначајна инверзна корелација између InBody 270 и Omron Viva за исту променљиву.

График 3 Повезаност масе скелетних мишића (SMM) добијене преко InBody 270 са: SMM добијених преко OMRON BF 511 (A), OMRON VIVA (B)



ДИСКУСИЈА

Ово истраживање је имало за циљ да процени валидност два типа OMRON BIA (BF 511 и VIVA) у поређењу са InBody 270 код каратиста. Генерално говорећи, очекивало се да ће ови налази пружити увид у применљивост OMRON анализатора за ПТК у спортским условима и открити потенцијалне неправилности у мерењу параметара састава тела као што су проценат телесне масти и масе скелетних мишића. Колико нам је познато, ово је прва студија која је истраживала валидност два различита OMNON BIA, у поређењу са InBody 270.

Резултати су показали високу корелацију између скоро свих примењених параметара три различита анализатора састава тела. Међутим, постоје мала одступања OMRON анализатора састава тела када су упоређени са широко коришћеним „златним стандардом“ InBody 270. Прво, варијабла BM (тј. телесна маса) је процењена помоћу два OMRON уређаја за ПТК и упоређена са резултатима InBody 270. Резултати су показали да су оба OMRON уређаја била скоро савршено у корелацији са InBody 270 (BF511: r = 1.000, r^2 = 1.000; Viva: r = 0.999, r^2 = 0.998). У случају варијабле BF (тј. телесне масти), повезаност је била мало другачија. OMRON BF511 и InBody 270 су постигли изузетно високе вредности коефицијента корелације (r = 0.927, r^2 = 0.859), док су OMRON Viva и InBody 270 постигли високу корелацију (r = 0.652, r^2 = 0.425). Коначно, када је у питању SMM (тј. маса скелетних мишића), удео исте варијансе између OMRON BF511 и InBody 270 био је 46% са

високом корелацијом (r = 0.690, r^2 = 0.476), а OMRON Viva и InBody 270 били су обрнуто и умерено повезани (r = -0.073, r^2 = 0.005). Ови резултати недвосмислено указују на то да OMRON BIA нису усклађени са InBody 270 када је у питању процена BF (масе телесних масти), а посебно SMM (масе скелетних мишића). Мора се истаћи да постоје очигледне разлике у прецизности између два OMRON анализатора састава тела, јер је OMRON BF511 био прецизнији од OMRON Viva у случају параметара BF и SMM.

Недавне студије потврђују важност телесног састава за каратисте, јер морфологија игра кључну улогу у њиховим извођачким перформансама. Ови спортисти имају тенденцију да показују нижи проценат телесне масти и већу без-масну масу у поређењу са спортистима из других спортова, што је у складу са потребом за високим нивоом брзине и снаге. На пример, студија Genton и сар. (2017) открила је да каратисти генерално поседују оптималну равнотежу мишићне масе и телесне масти, што им омогућава да изводе покрете високог интензитета потребне за такмичење. Слично томе, Gaba и сар. (2015) су истакли да су разлике у телесном саставу између спортиста у борилачким спортовима и оних у неборбеним дисциплинама често повезане са потребом за брзим, експлозивним акцијама у борилачким спортовима.

Мерење телесног састава је од виталног значаја за разумевање физиолошког стања спортиста, укључујући и каратисте. Методе попут уређаја за ПТК често се користе због своје способности да пруже брзе и поуздане процене масе масти и мишићне масе. Истраживања су показала да је уређаји за ПТК су практичан алат за праћење телесног састава у борбеним спортовима, јер тачно одражава промене у дистрибуцији масти и мишића, што је кључно за оптимизацију перформанси (Thurlow et al., 2017). На пример, Leahy et al. (2012) показали су да су уређаји за ПТК великој корелацији са прецизнијим методама као што је двоенергетска рендгенска апсорпциометрија (DEXA), која се сматра златним стандардом за процену телесног састава.

Употреба уређаја за ПТК код каратиста показала се корисном за праћење мишићне масе и процента масти, пружајући значајне увиде у њихову спремност за такмичење. Штавише, уређаји за ПТК могу да процене дистрибуцију воде у телу, што је важан аспект статуса хидратације спортисте. У борилачким спортовима, где равнотежа течности директно утиче на извошачке перформансе, праћење хидратације и састава тела кључни су за обезбеђивање оптималних резултата током тренинга и такмичења (Waki et al., 1991). Студије попут оних које су спровели Stewart и сар. (1993) указују да уређаји за ПТК нису само ефикасан у мерењу масе масти већ и у праћењу промена у мишићној маси и нивоу хидратације током интензивних циклуса тренинга, што га чини корисним алатом за спортске нутриционисте и тренере.

Недавна истраживања спроведена 2021. године нагласила су вредност уређаја за ПТК у праћењу промена телесног састава током периода тренинга. Показала су да је уређаји за ПТК поуздани и ефикасни методи за процену мишићне масе и процента масти код каратиста, подржавајући идеју да је одржавање оптималне равнотеже ових компоненти неопходно за постизање врхунских извођачких перформанси (Stewart et al., 1993). Међутим, студија је такође признала потенцијалне изворе грешака при коришћењу уређаја за ПТК, посебно код спортиста са великим обимом тренинга или ниским нивоом телесне масти, што сугерише потребу за пажљивим тумачењем резултата.

Главно ограничење истраживања је недоступност поузданости, јер нисмо спровели испитивање поузданости у току дана и између дана. Такође, ову врсту студије требало би поновити на различитим испитаницима у вези са узрастом и тренажним искуством, што би могло допринети генерализацији садашњих резултата.

ЗАКЉУЧАК

Резултати су показали високу корелацију између скоро свих примењених параметара три различита анализатора састава тела. Међутим, постоје мала одступања OMRON анализатора састава тела када су упоређени са широко коришћеним „златним стандардом“ InBody 270. Потребна су даља истраживања, са различитим узорцима учесника, како би се генерализовали резултати примећени у овој студији.

ЛИТЕРАТУРА

1. Aandstad, A., Holtberget, K., Hageberg, R., Holme, I., Anderssen, S. A. (2014). Va-lidity and reliability of bioelectrical impedance analysis and skinfold thickness in pre-dicting body fat in military personnel. Military Medicine, 179(2), 208-217.
2. Ciccone, G., Wootton, R., & Mahan, A. (2020). Comparison of body composition assessment methods: DXA and BIA. Journal of Clinical Nutrition, 102(3), 789-798.
3. Feng, Q., Bešević, J., Conroy, M., Omiyale, W., Lacey, B., & Allen, N. (2024). Com-parison of body composition measures assessed by bioelectrical impedance analysis versus dual-energy X-ray absorptiometry in the United Kingdom Biobank. Clinical Nutrition ESPEN, 63, 214-225.
4. Gaba, A., Kapus, O., Cuberek, R., & Botek, M. (2015). Comparison of multi- and single-frequency bioelectrical impedance analysis with dual-energy X-ray absorpti-ometry for assessment of body composition in post-menopausal women: effects of body mass index and accelerometer-determined physical activity. Journal of Human Nutrition and Dietetics, 28(4), 390–400.
5. Genton, L., Herrmann, F. R., Sporri, A., & Graf, C. E. (2017). Association of morta-lity and phase angle measured by different bioelectrical impedance analysis (BIA) devices. Clinical Nutrition, 36(5), 1490-1497.
6. Hopkins, W.G. (2015). Spreadsheets for analysis of validity and reliability. Sport-science, 19, 36-42.
7. Kabiri, L. S., Hernandez, D. C., Mitchell, K. (2015). Reliability, validity, and diagnos-tic value of a pediatric bioelectrical impedance analysis scale. Childhood Obesity, 11(5), 650-655.
8. Larsen, M. N., Krustrup, P., Araújo Póvoas, S. C., Castagna, C. (2021). Accuracy and reliability of the InBody 270 multi-frequency body composition analyser in 10-12-year-old children. PLoS One, 16(3), e0247362.
9. Lima, M. C. M., Silva, A. M., & Martins, S. A. (2020). BIA and DXA in the assess-ment of body composition: The importance of developing correction equations. BMC Physiology, 20(1), 14-19.
10. Ling, C. H. Y., Hartman, J., & Ho, J. (2011). Accuracy of bioelectrical impedance devices in body composition assessment. Obesity Reviews, 12(2), 133-145.
11. Leahy, S., O'Neill, C., Sohun, R., & Jakeman, P. (2012). A comparison of dual ener-gy X-ray absorptiometry and bioelectrical impedance analysis to measure total and segmental body composition in healthy young adults. European Journal of Applied Physiology, 112(2), 589–595.
12. McLester, C. N., Nickerson, B. S., Kliszczewicz, B. M., McLester, J. R. (2020). Relia-bility and agreement of various InBody body composition analyzers as compared to dual-energy X-ray absorptiometry in healthy men and women. Journal of Clinical Densitometry, 23(3), 443-450.
13. Nunes, M. L., Lima, M. L., & Vasconcelos, F. F. (2019). Evaluation of body compo-sition methods in athletes: A review. Journal of Sports Science & Medicine, 18(3), 622-629.
14. Santos, H. L. G., Souza, L. D., & Costa, M. J. (2020). Bioelectrical impedance ana-lysis for monitoring body composition in athletes: A systematic review. International Journal of Sport Nutrition and Exercise Metabolism, 30(2), 121-130.
15. Silva, A. M., & Sardinha, L. B. (2019). Comparison of body composition assess-ment by DXA and BIA in older adults. PLoS ONE, 14(1), 1-13.
16. Silva, A. M., Sardinha, L. B., & Mota, J. (2018). Comparison of body composition assessment by DXA and BIA in older adults. Journal of Clinical Densitometry, 21(3), 383-390.
17. Stojanović, D., Mandić, R., & Jovanović, S. (2017). Comparative analysis of diffe-rent methods for body fat assessment in elementary school students. Research in Physical Education, Sport and Health, 6(2), 147-152.
18. Stewart, A. D., Marfell-Jones, M., Olds, T., & De Ridder, J. (1993). International standards for anthropometric assessment. International Society for the Advance-ment of Kinanthropometry.
19. Thurlow, S., Taylor-Covill, G., Sahota, P., Oldroyd, B., & Hind, K. (2017). Effects of procedure, upright equilibrium time, sex and BMI on the precision of body fluid me-asurements using bioelectrical impedance analysis. European Journal of Clinical Nutrition, 71(1), 72–79.
20. Toskic, L., Markovic, M., Simenko, J., Vidic, V., Cikiriz, N., & Dopsaj, M. (2024). Analysis of Body Composition in Men and Women with Diverse Training Profiles: A Cross-Sectional Study. International Journal of Morphology, 42(5), 1278-1287.
21. Waki, K., Arima, N., Sato, M., Sato, Y., & Akahoshi, T. (1991). Body composition measurement using bioelectrical impedance analysis. The Journal of Clinical Nutrition, 64(4), 429–435.

VALIDITY OF TWO TYPE OMRON BODY COMPOSITION ANALYSERS IN KARATE ATHLETES

Arsenijević Radenko, Utvić Nikola, Marković Milan, Lilić Ljubiša, Stanković Veroljub

Abstract: *The aim of this study was to examine the validity of two types of OMRON body composition analyzers (BF 511 and VIVA) in comparison with the InBody 270 body composition analyzer, in karatekas. The measurements were performed during the summer national camp of the FUDO-KAN Karate Federation, and the sample of subjects included 20 men and 27 women (BH = 158 ± 14.13 cm; BM = 51 ± 17.29 kg; BMI = 20 ± 4.01 kg/m^2), and the following body composition variables were used: body mass (BM), body fat percentage (%BF) and skeletal muscle mass percentage (%SMM), which were estimated using all three body composition scales. Descriptive data (Mean, SD, Min, Max, cV%) were provided for all variables and in the case of assessing all three above-mentioned body composition analyzers, while the Pearson correlation coefficient (r) and the coefficient of determination (r^2) were used to determine validity, both OMRON body composition analyzers with the "gold standard" in assessing body composition which is InBody 270 scale. By applying the r and r^2 statistical tests, an extremely large correlation of BM InBody with BM OMRON (BF 511 – r = 1.000, r^2 = 1.000; VIVA – r = 0.999, r^2 = 0.998), an extremely large correlation of %BF InBody with %BF BF 511 (r = 0.927, r^2 = 0.859) and a large correlation of %BF InBody with %BF VIVA (r = 0.63, r^2 = 0.40), and finally, a large correlation of %SMM InBody with %SMM BF 511 (r =0.652, r^2 = 0.425), and a moderate negative correlation of %SMM InBody with %SMM VIVA (r = -0.073, r^2 = 0.005) were observed Although websites selling OMRON body composition analyzers claim that they are valid and accurate in assessing body composition, the results obtained clearly indicate that there are certain deviations, especially when it comes to assessing skeletal muscle, when compared with the InBody 270 body composition scale.*

Key words*: body mass, percent of body fat, percent of skeletal muscle mass, OMRON BF 511, OMRON VIVA*

ACUTE-TO-CHRONIC WORKLOAD RATIO AND INJURY RISK IN PROFESSIONAL VOLLEYBALL: A TWO-MONTH MONITORING STUDY

Stefanović Života
Faculty of Sport and Physical Education, University of Priština - Kosovska Mitrovica, Leposavić, Serbia

ORIGINAL SCIENTIFIC ARTICLE
DOI: 10.5937/ATAVPA25156S

***Abstract**: Monitoring training load is crucial for optimizing performance and minimizing injury risk in elite athletes. The acute-to-chronic workload ratio (ACWR) has gained attention as a potential tool for managing training loads. This study aimed to present ACWR in professional volleyball players and explore its relationship with injury occurrence. Fifteen male professional volleyball players from a Turkish team were monitored over two months. Training load was quantified using the rating of perceived exertion (RPE), recorded daily to calculate both acute (7-day) and chronic (28-day) workloads. The ACWR was then computed weekly to assess fluctuations in training intensity. Two players sustained injuries during periods of elevated ACWR, suggesting a potential link between rapid workload increases and injury risk. When ACWR exceeded recommended thresholds (>1.5), injury occurrences aligned with previous research indicating that sudden workload spikes may contribute to injury susceptibility. However, individual variability and other contributing factors, such as biomechanical and physiological responses, must be considered. The findings suggest that ACWR could be a useful tool for monitoring training loads and potentially reducing injury risk in professional volleyball players. However, further studies with larger sample sizes and additional monitoring methods are needed to establish definitive conclusions on its predictive validity. Implementing structured workload management strategies may enhance performance while minimizing injury occurrence.*
***Key words**: acute-to-chronic workload ratio, training load monitoring, injury risk*

INTRODUCTION

Monitoring training load has become a central component of contemporary sports science, particularly in elite team sports where athletes are exposed to high physical and physiological demands. The primary objective of systematic workload monitoring is to balance training stimulus and recovery to optimize performance while minimizing the risk of injury (Impellizzeri, Marcora, & Coutts, 2005). In this context, the acute-to-chronic workload ratio (ACWR) has emerged as one of the most frequently used models for interpreting fluctuations in training stress and identifying periods of potential vulnerability among athletes (Gabbett, 2016).

Acute workload is commonly defined as the cumulative training load over a short period, typically seven days, whereas chronic workload represents the average load accumulated across a longer period, most often four weeks. The ratio between these two metrics provides insight into whether an athlete is progressing through gradual, planned increases in workload or being exposed to sudden spikes that may exceed their current level of preparedness (Hulin et al., 2016). Previous research has suggested that excessive increases in ACWR—often operationalized as values exceeding 1.3 to 1.5—may be associated with elevated injury risk, as the athlete may not have sufficient time to physiologically adapt to the rapid change in training demands (Gabbett, 2016; Windt & Gabbett, 2018).

While ACWR has been widely studied in sports such as soccer, rugby, and basketball, far fewer investigations have examined its application in volleyball. This is noteworthy given the biomechanical and physiological complexity of the sport, which includes frequent jumping, rapid accelerations and decelerations, high-impact landing actions, and repetitive overhead movements. These demands place substantial stress on both the lower limbs and the shoulder complex, increasing the importance of structured workload monitoring to support performance enhancement and injury prevention (Gabbett & Domrow, 2007). Moreover, positional roles in volleyball differ markedly in their physical demands—liberos, setters, middle blockers, outside hitters, and opposites each experience unique movement patterns and load profiles—which further highlights the need for individualized and context-specific monitoring approaches.

Despite its growing popularity as a practical monitoring tool, ACWR remains a topic of debate due to methodological considerations, such as mathematical coupling and the variability of individual

responses to training. Nevertheless, its accessibility and ability to capture rapid fluctuations in workload have contributed to its widespread adoption among coaches, sports scientists, and performance staff seeking early indicators of increased injury risk (Windt & Gabbett, 2018).

Given the growing importance of workload monitoring in elite volleyball and the limited empirical evidence specific to this sport, additional research is needed to clarify how changes in weekly training loads relate to injury occurrence in professional players. Therefore, the aim of this study was to monitor the acute-to-chronic workload ratio over a two-month period in professional male volleyball players and examine its relationship with injury occurrence.

METHODS

Participants

Fifteen professional male volleyball players competing in the Turkish national league participated in this study. All players were members of the same professional club and were monitored continuously over a two-month period during the competitive season. The sample included athletes from different playing positions (setters, outside hitters, opposites, middle blockers, and liberos), all of whom were healthy and actively participating in full training at the beginning of the monitoring period. Player characteristics such as age, body mass, height, and playing experience were recorded as part of the team's standard profiling procedure; however, only workload data were used for the purposes of this analysis. The study utilized workload information routinely collected as part of the club's standard monitoring process

Study Design

A prospective observational design was employed to monitor internal training load and calculate the acute-to-chronic workload ratio (ACWR) over an eight-week period. Training sessions and matches were tracked daily, and players independently provided subjective ratings of perceived exertion (RPE) following each session. Weekly acute and chronic workloads were computed, after which ACWR values were calculated and compared with the occurrence of injuries documented during the same period.

Rating of Perceived Exertion (RPE)

Internal training load was quantified using the session rating of perceived exertion (sRPE) method, a widely validated and frequently used tool in team sports (Foster et al., 2001). Approximately 30 minutes after each training session or match, players provided an RPE score on the CR-10 Borg scale, indicating their subjective perception of effort. Session load was calculated by multiplying RPE by session duration (minutes): Session Load=RPE×Duration (min).

All RPE data were collected individually to minimize peer influence and ensure independent reporting.

Acute and Chronic Workload Calculation

Acute workload was defined as the total accumulated session load across the previous seven days (7-day rolling sum). Chronic workload represented the mean session load over the preceding 28 days (28-day rolling average). These time windows were selected in accordance with existing literature on ACWR modeling (Hulin et al., 2016; Gabbett, 2016).

ACWR Calculation

The acute-to-chronic workload ratio (ACWR) was calculated using the rolling average model: ACWR=Acute Workload (7-day)/Chronic Workload (28-day).

ACWR values greater than 1.5 were considered potentially indicative of rapid workload increases and elevated injury risk, based on previous research in team sports (Gabbett, 2016).

Injury Definition and Recording

All injuries occurring during the monitoring period were recorded by the club's medical staff as part of routine medical oversight. For the purposes of this study, an injury was defined as any physical

complaint resulting from training or match play that led to at least one day of modified, reduced, or missed participation. Two injuries were documented during the two-month period, both occurring in weeks characterized by elevated ACWR values.

Procedure

All training and match sessions were monitored daily by the coaching staff. RPE values were collected using standardized forms after each session. Workload calculations and ACWR values were computed weekly and aligned with injury records for descriptive analysis. No interventions were introduced; players completed their usual training program designed by the club.

RESULTS

During the eight-week monitoring period, weekly acute and chronic workloads were successfully calculated for all 15 athletes, allowing for the computation of ACWR values across the entire sample. ACWR values fluctuated throughout the monitoring period, with several weeks showing moderate workload changes, while two weeks demonstrated marked increases in the acute-to-chronic ratio, exceeding the commonly referenced risk threshold of 1.5.

A total of two injuries were recorded during the study period. Both injuries occurred during weeks in which players exhibited elevated ACWR values (>1.5), indicating a substantial rise in short-term workload relative to the chronic load. No injuries were reported during weeks in which ACWR remained at or below 1.5. These findings align with prior research suggesting that rapid increases in training load may heighten the likelihood of injury.

To provide a clear overview of the relationship between ACWR ranges and injury occurrence in the present study, a categorical summary is presented in Table 1.

Table 1 Injury Occurrence Relative to ACWR Categories During the Monitoring Period

ACWR range	Weeks	Injuries	Incidence
≤ 1.0	Several	0	None
1.01 – 1.50	Majority	0	None
> 1.5	2	2	High

During the eight-week monitoring period, weekly acute and chronic workloads were successfully calculated for all 15 athletes, allowing for the computation of ACWR values across the entire sample. ACWR values fluctuated throughout the monitoring period, with several weeks showing moderate workload changes, while two weeks demonstrated marked increases in the acute-to-chronic ratio, exceeding the commonly referenced risk threshold of 1.5.

DISCUSSION

The primary aim of this study was to examine the acute-to-chronic workload ratio (ACWR) over an eight-week period in professional male volleyball players and to explore its relationship with injury occurrence. The results demonstrated that both injuries recorded during the monitoring period occurred in weeks where ACWR values exceeded 1.5, whereas no injuries were observed in weeks with lower or moderate ratios. Although the findings should be interpreted with caution due to the limited sample size, they offer further support for the growing body of evidence suggesting that sudden increases in training load may elevate injury risk in team sport athletes.

Previous research has consistently highlighted the association between rapid workload spikes and injury incidence. Studies in rugby, soccer, and basketball have reported that ACWR values above commonly cited thresholds—typically between 1.3 and 1.5—are linked to higher injury likelihood, as athletes may be exposed to acute stress that surpasses their current level of physical preparedness (Gabbett, 2016; Hulin et al., 2016). The present findings appear to align with this pattern, suggesting that volleyball athletes may be similarly vulnerable when acute workloads rise faster than the chronic load

can accommodate. Given the high biomechanical demands of repeated jumping, landing, and overhead actions in volleyball, athletes might be particularly sensitive to abrupt workload escalations.

The absence of injuries in weeks where ACWR remained at or below 1.5 is also consistent with the concept of the "training sweet spot," a range in which workloads are sufficient to promote adaptation without imposing excessive stress (Gabbett, 2016). Maintaining athletes within this workload window has been proposed as an effective strategy for injury prevention, as it balances the need for performance improvement with the protection of athlete health. In the present study, the majority of training weeks fell within this moderate range, which may have contributed to the absence of injury during those periods.

Although the ACWR model has been widely adopted in applied settings, recent literature has pointed out conceptual and mathematical limitations. Critics argue that the ratio may oversimplify the complexity of training load and that its predictive capacity may vary depending on the model used and the characteristics of the sport (Windt & Gabbett, 2018). Moreover, individual differences—such as training history, positional roles, neuromuscular resilience, and recovery capacity—can influence how athletes respond to workload changes. For volleyball in particular, positional differences may play a substantial role: middle blockers experience a high density of jumps, setters have unique movement patterns, and libero players have different loading profiles than hitters. Such variability underscores the importance of individualized monitoring.

Another important consideration is that workload measures based solely on RPE may not fully capture the multidimensional nature of physical stress in volleyball. While RPE-based methods are valid and practical, integrating additional metrics—such as jump count, external load from inertial sensors, or biomechanical markers—could provide a more comprehensive understanding of how workload influences injury risk. Future studies incorporating multiple monitoring tools may offer deeper insights into sport-specific demands and adaptation patterns.

The primary limitation of this study is its small sample size and short monitoring period, which restrict the generalizability of the findings. Additionally, injury occurrence was low, preventing more advanced statistical analysis. Nonetheless, the clear pattern observed—injuries occurring only during high-ACWR weeks—reinforces the practical value of monitoring workload fluctuations in elite volleyball environments. Despite the limitations, the descriptive data provide meaningful insight into how sudden workload increases may relate to injury risk in this population.

Overall, the findings of this study suggest that ACWR can serve as a useful tool for identifying periods of heightened injury risk among professional volleyball players. Maintaining workloads within an appropriate range and avoiding abrupt spikes may be an effective strategy for reducing injury incidence and supporting consistent performance throughout the season.

CONCLUSION

The present study examined the acute-to-chronic workload ratio (ACWR) over an eight-week period in professional male volleyball players and explored its relationship with injury occurrence. The results showed that both injuries recorded during the monitoring period occurred exclusively in weeks where ACWR exceeded 1.5, whereas no injuries were observed during weeks with lower or moderate workload ratios. Although the study was limited by a small sample size and a low number of injuries, the findings are consistent with previous research suggesting that abrupt increases in training load may elevate injury risk in high-performance athletes.

These observations reinforce the practical importance of structured workload monitoring in elite volleyball. Maintaining athletes within moderate ACWR ranges and avoiding sudden spikes in weekly training load may support injury prevention and contribute to safer long-term performance development. While ACWR alone cannot fully explain or predict injury risk, it represents a valuable and accessible tool for coaches, sports scientists, and medical staff to identify potentially vulnerable periods within the training cycle.

Future research should incorporate larger samples, longer monitoring periods, and multimodal workload assessments—including both internal and external load metrics—to better understand the complex interplay between training demands, adaptation, and injury in volleyball. Integrating such

approaches may enhance the precision of load management strategies and further improve athlete health and performance.

REFERENCES

1. Foster, C., Florhaug, J. A., Franklin, J., Gottschall, L., Hrovatin, L. A., Parker, S., Doleshal, P., & Dodge, C. (2001). A new approach to monitoring exercise training. *Journal of Strength and Conditioning Research, 15*(1), 109–115.
2. Gabbett, T. J. (2016). The training–injury prevention paradox: Should athletes be training smarter and harder? *British Journal of Sports Medicine, 50*(5), 273–280. https://doi.org/10.1136/bjsports-2015-095788
3. Gabbett, T. J., & Domrow, N. (2007). Relationships between training load, injury, and fitness in sub-elite collision sport athletes. *Journal of Sports Sciences, 25*(13), 1507–1519. https://doi.org/10.1080/02640410701200944
4. Hulin, B. T., Gabbett, T. J., Blanch, P., Chapman, P., Bailey, D., & Orchard, J. W. (2016). Spikes in acute workload are associated with increased injury risk in elite cricket fast bowlers. *British Journal of Sports Medicine, 50*(5), 273–280. https://doi.org/10.1136/bjsports-2015-095800
5. Impellizzeri, F. M., Marcora, S. M., & Coutts, A. J. (2005). Internal and external training load: 15 years on. *International Journal of Sports Physiology and Performance, 1*(2), 50–64.
6. Malone, S., Roe, M., Doran, D. A., Gabbett, T. J., & Collins, K. (2017). High chronic training loads and exposure to bouts of maximal velocity running reduce injury risk in elite Gaelic football. *Journal of Science and Medicine in Sport, 20*(3), 250–254. https://doi.org/10.1016/j.jsams.2016.08.005
7. Windt, J., & Gabbett, T. J. (2018). How do training and competition workloads relate to injury? The workload–injury aetiology model. *British Journal of Sports Medicine, 52*(13), 1018–1025. https://doi.org/10.1136/bjsports-2016-096040

ODNOS AKUTNOG I HRONIČNOG OPTEREĆENJA I RIZIK OD POVREDE KOD PROFESIONALNIH ODBOJKAŠA: DVOMESEČNA STUDIJA PRAĆENJA

Stefanović Života

Sažetak*: Praćenje opterećenja u treningu neophodno je radi optimizacije performansi i smanjenja rizika od povreda kod vrhunskih sportista. Odnos akutnog i hroničnog opterećenja (ACWR) sve više se koristi kao alat za upravljanje opterećenjem. Cilj ove studije je da se predstavi ACWR kod profesionalnih odbojkaša i njegovu povezanost sa pojavom povreda. Petnaest profesionalnih odbojkaša turskog kluba praćeno je tokom dva meseca. Opterećenje treninga kvantifikovano je putem subjektivne procene napora (RPE), beležene svakodnevno kako bi se izračunalo akutno (7 dana) i hronično (28 dana) opterećenje. ACWR je računat na nedeljnom nivou radi analize varijacija u intenzitetu treninga. Dva igrača su zadobila povrede tokom perioda visokog ACWR, što ukazuje na moguću povezanost između naglih skokova u opterećenju i rizika od povreda. Kada je ACWR prelazio preporučeni prag (>1.5), učestalost povreda bila je u skladu sa prethodnim istraživanjima koja sugerišu da naglo povećanje opterećenja može doprineti većem riziku od povrede. Međutim, individualne razlike i drugi faktori moraju se uzeti u obzir. Rezultati sugerišu da ACWR može biti koristan alat za praćenje opterećenja i smanjenje rizika od povreda kod profesionalnih odbojkaša. Ipak, potrebna su dalja istraživanja sa većim uzorcima i dodatnim metodama praćenja kako bi se u potpunosti potvrdila njegova validnost. Strateško upravljanje opterećenjem može doprineti poboljšanju performansi i smanjenju učestalosti povreda.*

Ključne reči*: odnos akutnog i hroničnog opterećenja, praćenje opterećenja u treningu, rizik od povreda*

BODY COMPOSITION AND HANDGRIP STRENGTH RELATIONSHIP IN YOUNG FOOTBALL PLAYERS

Utvić Nikola[1], Arsenijević Radenko[1], Andonovski Martin[2], Prebeg Goran[3], Aleksandrović Marko[4]

[1]Faculty of Sport and Physical Education, University of Priština – Kosovska Mitrovica, Leposavić, Serbia
[2]Faculty of Physical Education, Sport and Health, Ss. Cyril and Methodius University, Skopje, N. Macedonia
[3]Faculty of Sport and Physical Education, University of Belgrade, Serbia
[4]Faculty of Sport and Physical Education, University of Niš, Serbia

ORIGINAL SCIENTIFIC ARTICLE
DOI: 10.5937/ATAVPA25161U

***Abstract**: The aim of this study is to analyze the relationship between different body composition parameters and handgrip strength in football players aged 11 to 15 years. Handgrip strength was measured using a dynamometer, while body composition was assessed with three different devices: In Body, Omron, and Tanita. Body composition parameters, including skeletal muscle mass , body fat percentage, body mass index , and segmental muscle distribution, may significantly impact strength performance. The results of the study indicate a positive correlation between muscle mass and handgrip strength. Players with higher muscle mass generally achieve greater handgrip strength values, confirming the importance of muscle mass in the development of maximal strength. An increased body fat percentage negatively affects handgrip strength due to an unfavorable distribution of mass relative to functional muscle power. Furthermore, the distribution of muscle mass between the upper and lower extremities may influence the ability to generate force during the dynamometer test. The findings of this study emphasize the importance of monitoring body composition in football players to optimize strength training and improve overall performance.*
***Key words**: body composition, muscle mass, body fat, handgrip strength, football players, athletes*

INTRODUCTION

Body composition is considered one of the fundamental determinants of physical performance in youth athletes, as it directly influences strength, endurance, motor coordination, and overall athletic potential. In growing athletes, particularly those engaged in sports requiring repeated high-intensity efforts such as football, optimal levels of skeletal muscle mass and controlled body fat are essential for maintaining performance efficiency and reducing injury risk (Murtagh et al., 2018; Hammami et al., 2020). Handgrip strength (HGS) is widely recognized as a simple, reliable, and valid indicator of overall muscular strength in children and adolescents, and it has been strongly associated with maturation status, neuromuscular development, and long-term athletic potential (Lima et al., 2020; Vicente-Rodríguez et al., 2021).

Previous research demonstrates that higher muscle mass is consistently linked to superior strength performance in youth populations, including young football players, where strength capacity directly contributes to key actions such as tackling, shielding, and explosive locomotion (Deprez et al., 2015; Mala et al., 2019). Studies have also shown that increased body fat percentage negatively affects functional strength outcomes by imposing greater non-functional mass and altering movement mechanics (Matta et al., 2020; Milanese et al., 2021). This is particularly relevant during puberty, when rapid anthropometric and hormonal changes can produce substantial inter-individual variability in performance.

In football-specific contexts, handgrip strength has been examined both as a predictor of general neuromuscular ability and as a maturational marker, with evidence suggesting that stronger players tend to perform better in sprinting, jumping, and change-of-direction tasks (Peña-González et al., 2019; Silva et al., 2021). Despite the extensive scientific attention directed toward body composition and performance metrics in youth athletes, limited research has simultaneously examined the relationship between body composition parameters and handgrip strength using multiple assessment technologies. Considering that devices such as InBody, Tanita and Omron differ in their measurement algorithms and segmental analysis capabilities, understanding their relevance in evaluating young football players is critical for applied sports science practice.

Given the need for evidence-based monitoring tools in talent development systems, investigating how body composition parameters correspond to functional strength is essential for optimizing training strategies and guiding long-term athlete development. Therefore, the aim of this study is to analyze the relationship between body composition characteristics and handgrip strength in football players aged 11 to 15 years. Insights gained from this research may help coaches, conditioning specialists, and practitioners adjust strength and conditioning programs to better support the physiological needs of youth athletes.

METHODS

Participants

The study included 62 male youth football players, aged 11 to 15 years, recruited from regional football academies. All participants had a minimum of two years of systematic football training and were free from injuries or medical conditions that could affect strength performance or body composition assessment. Prior to participation, written informed consent was obtained from the parents or legal guardians of each athlete, and the study was conducted in accordance with the ethical principles of the Declaration of Helsinki.

Study Design

A cross-sectional design was used to investigate the relationship between body composition parameters and handgrip strength. All measurements were conducted during a single assessment session under standardized laboratory conditions. Participants were tested individually and instructed to avoid strenuous activity for at least 24 hours before testing.

Body Composition Assessment

Body composition was evaluated using three bioelectrical impedance analysis (BIA) devices to ensure measurement reliability and cross-device comparison:

1. InBody 270 (InBody Co., South Korea)
2. Omron BF511 (Omron Healthcare, Japan)
3. Tanita BC-418 MA (Tanita Corporation, Japan)

All devices were calibrated before testing. Measurements included:

- Total body mass (kg)
- Body mass index (BMI)
- Skeletal muscle mass (SMM)
- Body fat percentage (BF%)
- Segmental muscle distribution (upper and lower limbs)

Participants were assessed barefoot, in light clothing, following a 3-hour fasting window as recommended in pediatric BIA protocols.

Handgrip Strength Testing

Handgrip strength was measured using a Jamar hydraulic dynamometer, a validated and widely used tool in pediatric strength assessment. The testing protocol followed the standardized procedure recommended by the American Society of Hand Therapists:

- Participants were seated with the shoulder adducted and neutrally rotated.
- The elbow was flexed at 90 degrees, the forearm in a neutral position, and the wrist between 0–30° extension.
- Three maximal contractions were performed with the dominant hand, with a 60-second rest between trials.

The highest value (kg) was used for further analysis. Handgrip strength is recognized as a reliable indicator of overall muscular strength and maturation in youth athletes (Lima et al., 2020; Vicente-Rodríguez et al., 2021).

Procedures

All testing was supervised by trained evaluators with experience in pediatric strength and body composition assessment. The testing order was identical for all participants:

1. Body composition (InBody → Omron → Tanita)
2. Five-minute standardized warm-up (light jogging and mobility exercises)
3. Handgrip strength testing

Participants were instructed to maintain normal hydration throughout the testing day. Environmental conditions (temperature 22–24°C) were kept constant.

Statistical Analysis

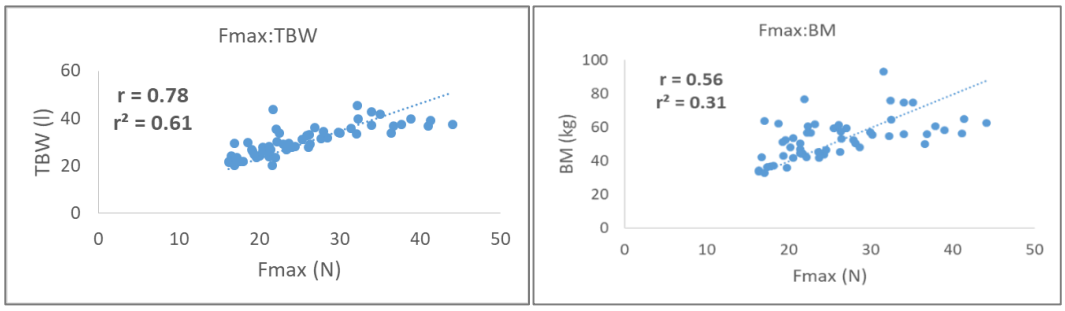
All data were analyzed using SPSS 26.0 (IBM Corp., USA). Descriptive statistics (mean ± SD) were calculated for all variables. Pearson correlation coefficients were used to evaluate relationships between:

- Handgrip strength and skeletal muscle mass
- Handgrip strength and body fat percentage
- Handgrip strength and BMI
- Handgrip strength and segmental muscle distribution

RESULTS

The results of the study are presented in the following section and include descriptive characteristics of the participants, as well as correlation analyses examining the relationship between maximal handgrip strength and selected body composition parameters. All findings are displayed through summary tables and graphical illustrations to facilitate interpretation.

Figure 1 Relationship between maximal handgrip strength (Fmax) with total body water (TBW) and body mass (BM)

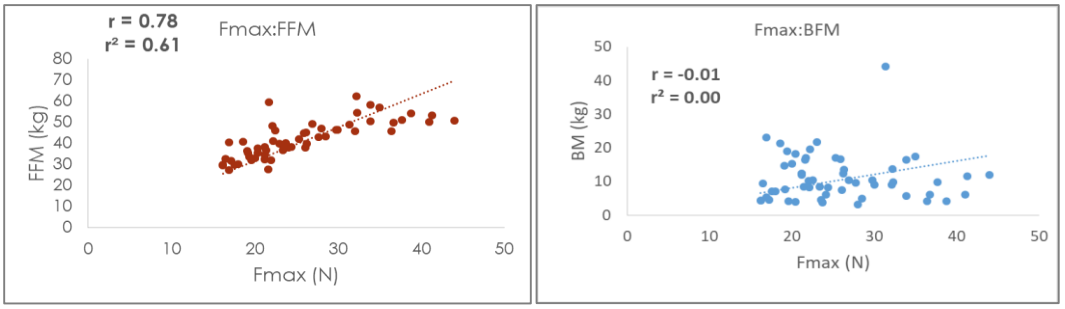


Legend: Fmax – maximal handgrip strength; TBW – total body water; BM – body mass.

The correlation analysis revealed notable relationships between maximal handgrip strength and basic body composition indicators. Total body water demonstrated a strong positive correlation with Fmax ($r = 0.78$; $r^2 = 0.61$), indicating that higher levels of lean, hydration-related tissue are closely associated with improved strength performance in young football players. Body mass also showed a moderate positive correlation with handgrip strength ($r = 0.56$; $r^2 = 0.31$), suggesting that overall mass contributes to strength output, but to a lesser extent than lean tissue components. These findings highlight that increases in functional, non-fat tissue appear to be more influential for maximal grip force than increases in total body mass alone.

The analysis revealed a markedly different contribution of fat-free and fat mass to maximal grip performance. Fat-free mass showed a robust positive correlation with Fmax ($r = 0.78$; $r^2 = 0.61$), indicating that increases in structurally and metabolically active tissue substantially enhance the ability to generate maximal force. This finding aligns with established physiological principles suggesting that neuromuscular capacity is largely driven by the quantity and functional quality of lean mass.

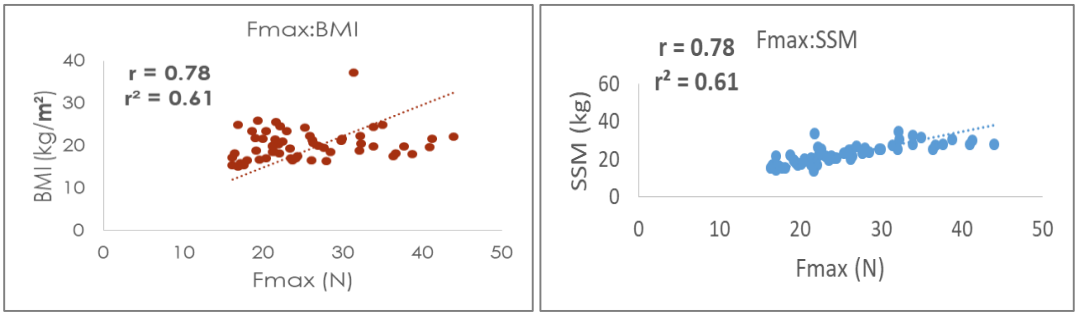
Figure 2 Relationship between maximal handgrip strength (Fmax) with fat-free mass (FFM) and body fat mass (BFM)



Legend: Fmax – maximal handgrip strength; FFM – fat-free mass; BFM – body fat mass.

In contrast, body fat mass exhibited no association with handgrip strength ($r = –0.01$; $r^2 = 0.00$). The absence of a meaningful relationship suggests that adipose tissue does not contribute to force production and may represent non-functional load with no influence on upper-limb strength in this age group. These results emphasize the dominance of fat-free tissue in determining maximal isometric strength during early and mid-adolescence.

Figure 3 Relationship between maximal handgrip strength (Fmax) with body mass index (BMI) and segmental skeletal muscle mass (SSM)



Legend: Fmax – maximal handgrip strength; BMI – body mass index; SSM – skeletal muscle mass.

The findings reveal that BMI exhibits a strong positive association with maximal handgrip strength ($r = 0.78$; $r^2 = 0.61$). Although BMI is a composite index that does not distinguish between adipose and lean tissue, its strong correlation in this cohort likely reflects the predominance of muscle mass within the developmental stage of these athletes. This suggests that higher BMI values in trained youth may be indicative of increased functional tissue rather than excess fat.

Similarly, segmental skeletal muscle mass demonstrated an equally strong correlation with Fmax ($r = 0.78$; $r^2 = 0.61$). This relationship underscores the importance of regional muscular development—particularly in the upper body—for maximal isometric force output. Given that handgrip performance is influenced by both local and systemic neuromuscular factors, the strong association with SSM highlights the relevance of targeted muscle development during adolescence.

DISCUSSION

The primary aim of this study was to examine the relationship between body composition parameters and maximal handgrip strength in young football players aged 11 to 15 years. The obtained results consistently demonstrated that indicators of lean body composition—including total body water (TBW), fat-free mass (FFM), skeletal muscle mass (SSM), and BMI (as an indirect anthropometric marker)—show strong positive correlations with handgrip strength. In contrast, body fat mass (BFM)

showed no association with strength output. These findings align with existing literature emphasizing the essential role of lean tissue in the development of neuromuscular strength in youth athletes.

A key outcome of this study is the strong correlation between FFM and handgrip strength (r = 0.78), indicating that increases in non-fat tissue are directly associated with greater force production. Similar relationships have been reported in previous studies, where FFM has been recognized as a dominant predictor of strength, power, and overall physical performance in young athletes (Mala et al., 2019; Hammami et al., 2020). Vicente-Rodríguez et al. (2021) also reported that children and adolescents with higher levels of fat-free mass exhibit significantly better performance in both isometric and dynamic strength tasks, supporting the role of lean mass as a fundamental component of muscular function.

The results also showed a strong association between TBW and handgrip strength. Given that TBW represents a major physiological component of fat-free tissue and reflects the hydration of metabolically active compartments, this finding aligns with previous evidence suggesting that cellular hydration status plays a significant role in muscle contractility and overall strength expression (Matta et al., 2020). Adequate hydration and intracellular water content have been linked to improved muscular performance, particularly in youth athletes undergoing rapid growth and tissue expansion.

Furthermore, skeletal muscle mass (SSM) demonstrated a strong positive correlation with Fmax. This supports earlier findings indicating that regional and segmental muscle development, especially in the upper extremities, contributes substantially to handgrip performance (Deprez et al., 2015; Peña-González et al., 2019). Since handgrip strength is influenced by both local muscle size and systemic neuromuscular development, the strong relationship with SSM reinforces the importance of targeted muscle development during adolescence.

Interestingly, BMI also showed a strong positive correlation with grip strength, which is consistent with research suggesting that higher BMI values in athletic youth populations often reflect greater muscle mass rather than excess fat (Milanese et al., 2021). In this study, the strong association between BMI and Fmax likely reflects the developmental characteristics of football players, who typically accumulate muscle mass due to regular training stimuli. This confirms earlier observations by Silva et al. (2021), who found that BMI may serve as a practical, albeit indirect, indicator of physical performance in adolescents involved in structured training programs.

In contrast, body fat mass demonstrated no meaningful association with handgrip strength. This finding is consistent with prior research indicating that excess adipose tissue does not contribute to force production and may even act as non-functional mass that impairs performance in certain motor tasks (Murtagh et al., 2018). Milanese et al. (2021) similarly reported that higher body fat percentages negatively influence strength, speed, and agility in young football players, reinforcing the concept that adipose tissue plays no functional role in the development of muscular strength.

Overall, the results of this study support the conclusion that lean body components, particularly fat-free mass and skeletal muscle mass, are strong predictors of handgrip strength in young football players. Handgrip strength has been widely recognized as a reliable indicator of general muscular fitness and maturational development (Lima et al., 2020), and the present findings further confirm its value in the assessment of youth athletes. Given the substantial inter-individual variation observed in this age group due to different maturation rates, the strong associations identified in this study highlight the importance of continuous monitoring of body composition to optimize training interventions, talent development, and long-term athletic progression.

These findings extend the current body of knowledge by simultaneously analyzing multiple body composition technologies (InBody, Tanita, Omron) and revealing consistent correlations across different measurement systems. This supports the practical application of BIA devices in sports settings where rapid, non-invasive assessments are required.

CONCLUSION

The findings of this study indicate that lean body composition components—including total body water, fat-free mass, skeletal muscle mass, and BMI (as an indirect anthropometric indicator)—are strongly associated with maximal handgrip strength in young football players aged 11 to 15 years. These results demonstrate that strength performance in this population is predominantly influenced by

metabolically active and functionally relevant tissue, while body fat mass shows no meaningful relationship with force production.

Given the importance of muscular development during adolescence, monitoring body composition through reliable and accessible assessment tools provides valuable insights for coaches, conditioning specialists, and practitioners working in youth football. The strong associations identified in this study support the use of handgrip strength as a practical indicator of neuromuscular development and an important component of talent identification and long-term athletic development. Future research should explore longitudinal changes and the influence of maturation status to further clarify developmental patterns in strength and body composition among youth athletes.

ACKNOWLEDGMENTS

The authors would like to express their gratitude to the participating football academies, coaches, and young athletes for their cooperation and commitment throughout the data collection process. Appreciation is also extended to the evaluators and staff members who assisted in conducting the assessments.

REFERENCES

1. Deprez, D., Valente-Dos-Santos, J., Coelho-E-Silva, M. J., Lenoir, M., Philippaerts, R., & Vaeyens, R. (2015). Multilevel development of anthropometric and fitness characteristics in youth football players. *International Journal of Sports Medicine, 36*(13), 1067–1073.
2. Hammami, R., Negra, Y., Aouadi, R., Shephard, R. J., & Chelly, M. S. (2020). Effects of lower-limb strength training on youth soccer performance. *Sports Medicine, 50*(2), 215–232.
3. Lima, R. A., Pfeiffer, K. A., Larsen, L. R., Bugge, A., Moller, N. C., Anderson, L. B., & Stodden, D. F. (2020). Physical fitness levels among children and adolescents in Denmark: A cross-sectional investigation. *Scandinavian Journal of Medicine & Science in Sports, 30*(1), 127–138.
4. Mala, L., Maly, T., Zahalka, F., Bujnovsky, D., Kaplan, A., & Jebavy, R. (2019). Strength training and body composition in adolescent soccer players. *Journal of Human Kinetics, 67*(1), 223–232.
5. Matta, M. O., Figueiredo, A. J., Garcia, E. S., Seabra, A., & Massa, M. (2020). Hydration, intracellular water, and muscular performance in youth athletes. *European Journal of Sport Science, 20*(4), 531–539.
6. Milanese, C., Campa, F., Zago, M., Favero, M., Rinaldo, N., & Corzato, F. (2021). Anthropometry and body composition of youth soccer players: Relationships with performance. *International Journal of Environmental Research and Public Health, 18*(7), 1–13.
7. Murtagh, C. F., Brownlee, T. E., O'Boyle, A., Morgans, R., Drust, B., & Erskine, R. M. (2018). Importance of muscle mass and strength in youth soccer performance. *Journal of Sports Sciences, 36*(20), 2399–2406.
8. Peña-González, I., López-Fernández, J., del Coso, J., & Abián, P. (2019). Reliability and usefulness of handgrip strength in youth football players. *Journal of Strength and Conditioning Research, 33*(4), 1–8.
9. Silva, R., Paiva, T. M., Rabelo, N. D., & Figueiredo, A. (2021). BMI and physical performance in adolescent athletes. *Journal of Sports Medicine and Physical Fitness, 61*(5), 693–700.
10. Vicente-Rodríguez, G., Rey-López, J. P., Mesana, M. I., & Ruiz, J. R. (2021). Muscular fitness in children and adolescents. *Sports Medicine, 51*(2), 1–15.

POVEZANOST TELESNE KOMPOZICIJE I SNAGE STISKA ŠAKE KOD MLADIH FUDBALERA

Utvić Nikola, Aresnijević Radenko, Andonovski Martin, Prebeg Goran, Aleksandrović Marko

***Sažetak**: Cilj ovog istraživanja je analiza povezanosti različitih parametara telesne kompozicije sa snagom stiska šake kod fudbalera uzrasta od 11 do 15 godina. Snaga stiska šake merena je dinamometrom, dok su merenja telesne kompozicije sprovedena korišćenjem tri različita uređaja: In Body, Omron i Tanita. Telesna kompozicija, uključujući mišićnu masu , procenat telesne masti, indeks telesne mase i segmentnu distribuciju mišićne mase, može značajno uticati na performanse snage. Rezultati istraživanja ukazuju na pozitivnu korelaciju između mišićne mase i snage stiska šake. Igrači sa većom mišićnom masom u proseku postižu veće vrednosti sile stiska, što potvrđuje značaj mišićne mase u razvoju maksimalne sile. Povećan procenat telesne masti pokazuje negativan uticaj na snagu stiska zbog*

nepovoljne distribucije mase u odnosu na funkcionalnu mišićnu snagu. Takođe, distribucija mišićne mase između gornjih i donjih ekstremiteta može uticati na sposobnost generisanja sile tokom izvođenja testa na dinamometru. Zaključak ovog istraživanja naglašava važnost praćenja telesne kompozicije fudbalera kako bi se optimizovao trening snage i poboljšale ukupne performanse.

***Ključne reči**: telesna kompozicija, mišićna masa, telesna mast, snaga stiska, fudbaleri, sportisti*

GENDER INEQUALITY IN HANDBALL: DIRECT, INSTITUTIONAL AND EPISTEMIC MECHANISMS OF DISCRIMINATION – A NARRATIVE REVIEW

Filipović Milica[1], Savuljić Ines[2], Durlević Slavka[3], Vitošević Jovana[4], Ilić Igor[1]
[1]Faculty of Sport and Physical Education, University of Priština – Kosovska Mitrovica, Leposavić, Serbia
[2]Faculty of Security Studies, University of Belgrade, Serbia
[3]Faculty of Sport and Physical Education, University of Novi Sad, Serbia
[4]Department of Business Studies Blace, Toplica Academy of Applied Studies (TAAS), Serbia

REVIEW ARTICLE
DOI: 10.5937/ATAVPA25168F

Abstract: *Gender inequality in handball operates through three interconnected mechanisms that shape the development, performance, and health of female athletes. Direct discrimination appears in unequal salaries, visibility, and media investment, reflecting long-standing norms that privilege men's sport. Institutional discrimination is embedded in resource allocation, as women's teams receive limited access to high-quality training facilities, medical support, and experienced coaching staff, restricting both performance optimization and career sustainability. Epistemic discrimination, the systematic exclusion of female athletes from sports science research, results in training models, injury-prevention protocols, and recovery practices derived primarily from male physiology. Consequently, female handball players train and recover under conditions misaligned with their biological profiles, increasing injury risk and slowing long-term development. Recognizing that these forms of discrimination reinforce one another, the paper argues that achieving equality in handball requires coordinated structural change across financial, organizational, and scientific domains.*
Key words: *women's handball, gender pay gap, media representation, resource allocation, research bias*

INTRODUCTION

Handball is a high-intensity intermittent team sport that requires a combination of explosive strength, speed, repeated sprint ability, jumping, throwing precision, and advanced perceptual–motor coordination (Aksović et al., 2021; Ilić, 2015; Ilić et al., 2023). The game alternates between phases of maximal physical effort, such as accelerations, rapid changes of direction and vertical jumps, and periods of lower-intensity movement (Póvoas et al., 2012). Because of these physiological demands, long-term athletic development in handball requires structured planning, especially during adolescence, when biological maturation and growth rates differ considerably both among individuals and between sexes (Filipović et al., 2019). Although handball has historically been perceived in Europe as a predominantly male sport, female participation has substantially increased in recent years, and women's leagues are steadily evolving toward a faster and more physically demanding style of play (Florin et al., 2023; Michalsik & Aagaard, 2015). As visibility grows, gender-based disparities in resources, representation, and scientific knowledge have become increasingly apparent, positioning handball as a relevant case study for examining structural gender inequality in sport.

One of the most persistent indicators of gender inequality in handball is the imbalance in scientific representation. A recent scoping review demonstrated that only 16.2% of studies using wearable technology to monitor training load in team sports included female athletes, while over 80% were conducted exclusively on men (Benson et al., 2020). This research gap means that many evidence-based recommendations for performance optimization, injury prevention, and workload management in women's handball are extrapolated from male data (Elliott-Sale et al., 2021; Emmonds et al., 2019). As a result, female athletes often train under methodologies that do not reflect sex-specific physiological characteristics.

Despite progress in participation rates, women now hold approximately 38% of all handball licenses in major European federations such as France and Spain (CSD, 2023; INJEP, 2023), substantial disparities remain in visibility and financial support. For example, the 2022/23 Women's EHF Champions League attracted 9.3 million broadcast viewers, compared to 81 million viewers of the men's edition, a nearly nine-fold difference (EHF, 2024a). Budget analyses show the same imbalance: the average operational budget of a top-tier French men's handball club exceeds €5.5 million, whereas women's leagues operate

with a fraction of that amount, often limiting access to professional infrastructure and full-time staff (Ayúcar-Sánchez et al., 2024).

Gender stratification in sport is grounded in what Coakley (2021) terms orthodox gender ideology, which assumes that biological sex represents a natural and fixed division between men and women, and that each category is associated with specific social roles and physical attributes. In sport, this ideology becomes visible through the classification of certain disciplines as "male" or "female," shaping public perception, investment patterns, and institutional decisions regarding resource allocation.

Two sociological frameworks are particularly useful for explaining how these inequalities persist. Hegemonic masculinity theory (Connell & Messerschmidt, 1995) posits that societies construct hierarchies of masculinities in which the dominant form is linked to strength, aggression, competitiveness, and physical dominance, traits that align closely with handball's symbolic identity. Gendered organization theory (Acker, 1990) argues that institutions embed gendered assumptions into their structures, procedures, and language, thereby systematically privileging men even when organizational practices appear neutral.

Direct discrimination is reflected in unequal pay, prize money, sponsorship structures, and media coverage. While several women's sports have undergone rapid professionalization, elite female handball players continue to receive significantly lower salaries and reduced exposure relative to male athletes (Fink, 2015). Viewership data from the 2024 Men's European Championships, over one million in-arena spectators, 45 million television viewers, and 400 million digital interactions—highlights the magnitude of this divide (EHF, 2024b).

Indirect discrimination emerges through structural mechanisms that are formally gender-neutral but systematically generate unequal opportunities. These include prioritizing men's competitions in scheduling, investing more heavily in male coaching development, and distributing federation funds in ways that favour men's leagues. Because elite handball requires specialized strength and conditioning support, performance-tracking technology, and expert staffing, unequal distribution of institutional resources directly constrains the professional development of women's teams (Cooky & Messner, 2018).

The most overlooked but potentially most consequential form is epistemic discrimination, the exclusion of women from the scientific evidence used to design training and medical practice. Due to insufficient female-specific research, coaches frequently rely on male-derived models, despite known sex differences in muscle morphology, hormonal regulation, fatigue profiles, and injury risk (Elliott-Sale et al., 2021; Tingelstad et al., 2023, Ilić et al., 2025). This knowledge gap produces a silent but systemic disadvantage that shapes every stage of women's athletic development.

The aim of this paper is to identify and critically analyse how gender inequality manifests within the sport of handball across three interconnected dimensions: direct discrimination, institutional discrimination, and epistemic discrimination. By synthesizing existing scientific evidence, the study seeks to demonstrate how these structural mechanisms influence the visibility, development, and performance of female handball players, and to highlight the consequences of relying on male-based research models when formulating training guidelines and performance standards in women's handball.

METHODS

This study was conducted as a narrative literature review with the aim of synthesizing current scientific knowledge on gender inequality in handball. A narrative approach was selected because it enables the integration of heterogeneous sources, including empirical studies, theoretical frameworks, and institutional reports, which is necessary for addressing a complex and multidimensional sociocultural issue such as gender discrimination in sport (Snyder, 2019). The literature search was carried out in four major scientific databases (Scopus, Web of Science, PubMed, and SPORTDiscus), complemented by official documents published by the European Handball Federation, International Handball Federation, and national handball governing bodies.

The search strategy included combinations of keywords related to handball, gender inequality, women in sport, athlete development, and research bias. Only peer-reviewed publications, theses, and institutional reports published in English between 2010 and 2025 were considered. Studies were included if they addressed gendered aspects of handball in relation to performance, visibility,

institutional structures, or research representation. Works without methodological rigor or those not distinguishing between male and female athletes were excluded.

All relevant sources were screened and analysed through an interpretative, thematic lens, guided by the conceptual distinction between direct, institutional, and epistemic forms of discrimination. This analytical structure allowed for the identification of recurrent mechanisms underlying gender inequality in handball, as well as the recognition of knowledge gaps that continue to disadvantage female athletes. Because the study relied exclusively on publicly available secondary sources, no ethical approval was required.

MANIFESTATIONS OF GENDER INEQUALITY IN HANDBALL

Economic Disparities

Economic inequalities in handball represent one of the most visible forms of direct discrimination against female athletes, as they manifest clearly in salary differences, club budgets, and the distribution of prize money. Contemporary literature confirms that the gender pay gap is not limited to highly commercialized sports but persists even in traditional European disciplines such as handball, which possess strong institutional frameworks and long-standing competitive structures. Recent media analyses show that female athletes, despite carrying identical training loads and operating under comparable performance demands, continue to earn significantly lower incomes than their male counterparts. Comparisons with other sports clearly demonstrate that economic inequalities have a structural character. Research on economic inequality in professional basketball in the U.S. strongly illustrates this mechanism: the minimum salary in the NBA is 15.76 times higher than the minimum salary in the WNBA, the maximum salary is even 206.72 times higher, while the average salary is 79.77 times higher. This results in a gender pay gap of 98.75%, meaning that women earn only 1.25% of the male average (Báčová, 2021). These data clearly show that extreme salary gaps do not reflect differences in athlete performance but rather institutional mechanisms of resource distribution and historical patterns of valuing men's sports. Similarly, in English football, Premier League players earn over sixty times the weekly salary of athletes in the Women's Super League, reflecting a persistent structural imbalance in financial investment and valuation (Poppelwell-Scevak, 2022). Even in tennis, a sport often cited as a model of gender equality, total annual income remains substantially skewed toward men (Flake et al., 2013). Recent data further indicate that in semi-professional sport, where overall salaries are much lower, the gender pay gap still reaches 14.5% (Wicker et al., 2021), highlighting the persistence of economic discrimination even in contexts where market logic should not be dominant.

A similar pattern is observed in European handball. Analyses of the financial structure of handball leagues reveal that men's competitions accumulate significantly higher levels of capital, resulting in higher salaries, more robust sponsorship contracts, and greater availability of professional support services. Budgets of elite men's clubs commonly reach several million euros, approximately €5.5 million in the French league, €4.5 million in the German league, and around €1.3 million in the Spanish league (Ayúcar-Sánchez et al., 2024). In contrast, women's clubs operate with considerably more limited resources, which affects the degree of professionalization, staffing capacities, and contractual stability. These disparities also contribute to a reduction in competitive balance, particularly in leagues where only a small number of well-funded women's clubs consistently dominate. This was confirmed in a recent 15-year analysis of four major European handball leagues (Ayúcar-Sánchez et al., 2024).

Although arguments frequently rely on differences in revenue and popularity between men's and women's leagues, data from the European Handball Federation demonstrate that the gap in media exposure and financial investment is considerably larger than market criteria would suggest. According to the EHF report (2024), the men's EHF Champions League attracted approximately 81 million viewers in the 2022/23 season, while the women's competition recorded 9.3 million. While differences in viewership exist, investment in marketing and production resources fails to reflect the actual potential of women's handball, especially given that digital platforms consistently show high engagement for women's teams and players. The persistent lack of financial investment reinforces a self-perpetuating cycle: limited economic support lowers the professional standards and public visibility of women's

handball, which is then used as justification for the continued unequal distribution of financial and media resources.

The literature clearly emphasizes that such disparities do not stem from performance-based factors but from historically shaped norms of valuing sport. A recent study by Meier et al. (2025) shows that media narratives most commonly frame the gender pay gap as "unfair," yet proposed solutions remain primarily market-oriented, suggesting that women's sport must become commercially competitive before equal compensation can be justified. This narrative disregards the fact that men's sports have benefited from decades of institutional privilege, media investment, and infrastructural support, while women's sports have been systematically marginalized. As a result, female handball players are placed at a structural disadvantage, as they are expected to meet a standard of commercialization that men's sports achieved due to long-standing advantages.

The study by Ayúcar-Sánchez et al. (2024) further confirms that unequal investment has direct sporting consequences. Women's handball leagues exhibit higher concentration of success and fewer teams competing at the top level, a pattern linked to lower budgets and limited funds available for talent development. Thus, financial inequality becomes a performance-related inequality, directly influencing professional growth, training quality, and the overall sustainability of athletes' careers.

Economic disparities are the core problem because they have shaped how handball develops over time. Women's clubs simply don't have the financial resources that men's clubs do, and this is ultimately why women's handball remains marginalized. This inequality operates at two levels: at the professional level, where salaries and prize money are significantly lower, and at the youth development level, where training conditions are inadequate and investment in talent development is minimal. The outcome is an uneven development of the sport overall and unstable careers for female athletes.

Media Representation

Female athletes receive considerably less media attention than male athletes. Research (Bruce, 2016; Cooky et al., 2015; Cooky et al., 2013) indicates that the disparity arises not only in the volume of coverage but also in its framing. Media narratives frequently emphasize women athletes' appearance, emotional expressions, and personal lives, whereas men are predominantly portrayed through their athletic performance, tactical competence, and competitive achievements. This differentiation produces tangible effects. Female athletes are often mediated through male figures—such as coaches, partners, or commentators—rather than being represented as autonomous professionals. Salido-Fernández and Muñoz-Muñoz (2021) examined this dynamic and demonstrated its influence on audience perception, showing that women's accomplishments are frequently interpreted as less significant. This constitutes a form of marginalization driven by representational practices rather than overt exclusion.

Research focusing on European media further shows that women's handball receives significantly less broadcast time, fewer analytical segments, and far fewer prime-time placements compared to men's competitions, despite comparable or stronger competitive results among women's teams (Meier et al., 2025). Limited media exposure consequently reduces the commercial value and public visibility of female handball players.

Recent data from the European Handball Federation reinforce these findings, showing that the men's EHF Champions League attracted approximately 81 million viewers in the 2022/23 season, while the women's league reached only 9.3 million, illustrating a substantial gap in media reach and marketing investment (EHF, 2024). This restricted exposure generates a self-reinforcing cycle: reduced visibility limits audience engagement, which is then used to justify further unequal distribution of media resources.

Differences are also evident in production quality. Men's handball matches are typically broadcast with higher technical investment, more experienced commentary teams, and superior production standards, further reinforcing their perceived prestige. Achieving equitable conditions requires media institutions to commit to proportional coverage, equal production standards, and improved promotional strategies.

Although digital media offer alternative avenues for increasing visibility, allowing female handball players and teams to communicate directly with audiences, these efforts still depend on institutional and

sponsorship support (Galván, 2021; Rogstad et al., 2024). Without such backing, digital engagement cannot fully compensate for structural inequalities in mainstream media coverage.

Access to training facilities

Gender inequality in handball becomes particularly evident in how training facilities are distributed and maintained. Men's teams routinely obtain preferential access to optimal training times and superior sports venues, while women's teams are relegated to less favourable time slots, often late at night, or to facilities of noticeably lower quality (UNI Europa Sport, 2024). Across various European leagues, notably in Spain, Romania, and Poland, players describe situations in which they "train whenever the hall is available," leading to shorter, irregular practices and environments that hinder both technical and tactical progression. Qualitative evidence further illustrates that women's teams are frequently situated in halls with deteriorated floors, insufficient lighting, or minimal equipment, whereas men's teams utilize the main club facilities, which are fully resourced and professionally maintained.

This disparity is not merely logistical; it directly affects training quality, elevates injury risk, and restricts long-term athletic development (UNI Europa Sport, 2024).

Medical support and healthcare provision in women's handball

Parallel to broader financial and institutional disparities, women's handball teams systematically operate with reduced access to medical support, sport-specific health professionals, and modern recovery technologies compared with their male counterparts. Evidence shows that women in professional sport have significantly less access to qualified medical staff, including orthopaedic surgeons, physiotherapists, strength-and-conditioning specialists, and team physicians, which directly affects injury prevention, training quality, and recovery timelines (Crossley et al., 2025; Wilson et al., 2023). While men's teams typically employ specialists with advanced expertise and continuous medical coverage, women's teams often function with minimal or fragmented medical structures, reflecting long-standing institutional bias in the allocation of funding and technical resources. These disparities are reinforced by the historical underrepresentation of women in leadership positions across sports-medicine organizations, such as the American Orthopaedic Society for Sports Medicine, where only 1 of 60 presidents has been a woman, perpetuating male-normed medical standards and practices (Sachdeva et al., 2022).

Handball-specific research further demonstrates the concrete consequences of these systemic inequalities. According to the UNI Europa Sport (2024) survey on working conditions in European handball, women's teams frequently lack on-site physicians, physiotherapists, and injury-prevention staff; many clubs do not provide immediate medical supervision during training, and several players report paying for their own rehabilitation or receiving delayed diagnostic evaluation. Additionally, players from Spain, Poland, and Romania report significantly higher injury-related work absences, often exceeding 40 days per season, alongside limited access to insurance, recovery equipment, and structured rehabilitation programs. These deficits stand in stark contrast to men's professional teams, which more consistently employ medical personnel and maintain formalized injury-management protocols. The European Handball Federation (EHF) has likewise recognized this structural gap, noting that women's teams receive substantially fewer medical resources and less advanced monitoring technologies, contributing to disproportionate injury burdens among female athletes (EHF Medical Commission, 2022).

As a result, female handball players more frequently experience delayed diagnosis, inadequate injury prevention, and non-individualized rehabilitation, which collectively increase the likelihood of reinjury and prolong return-to-play timelines. Research highlights that limited access to gender-specific sports-medicine knowledge, such as expertise in hormonal fluctuations, post-partum training, pelvic-floor injuries, and sex-specific neuromuscular profiles—places women at a systematic disadvantage compared with male athletes (Crossley et al., 2025). The lack of support staff, e.g., physiotherapists, S&C coaches, is strongly associated with higher injury prevalence, greater cumulative load, and reduced recovery quality throughout the season (Wilson et al., 2023). The combined effects of insufficient medical investment, reduced availability of recovery technologies, and lower staffing levels create conditions in

which women handball players face longer recovery trajectories, higher reinjury risk, and greater long-term health burdens, demonstrating that medical inequality is a central structural component of gender discrimination in the sport.

Coaching expertise and staffing imbalance

Structural gender inequality is deeply embedded in the distribution of coaching expertise within European handball: elite and highly qualified coaches are significantly more likely to assume leadership of men's teams, while women's teams are systematically deprived of equivalent levels of professional coaching staff. Research consistently demonstrates that men's professional leagues offer substantially higher financial compensation, better working conditions, and more stable contracts, which drives experienced coaches to "migrate" toward men's teams. As a result, women's teams frequently receive coaches with shorter professional experience, lower levels of formal education, or those at the early stages of their careers (LaVoi & Dutove, 2012; Norman, 2015). Importantly, this staffing asymmetry is not attributable to the athletic quality of female players but to institutional practices that historically associate "coaching prestige" with men's sport. Within the European context, studies by Fasting and colleagues reveal that women's teams often rely on less-qualified coaches and have limited access to ongoing professional development, which directly influences training planning, individualized preparation, injury prevention, and long-term talent development (Pfister, 2010).

Empirical evidence specific to handball further confirms that structural inequality in coaching expertise is particularly pronounced in women's leagues. The UNI Europa Sport (2014) analysis found that women's professional handball clubs in Spain, France, Poland, and Romania frequently lacked access to high-level licensed coaches, while men's clubs in the same countries employed more credentialed staff, secured better contracts, and maintained greater professional stability. This deficit in coaching specialization within women's teams is strongly associated with lower financial investment, club instability, limited training resources, and a systemic lack of support for women's advancement in coaching careers (Pfister, 2010). These inequalities produce measurable consequences: less-structured training processes, reduced individualization, weaker load-monitoring practices, and slower development of tactical and neuromuscular competencies among female athletes. Over time, this contributes not only to reduced competitiveness of women's clubs but also to increased injury risk and decreased sustainability of professional athletic careers, demonstrating that coaching inequality is a key mechanism through which gender discrimination is reproduced in handball.

Epistemic discrimination

Scientific knowledge in sport has been built primarily on male bodies. Epistemic discrimination does not manifest as explicit prohibition but rather as systematic disregard for female physiology in research design. Analyses of leading sports science journals show that only 4–13% of publications include exclusively female participants, while over 70% of studies use male samples or mixed samples without gender-specific analysis (Costello et al., 2014). The problem runs deeper than it appears: even when women are present as research subjects, investigations routinely fail to control for menstrual cycle and hormonal fluctuations. A systematic review of 299 sports medicine studies revealed a paradox, 71% of participants were female, yet only 7% of studies were designed to examine sex differences, and none controlled for hormonal status (Smith et al., 2022). This means women become visible as numbers but remain invisible as biology. Literature on young athlete development demonstrates the same asymmetry: systematic reviews of adolescent motor abilities predominantly analyse boys, while dramatic physiological differences between ages twelve and sixteen remain unexamined and unincorporated into training programs (Malina et al., 2004; Owen et al., 2020). The result is a global "gender data gap" in sport, where the absence of female-specific findings produces the absence of female-specific training models, which directly increases injury risk (Curran et al., 2019).

The epistemic lack of data has concrete consequences. Female handball players train according to programs developed for the male body, periodization models, load protocols, strength testing, and even injury prevention are all based on male physiology. Coaches have standards for men, and women fit into those standards, without consideration of their distinct neuromuscular structure, different adaptation

to intense training, or specific risks such as ACL injuries and pelvic floor dysfunction (Elliott-Sale et al., 2021). The absence of female-specific science produces measurable harm: athletes receive inadequate prevention protocols, recovery is designed without understanding hormonal change, and sports physicians and coaches lack the foundation to comprehend menstrual cycle effects, RED-S syndrome, iron deficiency, or postpartum adaptation (Smith et al., 2022). Women's handball pays the price. Young handball players are prepared according to programs misaligned with their physiology, resulting in higher dropout rates in adolescence, elevated injury rates in elite careers, and suboptimal early talent development.

CONCLUSION

Gender inequality in handball emerges through three mutually reinforcing mechanisms that permeate all layers of the sport. Direct discrimination manifests in unequal salaries, prize structures, and the volume and framing of media exposure—visible disparities rooted in long-standing traditions that prioritize men's competitions. Institutional discrimination is embedded in organizational routines that appear gender-neutral yet consistently produce unequal outcomes: disproportionate budget distribution restricts women's access to high-quality facilities and confines them to less favourable training times; medical and support staff remain concentrated in men's programs; and coaching expertise is drawn toward men's leagues due to greater financial security and professional advancement. The most pervasive form, epistemic discrimination, unfolds quietly through the dominance of male-centred research in sports science. Because training models, injury-prevention guidelines, and performance frameworks are largely derived from studies on male athletes, female handball players are required to follow protocols misaligned with their physiological profiles, resulting in structural disadvantages that shape their development, health, and long-term performance potential.

This knowledge gap produces a circular disadvantage: the absence of female-specific research creates the absence of female-specific training models, which results in inadequate injury prevention, prolonged recovery, and reduced optimization of performance.

These three forms of discrimination do not exist in isolation. Economic inequality produces institutional inequality, underfunded women's teams cannot employ qualified medical staff or high-level coaches. Institutional inequality perpetuates epistemic discrimination, under-resourced programs cannot invest in research or implement gender-specific practices. Epistemic discrimination then reinforces all previous forms, without scientific evidence of women's specific needs, decision-makers justify continued underinvestment as a matter of "market logic" rather than institutional choice. The result is that female handball players encounter systematic disadvantage at every stage of development: inadequate training conditions in youth, insufficient medical support and coaching expertise in elite careers, and recovery protocols designed for male bodies. The sustainability of women's professional careers is compromised not by women's athletic capacity but by structural choices made at institutional levels.

When structural barriers are dismantled, female athletes thrive. Addressing gender inequality in handball requires intervention at all three levels simultaneously. Direct discrimination must be confronted through equal pay policies and transparent media investment. Institutional discrimination requires deliberate resource reallocation, equitable facility access, investment in medical staff, and support for coaching development in women's leagues. Epistemic discrimination demands a commitment to female-specific research, integration of gender-informed practices into training design, and education of coaches and physicians in sex-specific physiology. Without action at all three levels, inequality will persist because each form sustains the others. The task ahead is not to wait for women's handball to become "commercially competitive" before offering equal support, but to recognize that equal support is the precondition for competitive development. Structural change in sport requires structural commitment.

REFERENCES

1. Acker, J. (1990). Hierarchies, jobs, bodies: A Theory of Gendered Organizations: A Theory of Gendered Organizations. *Gender & Society*, *4*(2), 139-158. https://doi.org/10.1177/089124390004002002

2. Aksović, N., Bjelica, B., Ilić, I., Ilić, H. S. & Miletić, M. (2022). Structure of situational motor abilities in handball. *Sport and Health*, *16*(1), 111–120. https://doi.org/10.7251/SIZEN2101111A
3. Ayúcar-Sánchez, A., Lera-López, F., & Iraizoz, B. (2024). Comparing competitive balance for men's and women's leagues in European handball. *Managing Sport and Leisure*, 1-18. https://doi.org/10.1080/23750472.2024.2387104
4. Báčová, M. (2022). *Wage gap between NBA and WNBA* (Bachelor's thesis, Charles University, Faculty of Social Sciences, Institute of Economic Studies). Charles University Digital Repository. https://dspace.cuni.cz/handle/20.500.11956/175471
5. Benson, L. C., Räisänen, A. M., Volkova, V. G., Pasanen, K., & Emery, C. A. (2020). Workload a-WEAR-ness: Monitoring Workload in Team Sports With Wearable Technology. A Scoping Review. *The Journal of orthopaedic and sports physical therapy*, *50*(10), 549-563. https://doi.org/10.2519/jospt.2020.9753
6. Bruce, T. (2016). New Rules for New Times: Sportswomen and Media Representation in the Third Wave. *Sex Roles, 74*, 361-376. https://doi.org/10.1007/s11199-015-0497-6
7. Coakley, J. (2021). *Sports in society: Issues and controversies* (13th ed.). McGraw-Hill.
8. Connell, R. W., & Messerschmidt, J. W. (2005). Hegemonic masculinity: Rethinking the concept. *Gender & Society, 19*(6), 829-859. https://doi.org/10.1177/0891243205278639
9. Cooky, C., & Messner, M. A. (2018). *No slam dunk: Gender, sport and the unevenness of social change*. Rutgers University Press.
10. Cooky, C., Messner, M. A., & Hextrum, R. H. (2013). *Women play sport, but not on TV: A longitudinal study of televised news media*. *Communication & Sport, 1*(3), 203-230. https://doi.org/10.1177/2167479513476947
11. Cooky, C., Messner, M. A., & Musto, M. (2015). "It's dude time!" A quarter century of excluding women's sports in televised news and highlight shows. *Communication & Sport*, *3*(3), 261-287. https://doi/abs/10.1177/2167479515588761
12. Costello, J. T., Bieuzen, F., & Bleakley, C. M. (2014). Where are all the female participants in Sports and Exercise Medicine research?. *European journal of sport science*, *14*(8), 847-851. https://doi.org/10.1080/17461391.2014.911354
13. Crossley, K. M., Haberfield, M. J., Ross, A. G., Gracias, L. J., Bruder, A. M., Whittaker, J. L., Chintoh, A., Thornton, J. S., Davenport, M. H., Mountjoy, M., Hayman, M., Patterson, B. E., Blauwet, C. A., Verhagen, E., van den Berg, C., Okoth, C. A., Bolling, C., Janse van Rensburg, D. C. C., Casey, E., Constantini, N. W.,Adom-Aboagye, N. A., Tomás, R., Tsukahara, Y., Emery, A. C., & Donaldson, A. (2025). Gender- and/or sex-specific considerations for sport-related injury: a concept mapping approach for the Female, woman and/or girl Athlete Injury pRevention (FAIR) consensus. *British journal of sports medicine*, *0*, 1-15. https://doi.org/10.1136/bjsports-2025-109946
14. Curran, O., MacNamara, Á., & Passmore, D. (2019). What about the girls? Exploring the gender data gap in talent development. *Frontiers in Sports and Active Living*, 1(3). https://doi.org/10.3389/fspor.2019.00003
15. Elliott-Sale, K. J., Minahan, C. L., de Jonge, X. A. K. J., Ackerman, K. E., Sipilä, S., Constantini, N. W., & Hackney, A. C. (2021). Methodological considerations for studies in sport and exercise science with women as participants: A working guide for standards of practice for research on women. *Sports Medicine*, *51*(5), 843-861. https://doi.org/10.1007/s40279-021-01435-8
16. Emmonds, S., Nicholson, G., Begg, C., Jones, B., & Bissas, A. (2019). *Importance of physical qualities for speed and change of direction ability in elite female soccer players*. *Journal of Strength and Conditioning Research*, *33*(6), 1669-1677. https://doi.org/10.1519/JSC.0000000000002114
17. European Handball Federation – EHF. (2024). *Broadcast and digital engagement report 2022/23.* https://ehfec.eurohandball.com/men/2022-23/news/en/men-s-ehf-euro-2024-celebrates-33-increase-in-broadcast-reach-on-previous-edition/
18. European Handball Federation Medical Commission. (2022). *EHF medical and player safety report. Vienna: EHF*. https://www.eurohandball.com/en/who-we-are/ehf-commissions/
19. European Handball Federation, EHF. (2024a). European Handball 2023. EHF Business Reports. https://www.eurohandball.com/en/what-we-do/publications/business-reports/
20. Filipović, M., Stanković, V., Čoh, M., Vitošević, B., & Radosavljević, D. (2019). Regression algorithms in assessing the impact of morphological and motor characteristics on 60-m sprint. *Facta Universitatis, Series: Physical Education and Sport, 17*(2), 221-236. https://doi.org/10.22190/FUPES190731022F
21. Fink, J. S. (2015). Female athletes, women's sport, and the sport media commercial complex: Have we really "come a long way, baby"?. *Sport management review*, *18*(3), 331-342. https://doi.org/10.1016/j.smr.2014.05.001
22. Flake, C., Dufur, M. J., & Moore, E. L. (2013). Advantage men: The sex pay gap in professional tennis. *International Review for the Sociology of Sport*, *48*(3), 366-376. https://doi.org/10.1177/1012690212442166

23. Florin, T. D., Adrian, G., Marco, C., Daniele, S., Sara, B., Christina, T., & Panos, P. (2023). Strategies and best practices for international handball development. *Ovidius University Annals, Series Physical Education and Sport / Science, Movement and Health, 23*(2, Supplement), 515-520.
24. Galván Cárdenas, Á. (2022). La infrarrepresentación de los medios de comunicación hacia el deporte femenino llega a las redes sociales: Estudio de casos en Instagram. *Sociología del Deporte*, *2*(2). https://doi.org/10.46661/socioldeporte.6275
25. Ilić, I. (2015). Structures and differences of the cognitive abilities of top handball, volleyball, basketball and soccer players. Facta Universitatis, Series: Physical Education and Sport, 403-410.
26. Ilić, I., Durlević, S., Bubanj, S., Bjelica, B., Aksović, N., & Dobrescu, T. (2023). Impact of explosive strength on shot speed in handball. *Gymnasium*, *24*(2), 109–119. https://doi.org/10.29081/gsjesh.2023.24.2.07
27. Ilić, I., Filipović, M., Durlević, S., & Stojanović, N. (2025). Sex-based multidimensional analysis of explosive power in handball players. *Physical education and sport through the centuries*, *12*(2), 13–25. https://doi.org/10.5937/spes2502013I
28. LaVoi, N. M., & Dutove, J. K. (2012). Barriers and supports for female coaches: An ecological model. *Sports Coaching Review, 1*(1), 17-37. https://doi.org/10.1080/21640629.2012.695891
29. Malina, R. M., Bouchard, C., & Bar-Or, O. (2004). *Growth, maturation, and physical activity* (2nd ed.). Human Kinetics. https://doi.org/10.5040/9781492596837
30. Meier, H. E., Konjer, M. V., Müller, S., & Mutz, M. (2025). *Getting the pay gap on the board: Female athletes' demands for "equal pay" in German media narratives*. *Communication & Sport, 0*(0), 1-31. https://doi.org/10.1177/21674795251363427
31. Michalsik, L. B., & Aagaard, P. (2015). Physical demands in elite team handball: comparisons between male and female players. *The Journal of sports medicine and physical fitness*, *55*(9), 878-891.
32. Norman, L. (2015). The coaching needs of high-performance female athletes within the coach–athlete dyad. *International Sport Coaching Journal, 2*(1), 15-28. https://doi.org/10.1123/iscj.2013-0037
33. Owen, C., Till, K., Weakley, J., & Jones, B. (2020). Testing methods and physical qualities of male age grade rugby union players: A systematic review. *PloS one*, *15*(6), e0233796. https://doi.org/10.1371/journal.pone.0233796
34. Pfister, G. (2010). Women in sport: Gender relations and future perspectives. *Sport in Society, 13*(2), 234-248. https://doi.org/10.1080/17430430903522954
35. Poppelwell-Scevak, C. (2022). The gender pay gap: How FIFA dropped the ball. *International Journal of Constitutional Law*, *20*(1), 325-350. https://doi.org/10.1093/icon/moac011
36. Póvoas, S. C., Seabra, A. F., Ascensão, A. A., Magalhães, J., Soares, J. M., & Rebelo, A. N. (2012). Physical and physiological demands of elite team handball. *Journal of strength and conditioning research*, *26*(12), 3365-3375. https://doi.org/10.1519/JSC.0b013e318248aeee
37. Rogstad, E. T., Tjønndal, A., Røsten, S., & Skirbekk, S. B. (2024). From field to feed: Norwegian Football Players' usage and self-presentation on Instagram throughout the UEFA Women's EURO 2022 Championship. *International Review for the Sociology of Sport*, *59*(8), 1144-1166. https://doi.org/10.1177/10126902241252319
38. Sachdeva, S., Hartley, B., & Roberts, C. (2022). Ladies in the Bone Room? Addressing the Gender Gap in Orthopaedics. *Injury*, *53*(10), 3065-3066. https://doi.org/10.1016/j.injury.2022.09.006
39. Salido-Fernández, J., & Muñoz-Muñoz, A. M. (2021). Media representation of women athletes at the Olympic Games: A systematic review. *Apunts Educación Física y Deportes, 146*(4), 32-41. https://doi.org/10.5672/apunts.2014-0983.es.(2021/4).146.04
40. Smith, E. S., McKay, A. K. A., Kuikman, M., Ackerman, K. E., Harris, R., Elliott-Sale, K. J., Stellingwerff, T., & Burke, L. M. (2022). Managing Female Athlete Health: Auditing the Representation of Female versus Male Participants among Research in Supplements to Manage Diagnosed Micronutrient Issues. *Nutrients*, *14*(16), 3372. https://doi.org/10.3390/nu14163372
41. Snyder, H. (2019). Literature review as a research methodology: an overview and guidelines. *Journal of Business Research*, 104, 333-339. https://doi.org/10.1016/j.jbusres.2019.07.039
42. Tingelstad, L. M., Raastad, T., Till, K., & Luteberget, L. S. (2023). The development of physical characteristics in adolescent team sport athletes: A systematic review. *Plos One, 18*(12), e0296181. https://doi.org/10.1371/journal.pone.0296181
43. UNI Europa Sport. (2024). *An analysis of the working conditions of professional sports players*. https://euathletes.org/wp-content/uploads/2017/06/2013-UNI-An-Analysis-of-Working-Conditions-of-Professional-Sports-Plyers-ilovepdf-compressed-1.pdf?utm_source=chatgpt.com

44. Wicker, P., Breuer, C., & Dallmeyear, S. (2021). The gender earnings gap among elite athletes in semi-professional sports. *Managing Sport and Leisure*, *28*(6), 583-600. https://doi.org/10.1080/23750472.2021.1944819
45. Wilson, J., Agha, O., Wiggins, A. J., Diaz, A., Jones, K. J., Feeley, B. T., Pandya, N. K., & Wong, S. E. (2023). Gender and Racial Diversity Among the Head Medical and Athletic Training Staff of Women's Professional Sports Leagues. *Orthopaedic journal of sports medicine*, *11*(2), 23259671221150447. https://doi.org/10.1177/23259671221150447

INTEGRATING FIELD HANDBALL INTO HANDBALL TRAINING: PERFORMANCE, PSYCHOLOGICAL AND INJURY-RELATED EFFECTS – A NARRATIVE REVIEW

Durlević Slavka[1], Filipović Milica[2], Ilić Igor[2]
[1]Faculty of Sport and Physical Education, University of Novi Sad, Serbia
[2]Faculty of Sport and Physical Education, University of Priština – Kosovska Mitrovica, Leposavić, Serbia

REVIEW ARTICLE
DOI: 10.5937/ATAVPA25178D

Abstract: *The research examines the potential benefits and risks associated with incorporating field handball into the training process in modern handball. The game of field handball, historically played on large outdoor pitches, offers various advantages, including the development of motor skills, enhanced functional abilities, refined technical execution, and psychological benefits through outdoor training. Players benefit from improved ball handling, endurance, and mental resilience, alongside reduced injury risks. Training on grass surfaces promotes joint stability and reduces overuse injuries often associated with repetitive training. However, there are inherent risks in overemphasising the use of field handball in the training process. The larger playing field and different rules may detract from technical and tactical skills specific to indoor handball, particularly spatial awareness and coordination in limited manoeuvring spaces. Moreover, environmental factors such as prolonged sun exposure, high humidity, and allergens pose health risks, including dehydration, respiratory and skin issues. Careful planning, including appropriate timing of outdoor sessions and protective measures, can mitigate these risks. Despite these challenges, the strategic incorporation of field handball into handball training programs presents a unique opportunity to enhance both individual and team performance while diversifying traditional training methods.*
Key words: *field handball, outdoor training, physical preparation, motor skills, sports injuries*

INTRODUCTION

Handball is one of the most widespread and popular team sports. Throughout its evolution, handball rules changed several times, which directly affected the change in the structure of the game (Ilić, 2025). Handball belongs to the group of polystructured sports, in which cyclic and acyclic movement structures are equally represented (Bragazzi et al., 2020; Branković et al., 2012; Vuleta & Milanović, 2004). Namely, handball, as rarely any other sport, contains almost all natural forms of movement that constantly alternate such as running, jumping, pushing and landing (Buchheit et al., 2009; Chelly et al., 2010). The results achieved by the most successful clubs and national teams in the world can be attributed to the high level of preparation of handball players, who are subjected to a well-planned and organised training process (Bjelica et al., 2012; Gómez-López et al., 2020). The long-term training process in handball leads to the transformation of morphological characteristics, motor and functional abilities that are responsible for achieving top results in the handball game (Pavlović et al., 2013; Pori et al., 2012; Sporiš et al., 2010). The training process is the continuous repetition and combination of planned exercises and movements with the aim of adapting the body to the required demands (Fulgozi, 1994; Koprivica, 2013). In the handball training process, physical preparation is one of the most important training areas, which is supplemented by tactical, technical and psychological preparation (Bompa, 2000; Fulgozi, 1994; Granados et al., 2008; Koprivica, 2013; Milanović, 2010; Milanović et al., 2012; Stojanović et al., 2009). According to Željaskov (2004), the physical preparation of athletes is defined as a complex process of implementing various programs and means for the development, maintenance and improvement of athletes' morphological characteristics, motor and functional abilities. Malacko (2002), Metvejev (2000) and Jalolovich (2022) point out that the primary task of physical preparation is to improve training and sports results by raising the basic and specific abilities necessary for handball.

The current iteration of handball is a modern version of field handball, the game that was played at the beginning and middle of the 20th century, and was in many ways comparable to football (Ilić, 2000; Kamolovich, 2024). It was played on a grass surface whose field dimensions ranged from 90 to 100 m in length and 55 to 65 m in width. With the introduction of indoor handball, interest in field handball declined, which led to the need for its modernisation. Additional pair of parallel lines, which divided the pitch into three parts, was introduced - defence, midfield, also known as central, and attack zone. The

end zones were 35 m long, while the central zone length varied and depended on the length of the field. The game was played between two teams of 11 players on the fields and two substitutes. At one time a maximum of six attacking players could be in the attack zone, as well as a maximum of six players which could occupy the defence zone. The goalkeeper's area was semicircular in shape with a radius of 13 m, whilst the penalty was taken from a distance of 14 m. The ball could be held in the hands for three or six seconds, depending on the rule, or it could be used for a maximum of three steps, after which the player had to pass or dribble it. Unlike dribbling rules in indoor handball, players could dribble the ball once, catch the ball and make three steps with it, after which they could dribble it again. The match consisted of two halves lasting 30 minutes each for men and 25 minutes for women, with a 10-minute break between halves. Progressive punishment in field handball was reflected in a five- or ten-minute suspension, or in the case of the most serious violations, a sending-off for the rest of the game.

Because of the field handball specific rules and pitch size, training on a large pitch, on which a game of field handball is played can, on the one hand, adequately implement existing training processes that lead to learning and improving technical and tactical (TE-TA) skills of handball players, which could still be applied in modern, indoor handball, and on the other hand, the supra-situational character of this training can contribute to improving the standard or existing training process by introducing new stimuli and on-field situations. The goal of this research is to ascertain the potential of integrating the game and elements of field handball in the modern handball training process, with the aim of identifying the potential benefits and risks of the implementation of this training method.

METHODS

This study was designed as a narrative literature review with the aim of synthesising current knowledge on the integration of field handball as an outdoor training method within the handball training process. A narrative approach was chosen because it allows the combination of heterogeneous sources, including empirical studies on handball and other team sports, theoretical and methodological texts on training, sports medicine literature, and historical accounts of field handball. This flexibility was necessary due to the limited number of studies directly examining field handball and the multidimensional character of the topic, which encompasses performance, psychological adaptation, injury prevention, and environmental conditions.

The literature search was conducted in several major scientific databases (Scopus, Web of Science, PubMed, and SPORTDiscus), supplemented by searches in Google Scholar and by reviewing reference lists of key articles and books. In addition, relevant textbooks on sport training theory and handball, as well as official documents and materials from handball governing bodies, were consulted to contextualise the historical development and rules of field handball and its relationship to modern indoor handball. The search strategy combined keywords related to handball, field handball, outdoor training, grass surface, physical preparation, environmental conditions, psychological effects, and injury prevention. For empirical training and sports medicine studies, the primary focus was on works published from 2000 onwards, whereas no lower year limit was imposed on historical or conceptual sources relevant to the origins and rules of field handball.

Studies and documents were included if they addressed at least one of the following areas relevant to the potential implementation of field handball in training: (a) the physical, functional, or technical development of handball players or athletes in comparable team sports; (b) the effects of outdoor or natural-surface training on performance, health, or injury risk; (c) psychological or cognitive outcomes associated with outdoor or nature-based exercise; (d) environmental and climatic factors (such as heat, humidity, solar radiation, allergens, or altitude) that may influence training load and health in outdoor settings; or (e) descriptions of field handball rules and playing characteristics with implications for training design. Sources were excluded if they were unrelated to training and performance, did not provide sufficient methodological information, or focused exclusively on indoor technical–tactical analysis without relevance to outdoor or field-based contexts. red.

BENEFITS OF THE FIELD HANDBALL TRAINING IMPLEMENTATION

The modern training process requires a very meticulous approach from the coach in its planning and programming. Determining the impact of differently designed, planned and programmed handball training programs on changes in morphological characteristics, motor and functional abilities in different cycles of the training process is of great importance in order to maximise the training benefits. The past research demonstrated the effects and impacts of various training programs that could be applied to improve the characteristics and abilities of handball players (Buchheit et al., 2010; Gorostiaga et al., 2006; Iacono et al., 2016). However, there is a lack of research related to the game of field handball and its potential implementation in the indoor handball training process. The game of field handball represents a specific situational and supra-situational training method that can be applied in the training process. In addition to the training taking place outdoors, the implementation of field handball in the training process of handball players has a number of positive benefits. Among them, the development and improvement of general and specific motor skills, the development of functional abilities, improvement of the players' technique, as well as a positive effect on the psychological preparation of handball players and the reduction of injuries.

One notable instance of field handball's resurgence occurred during the COVID-19 pandemic when health regulations prioritised outdoor, well-ventilated or isolated training environments (Ilić et al., 2023c). Due to the large playing area of field handball and the inherent spacing between players, it was an ideal method for maintaining training continuity while adhering to social distancing measures. This demonstrates that field handball can serve as a valuable tool even in special circumstances.

Training outdoors, particularly on natural surfaces, offers a host of mental and physical benefits (Pereira et al., 2024). Exposure to sunlight and fresh air improves mood, mental health, and cognitive functioning while fostering social connection. Training in nature also boosts vitamin D levels and attention capacity, which may indirectly contribute to better athletic performance (Valtueña et al., 2014; Krzywanski et al., 2016). Aerobic and anaerobic activities, which are dominant to field handball, enhance the cardiovascular and respiratory systems. Playing on large, uneven outdoor fields promotes greater muscular engagement, particularly for the legs and core, improving joint stability and reducing the risk of injuries over time.

Altitude training, often utilised by athletes seeking to improve aerobic capacity, can be easily integrated into field handball sessions. Moderate altitude training, commonly conducted at elevations of 1000-1500 meters, forces the body to adapt to lower oxygen levels, thereby enhancing oxygen transportation and boosting endurance (Hamlin et al., 2018). The result is improved blood flow, muscle oxygenation, and metabolic efficiency, all of which are vital for elite athletic performance (Billaut et al., 2012). Training in the outdoor environment introduces external variables, such as temperature, humidity, and altitude, which compel the body to adapt to fluctuating levels of oxygen and atmospheric pressure (Aughey et al., 2013). Incorporating field handball into a preseason high-altitude training program can bolster endurance and cardiovascular health. Athletes who train at higher altitudes often experience physiological adaptations that translate into better performance in low-altitude environments, providing an additional performance edge during the competitive season (Brocherie et al., 2015).

Field handball also offers relief from the monotony of repetitive indoor training sessions. By engaging in diverse and dynamic training on large, open fields, players avoid overuse injuries caused by repetitive movements. The unpredictability of outdoor conditions challenges players to constantly adjust, improving agility, balance, and coordination, which are crucial for optimal performance in modern handball (Spasic et al., 2015; Chaabene et al., 2021).

A key advantage of field handball training is its impact on ball handling and passing skills. The grassy surface, which is less predictable and offers higher resistance than indoor courts, challenges players to focus on precise ball control, passing, and catching. The absence of adhesives like glue forces players to develop superior hand-eye coordination and tactile ball control (Ilić et al., 2023a). The larger field dimensions increase the distance between teammates, requiring more powerful and accurate throws (Ilić et al., 2023b). The specific demands of field handball help players refine their technique, throwing power, and tactical awareness.

From a psychological standpoint, field handball creates unique cognitive challenges for players. The larger playing surface and different environmental stimuli require players to solve tactical problems quickly, enhancing their decision-making and spatial awareness (Ilić, 2016). Additionally, the stress-reducing effects of outdoor training, combined with the cognitive demands of the larger playing pitch, foster improved focus, creativity, and mental resilience.

Field handball training has also been shown to reduce the risk of ankle and knee injuries. Teams that incorporate outdoor grass-field training in their preseason preparation report fewer joint-related injuries compared to teams that primarily train indoors. Grass surfaces provide a natural, softer landing, which, combined with the uneven terrain, strengthens the muscles and tendons surrounding the joints. This reduces the strain placed on joints during movement, effectively lowering injury rates over time.

POTENTIAL RISKS OF THE FIELD HANDBALL TRAINING IMPLEMENTATION

While field handball offers numerous advantages, it is essential to recognise and mitigate potential risks. Excessive exposure of players to field handball training, especially during the competitive season, may lead to the deterioration of technical and tactical abilities specific to indoor handball, such as spatial awareness and timing on a smaller court. Training too frequently on large fields can reduce the efficiency of group and team tactics.

Environmental factors, such as excessive sun exposure, present another risk (Snyder et al., 2020). Direct sunlight during training can lead to skin and eye damage (Kohmura, 2021). To minimise this risk, training sessions should be scheduled during periods of lower solar intensity, and athletes should be encouraged to wear protective gear (Jablonski & Chaplin, 2010). Additionally, high humidity levels may exacerbate the physiological strain during intense outdoor training sessions (Popović Ilić & Ilić, 2022). Finally, outdoor environments may expose athletes to allergens, which can impair respiratory function and overall performance (Helenius et al., 2000; Katelaris, 2000).

CONCLUSION

The handball training process remains a key determinant of success in modern handball. A well-structured, properly implemented training program significantly improves player performance and reduces injury risk. Field handball, with its specific situational training methods, can serve as an effective tool during physical preparation. The inclusion of field handball not only diversifies training stimuli but also offers a range of physical and psychological benefits. Training in nature enhances functional and motor skills, improves mental health, refines technical abilities, and reduces the occurrence of injuries. By thoughtfully incorporating field handball into the training process, handball teams can improve player development while optimising both individual and team performance.

REFERENCES

1. Aughey, R., Buchheit, M., Garvican-Lewis, L., Roach, G., Sargent, C., Billaut, F., Varley, M., Bourdon, P., & Gore, C. (2013). Yin and yang, or peas in a pod? Individual-sport versus team-sport athletes and altitude training. *British Journal of Sports Medicine*, *47*(18), 1150–1154. https://doi.org/10.1136/bjsports-2013-092764
2. Billaut, F., Gore, C. J., & Aughey, R. (2012). Enhancing team-sport athlete performance: is altitude training relevant? *Sports medicine*, *42*, 751-767. https://doi.org/10.1007/BF03262293
3. Bjelica, D., Georgiev, G., & Muratović, A. (2012). Basic motor abilities of young handball players from Montenegro. *Sport Science*, *5*(1), 71-76.
4. Bompa, T. (2000). *Cjelokupan trening za mlade pobjednike*. Hrvatski košarkaški savez, Udruga hrvatskih košarkaških trenera.
5. Bragazzi, N. L., Rouissi, M., Hermassi, S., & Chamari, K. (2020). Resistance Training and Handball Players' Isokinetic, Isometric and Maximal Strength, Muscle Power and Throwing Ball Velocity: A Systematic Review and Meta-Analysis. *International journal of environmental research and public health*, *17*(8), 2663. https://doi.org/10.3390/ijerph17082663
6. Branković, D., Martinović, D., & Ilić, J. (2012). Relations between general motor skills and handball specific test "ball slalom" in students of the iv grade of primary school. *Sport Mont*, *10*(34-35-36), 188-193.

7. Brocherie, F., Girard, O., Faiss, R., & Millet, G. P. (2015). High-intensity intermittent training in hypoxia: a double-blinded, placebo-controlled field study in youth football players. *The Journal of Strength & Conditioning Research*, *29*(1), 226-237. https://doi.org/10.1519/JSC.0000000000000590
8. Buchheit, M., Laursen, P. B., Kuhnle, J., Ruch, D., Renaud, C., & Ahmaidi, S. (2009). Game-based training in young elite handball players. *International journal of sports medicine*, *30*(4), 251-258. https://doi.org/10.1055/s-0028-1105943
9. Buchheit, M., Mendez-Villanueva, A., Quod, M., Quesnel, T., & Ahmaidi, S. (2010). Improving acceleration and repeated sprint ability in well-trained adolescent handball players: speed versus sprint interval training. *International Journal of Sports Physiology and Performance*, *5*(2), 152-164. http://dx.doi.org/10.1123/ijspp.5.2.152
10. Chaabene, H., Negra, Y., Sammoud, S., Moran, J., Ramirez-Campillo, R., Granacher, U., & Prieske, O. (2021). The effects of combined balance and complex training versus complex training only on measures of physical fitness in young female handball players. *International Journal of Sports Physiology and Performance*, *16*(10), 1439-1446. https://doi.org/10.1123/ijspp.2020-0765
11. Chelly, M. S., Hermassi, S., & Shephard, R. J. (2010). Relationships between power and strength of the upper and lower limb muscles and throwing velocity in male handball players. *The Journal of Strength & Conditioning Research*, *24*(6), 1480-1487. https://doi.org/10.1519/JSC.0b013e3181d32fbf
12. Fulgozi, K. (1994). *Rukomet – fizička priprema*. Sportski Savez Beograd.
13. Gómez-López, M., Manzano-Sánchez, D., Merino-Barrero, J. A., & Valero-Valenzuela, A. (2020). Causes of success in handball through the beliefs about ability. *International Journal of Medicine & Science of Physical Activity & Sport*, *20*(77), 103-118. https://doi.org/10.15366/rimcafd2020.77.007
14. Granados, C., Izquierdo, M., Ibáñez, J., Ruesta, M., & Gorostiaga, E. M. (2008). Effects of an entire season on physical fitness in elite female handball players. *Medicine & Science in Sports & Exercise*, *40*(2), 351-361.
15. Gorostiaga, E., Granados, C., Ibanez, J., & Izquierdo, M. (2005). Differences in physical fitness and throwing velocity among elite and amateur male handball players. *International Journal of Sports Medicine*, *26*(3), 225-232. https://doi.org/10.1055/s-2004-820974
16. Hamlin, M. J., Lizamore, C. A., & Hopkins, W. G. (2018). The effect of natural or simulated altitude training on high-intensity intermittent running performance in team-sport athletes: a meta-analysis. *Sports medicine*, *48*, 431-446. https://doi.org/10.1007/s40279-017-0809-9
17. Helenius, I., & Haahtela, T. (2000). Allergy and asthma in elite summer sport athletes. *Journal of allergy and clinical immunology*, *106*(3), 444-452. https://doi.org/10.1067/mai.2000.107749
18. Iacono, A. D., Ardigo, L. P., Meckel, Y., & Padulo, J. (2016). Effects of small-sided games and repeated shuffle sprint training on physical performance in elite handball players. *Journal of Strength and Conditioning Research*, *30*(3), 830-840.
19. Ilić, I., Durlević, S., & Stojanović, T. (2023). Differences in the maximum shot speed of handball players in relation to the resin used. *Sportlogia*, *19*(1), 87-94. https://doi.org/10.7251/sgia.2319108i.en.jrm
20. Ilić, I., Durlević, S., Bubanj, S., Bjelica, B., & Aksović, N. (2023). Impact of Explosive Strength on Shot Speed in Handball. *Gymnasium: Scientific Journal of Education, Sports & Health*, *24*(2), 109-119. https://doi.org/10.29081/gsjesh.2023.24.2.07
21. Ilić, I. (2016). Structures and differences of the cognitive abilities of top handball, volleyball, basketball and soccer players. *Facta Universitatis, Series: Physical Education and Sport*, *13*(3), 403-410.
22. Ilić, I. (2025). *Osnove rukometa*. Fakultet za sport i fizičko vaspitanje Univerziteta u Prištini sa privremenim sedištem u Kosovskoj Mitrovici. https://plus.cobiss.net/cobiss/sr/en/data/cobib/175927049
23. Ilić, I., Filipović, M., Durlević, S., & Pavlović, J. (2023). Resilience and adaptation: evaluating the socioeconomic impact of COVID-19 on handball. *SCIENCE International Journal*, *2*(4), 81-85. https://doi.org/10.35120/sciencej0204081i
24. Ilić, M. (2000). *Rukomet 1949-1999*. Pelikan print.
25. Jablonski, N. G., & Chaplin, G. (2010). Human skin pigmentation as an adaptation to UV radiation. *Proceedings of the National Academy of Sciences*, 107(Supplement 2), 8962-8968. https://doi.org/10.1073/pnas.0914628107
26. Jalolovich, S. J. (2022). Physical training of young handball players and its importance. *Web of Scientist: International Scientific Research Journal*, *3*(1), 406-413.
27. Kamolovich, K. I. (2024). History of the origin and development of the game of handball. *American Journal of Innovation in Science Research and Development*, *1*(4), 16-20.
28. Katelaris, C. H., Carrozzi, F. M., Burke, T. V., & Byth, K. (2000). A springtime Olympics demands special consideration for allergic athletes. *Journal of Allergy and Clinical Immunology*, *106*(2), 260-266. https://doi.org/10.1067/mai.2000.108603

29. Kohmura, Y. (2021). Importance of vision and sun protection in outdoor sports: a narrative review. *Journal of Physical Education and Sport*, *21*(Suppl. issue 6), 3187-3194. https://doi.org/10.7752/jpes.2021.s6424
30. Koprivica, V. (2013). *Teorija sportskog treninga*. Fakultet za sport i fizičko vaspitanje Univerziteta u Beogradu.
31. Krzywanski, J., Mikulski, T., Krysztofiak, H., Mlynczak, M., Gaczynska, E., & Ziemba, A. (2016). Seasonal vitamin D status in Polish elite athletes in relation to sun exposure and oral supplementation. *PloS one*, *11*(10), e0164395. https://doi.org/10.1371/journal.pone.0164395
32. Malacko, J. (2002). *Osnove sporstkog treninga.* Sportska akademija.
33. Metvejev, L.P. (2000). Osnovi suvremenog sistema sportivnoj trenirovki. Moskva: FIS.
34. Milanović, D. (2010). *Teorija i metodika treninga; primjenjena kineziologija u sportu*. Kineziološki fakultet Univerziteta u Zagrebu.
35. Milanović, D., Šalaj, S., & Gregov, C. (2012). Basic physical conditioning in athlete's health protection. *Arhiv za higijenu rada i toksikologiju*, *63*(Supplement 3), 103-119.
36. Pereira, R., Krustrup, P., Castagna, C., Resende, C., Carneiro, I., Magalhães, J., & Póvoas, S. (2024). Exercise intensity and reliability during recreational team handball training for 50–77-year-old unexperienced women. *Biology of Sport*, *41*(4), 253-261. https://doi.org/10.5114/biolsport.2024.132995
37. Pavlović, S., Talović, M., Kazazović, E., & Lakota, R. (2013). Analysis and Differences in the Basic Motor and Situational Motor Abilities between Female Handball Players in the Bih First Federal League and the First League of the Republika Srpska. *SportLogia*, *9*(2), 217-224. https://doi.org/10.5550/sgia.130902.en.008P
38. Popović Ilić, T., & Ilić, I. (2022). *Sportska medicina*. Fakultet za sport i fizičko vaspitanje Univerziteta u Prištini – Kosovska Mitrovica. https://plus.cobiss.net/cobiss/sr/sr_latn/bib/68985865
39. Pori, P., Šibila, M., Justin, I., Kajtna, T., & Pori, M. (2012). Correlation between the motor abilities and competitive performance of Slovenian handball goalkeepers. *Kinesiologia Slovenica*, *18*(2), 19-26.
40. Snyder, A., Valdebran, M., Terrero, D., Amber, K. T., & Kelly, K. M. (2020). Solar ultraviolet exposure in individuals who perform outdoor sport activities. *Sports medicine-open*, *6*, 1-12. https://doi.org/10.1186/s40798-020-00272-9
41. Spasic, M., Krolo, A., Zenic, N., Delextrat, A., & Sekulic, D. (2015). Reactive Agility Performance in Handball; Development and Evaluation of a Sport-Specific Measurement Protocol. *Journal of sports science & medicine*, *14*(3), 501–506.
42. Sporiš, G., Vuleta, D., Vuleta Jr, D., & Milanović, D. (2010). Fitness profiling in handball: physical and physiological characteristics of elite players. *Collegium antropologicum*, *34*(3), 1009-1014.
43. Stojanović, T., Dragosavljević, P., & Kostić, R. (2009). *Teorija i metodika sportskog treninga*. Fakultet fizičkog vaspitanja i sporta Univerziteta u Banja Luci.
44. Valtueña, J., Dominguez, D., Til, L., González-Gross, M., & Drobnic, F. (2014). High prevalence of vitamin D insufficiency among elite Spanish athletes; the importance of outdoor training adaptation. *Nutricion hospitalaria*, *30*(1), 124-131. https://doi.org/10.3305/nh.2014.30.1.7539
45. Vuleta, D., & Milanović, D. (2004). *Rukomet znanstvena istraživanja*. Kineziološki fakultet Univerziteta u Zagrebu.
46. Željaskov, C. (2004). *Kondicioni trening sportista*. Sportska akademija.

THE IMPACT OF PHYSICAL FITNESS COMPONENTS ON FOOTBALL PLAYERS' PERFORMANCE – A SYSTEMATIC REVIEW

Stojković Dejan, Utvić Nikola
Faculty of Sport and Physical Education, University of Priština in Kosovska Mitrovica, Leposavić, Serbia

REVIEW ARTICLE
DOI: 10.5937/ATAVPA25184S

Abstract: *Football requires a high level of physical conditioning, and key fitness components directly influence player performance. Aerobic endurance enables players to maintain a high game intensity and recover more quickly, while anaerobic strength is crucial for executing explosive movements, sprints, and direction changes. The aim of this research was to examine the influence of different physical components of fitness—strength, endurance, speed, and flexibility—on the performance of football players. The systematic review was conducted using relevant scientific databases, including PubMed, Scopus, Web of Science, Google Scholar, and SportDiscus, to encompass the most recent and relevant studies in the field of sports science and football players' physical conditioning. Speed, agility, strength, and explosiveness enhance stability, duels, and shooting accuracy, while flexibility reduces the risk of injuries. Effective training methods include high-intensity interval training (HIIT), sprint training with plyometrics, strength training, small-sided games, and fartlek training. These methods improve aerobic and anaerobic capacity, explosive power, and technical and tactical skills. Core stabilization and flexibility training contribute to injury prevention and optimal movement biomechanics. Further research should focus on individualized training approaches tailored to the specific demands of positional play.*
Key words: *football, physical fitness, aerobic endurance, anaerobic endurance, strength, agility, flexibility.*

INTRODUCTION

Football, as a dynamic and demanding sport, requires players to have a high level of physical fitness that encompasses various components of fitness, including strength, endurance, speed, coordination, and flexibility (Hoff & Helgerud, 2004).

Football, as a complete sport that abounds in the most diverse possible movements, is classified as a polystructural, complex sport. In order for a football player to be able to perform football tasks, he must, among other things, possess the necessary level of motor skills that can only be achieved through systematic physical training (Amiri-Khorasani, Osman, & Yusof, 2011). Lower limb muscle strength and anaerobic power are neuromuscular variables that affect performance in many sports activities, including football (Hoff & Helgerud, 2004).

Today's game requires a higher level of physical fitness from players, unlike in the past when the most important thing was the technical fitness of the players (Bloomfield, Polman, O'donoghue, & McNaughton, 2007). Physical fitness is a key element for success in football. Football is a sport characterized by numerous and diverse complex dynamic kinesiological activities characterized by a large number of cyclic and acyclic movements (Gardasevic et al., 2016). A high level of physical fitness is the foundation for performing all technical-tactical elements and is a key factor distinguishing high-level from lower-level football players (Gissis, 2006). During a football match, players perform approximately 1.200–1.400 different movements, of which 700–800 involve changes of direction (such as sprints, jumps, stops, and accelerations). Only about 11% of the total distance covered is performed at high intensity, yet this portion is crucial for determining match outcomes (Williams, 2006).

Football is a rather dynamic and highly explosive sport that requires a wide range of motor skills, due to the large number of changes in direction of movement, explosive accelerations and reactions. In football, explosive strength, speed and agility, including aerobic and anaerobic endurance, stand out as the most important fitness skills relevant for success (Kaplan, Erkmen, & Taskin, 2009). Physical fitness is an essential part of health and is directly related to quality of life, the development of lifestyle diseases, and mortality. The main aspects of physical fitness are cardiorespiratory fitness, strength, flexibility, and body composition (Schlegel, Křehký & Hiblbauer, 2022).

Therefore, the aim of this research was to examine the influence of different physical components of fitness—strength, endurance, speed, and flexibility—on the performance of football players. It is

hypothesized that higher levels of strength, endurance, speed, and flexibility will significantly improve the performance of football players.

MATERIALS AND METHODS

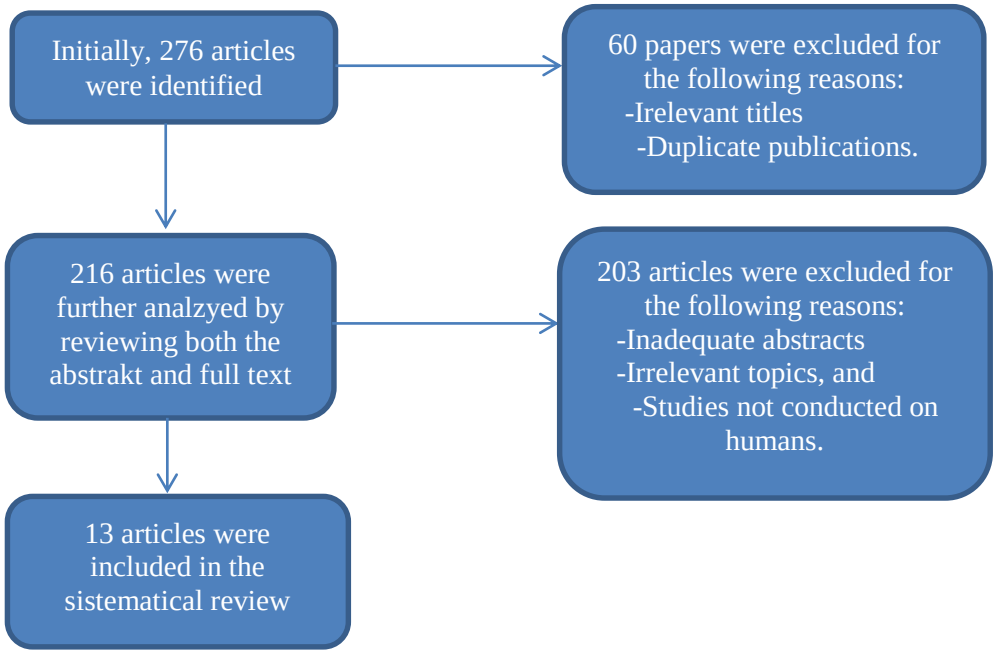
Literature search

Research data for the purposes of this review were collected through the electronic search engines PubMed, Google Scholar, journals in the field of sports sciences, as well as relevant literature that could answer the set problem.

Selection of papers

The selection of papers was determined based on the title and keywords, two selection criteria were set. The first criterion refers to success in football itself. The second criterion was the implementation of the analysis of papers in the period from 2005 to 2025. The papers were close to the research subject and met all the criteria for further consideration.

The flow of the data download procedure



RESULTS

In the time period from 2005 to 2025, twelve papers (n = 12) were taken, which were analyzed in detail and shown in Table 1. The influence of physical components on the success of football players but also the influence of motor abilities on the success of football players.

Table 1 Systematic review of the included studies

References	Population	Group	Treatment	Measurements	Results
Lolić et al. (2006)	Football players of junior cadet age	n=28, 12–13 years	BMS (General and Explosive Power) and SMS (Ball-to-Leaf Range and Ball-to-Head Range)	An initial and final measurement was made	Full recovery (up to 8 minutes) between sets
Smajić et al. (2008)	Football playeres of pioneer age	n=256, 10–12 years	Speed endurance and SP	Measurement	Soccer players with better BMS also have better SP

Molnar et al. (2008)	Football school students	n=105, 10 years	SMS (strikes on the ball, handling, running speed) and morphological characteristics	One measurement was taken	Subjects with worse SMS also have unfavorable morphological characteristics
Ejup et al. (2010)	Football school students	n=105, 10 years	SMS (ball strikes, dribbling, running speed) and morphological characteristics	One measurement was taken	Subjects with worse SMS also have unfavorable morphological characteristics
Janjić et al. (2010)	Senior football players	n=20	Training work aimed at characteristics of BMS and SMS: strength, flexibility, endurance	An initial and final measurement was made	Statistically significant changes in BMS and SMS
Lolić et al. (2011)	Cadet football players	n=83, 13–14 years	SMS (explosive and repetitive speed with endurance and aerobic CMJ)	One measurement was taken	Significant effect: speed, sprint speed, aerobic & anaerobic endurance improved
Jelaška et al. (2013)	Senior female footballers	n=70	Morphological characteristics of BMS and SMS	One measurement was taken	BMS and SMS have greatest influence on player quality
Gardašević et al. (2014)	Cadet football players	n=120, 15 years	Programmed training work and SMT	An initial and final measurement was made	Training program has positive effect on ball-handling speed
Bush et al. (2015)	Senior football players	n=147	Multiple camera and computerized system	Watching the seven seasons	New tactics affect physical and technical demands
García-Pinillos et al. (2015)	Junior football players	n=34, 14–18 years	Flexibility and SMT	One measurement was taken	Flexibility of rear lodge key for SMT performance
Athos et al. (2016)	Prepubescent football players	EG=20 (10.5 y), CG=19 (10.7 y)	Fast feet, sprints, rope ladders, visual stimulation, chase runs, mirror exercises	Initial and final measurement	SPS* SP20 reactive agility CODS
Le et al. (2024)	College football players	EG=9, CG=10 (18.89± 0.8)	Speed wall drills, COD, agility ladders, reaction balls, mirror games	Initial and final measurement	Significant differences in SP20 with ball (EG vs CG)

Legend: BMS - basic motor skills; SMS - Specific motor skills; SP - Specific precision; SMT - Situional motor-test; CMJ - Counter movement jump; FSFV - Faculty of sport and physical education.

DISCUSSION

The primary purpose of this research was to examine the influence of different physical components of fitness—strength, endurance, speed, and flexibility—on the performance of football players. Our results clearly indicate that strength and endurance are key elements that contribute to players' effectiveness during matches, as well as their technical performances. Therefore, the results fully support the hypothesis outlined in the introduction, confirming that physical fitness components play a decisive role in football performance.

A recurrent theme across the studies is the critical role of motor skills in the performance of soccer players. Lolić et al. (2006) observed significant improvements in explosive power among young players, aligning with Smajić et al. (2008) who noted that larger skeletal dimensions and explosive strength correlated with improved performance in specific accuracy tests. This emphasizes that foundational

motor skills, particularly strength and speed, play a pivotal role at early ages in developing players' abilities on the field. The relationship between anthropometric variables and motor skill performance is clear. Molnar et al. (2008) showed that players who demonstrate better motor abilities also have favorable morphological measurements, such as body height and body composition, suggesting that physical attributes can significantly influence performance. This relationship is crucial when considering training focuses, as improving a player's physical profile can lead to improved motor efficiency and effectiveness in the game. On the other hand Janjić et al. (2010) indicates that targeted training during preparation periods can lead to significant progress in motor abilities. The study found significant changes in various motor abilities after a structured training regimen, reinforcing the importance of systematic approaches to training. Programs should be designed to address the specific motor ability deficits of players, taking into account their individual progress and physiological responses. The focus on specific motor ability tests, as shown in the study by Ejup et al. (2010), suggests that individualized assessments are valuable for designing tailored training programs. The analysis pointed out that motor capabilities significantly predict success in situational tests, particularly for energy regulation systems. This indicates that practical, situational assessments can offer valuable insights into training effectiveness and help guide future directions for skill development. More recent studies, particularly the last two reviewed, add an important dimension by considering cognitive and reactive agility components. The meta-analysis emphasizes the lack of research specifically addressing reactive agility in football and highlights the cognitive demands associated with this ability. More attention to cognitive training, alongside physical training, is necessary to equip players not only with speed but also with the decision-making skills required in high-pressure match situations.

Football players who scored higher in strength tests had an improved ability to keep the ball, which is in line with research findings (García et al., 2019) that confirmed the importance of strength in contact with opponents. In addition, the results of our research indicate that speed is directly related to the number of goals and assists scored during the season. This is especially important given that quick reactions and movement are key attributes for success on the field. Miller (2020) similarly reported that players exhibiting superior speed and agility achieve better outcomes in tactical scenarios, a factor of particular importance given the dynamic nature of football matches. Flexibility, although less emphasized, can also play an important role in reducing injuries. Players who demonstrated a higher degree of flexibility had a lower incidence of muscle injuries, which has been confirmed (Rowe, 2018). This finding may help coaches develop a comprehensive training program that emphasizes not only performance, but also injury prevention.

The results should be interpreted with certain limitations in mind. First, the limited number of relevant studies included in the review may restrict the generalizability of the conclusions. Second, the included studies varied in methodology, population, and measurement instruments, making direct comparisons and synthesis of results difficult. Finally, some studies had methodological weaknesses (e.g., small sample sizes), which may affect the reliability of the conclusions. Collectively, these papers open several avenues for future research. There is a need for longitudinal studies to track the development of motor and anthropometric factors over time and their direct impact on performance. Additionally, there's a notable gap in understanding the interplay between cognitive skills and motor performance, particularly in agility and decision-making in football environments. Addressing these gaps can lead to more holistic training strategies that include cognitive skill development alongside physical conditioning.

CONCLUSION

Based on a review of previous research and detailed discussions of each paper, conclusions were drawn that indicate some fundamental importance of success in football. For the success of every young football player, it is necessary to work on the development of motor abilities from the earliest age category. In modern football, physical preparation is one of the most important components of a football player's sports preparation. Indirectly, the improvement of physical preparation will be influenced by improved nutrition, good health, adequate personal hygiene, permitted pharmacological agents, the ability to quickly adapt and acclimatize, player equipment and other similar factors.

The analysis of the influence of motor indicators in situational-motor tests of the football game suggests two main conclusions: the results in motor tests significantly affect the level of achievement in all analyzed situational football tests. Achievements in situational tests are significantly more influenced by those indicators of motor abilities that are under the influence of the energy regulation system than by abilities that are under the influence of the movement regulation system. There are also differences in vertical jump in relation to position in time. Specific motor abilities and basic motor abilities as a factor of general efficiency have the greatest influence on the quality of players, and these factors have been identified as the most important predictors of player quality.

REFERENCES

1. Amiri-Khorasani, M., Osman, N. A. A., & Yusof, A. (2011). Acute effect of static and dynamic stretching on hip dynamic range of motion during instep kicking in professional soccer players. *The Journal of Strength & Conditioning Research*, *25*(6), 1647-1652.
2. Apor, P. (2013). Successful formulae for fitness training. In *Science and Football (Routledge Revivals)* (pp. 95-107). Routledge.
3. Bloomfield, J., Polman, R., O'donoghue, P., & McNaughton, L. A. R. S. (2007). Effective speed and agility conditioning methodology for random intermittent dynamic type sports. *The Journal of Strength & Conditioning Research*, *21*(4), 1093-1100.
4. Bush, M., Barnes, C., Archer, D. T., Hogg, B., & Bradley, P. S. (2015). Evolution of match performance parameters for various playing positions in the English Premier League. *Human Movement Science*, *39*, 1-11.
5. França, C., Gouveia, É., Caldeira, R., Marques, A., Martins, J., Lopes, H., ... & Ihle, A. (2022). Speed and agility predictors among adolescent male football players. *International Journal of Environmental Research and Public Health*, *19*(5), 2856.
6. Gardasevic, J., Bjelica, D., Milasinovic, R., & Vasiljevic, I. (2016). The effects of the training in the preparation period on the repetitive strength transformation with cadet level football players. *Sport Mont*, *14*(2), 31-33.
7. Gissis, I., Papadopoulos, C., Kalapotharakos, V. I., Sotiropoulos, A., Komsis, G., & Manolopoulos, E. (2006). Strength and speed characteristics of elite, subelite, and recreational young soccer players. *Research in Sports Medicine*, *14*(3), 205-214.
8. Hartmann, J., & Tünnemann, H. (1989). Fitness and strength training. *(No Title)*.
9. Hoff, J., & Helgerud, J. (2004). Endurance and strength training for soccer players: physiological considerations. *Sports medicine*, *34*(3), 165-180.
10. Janjić, A., Suzović, D., & Janković, A. (2010). The motor abilities change of soccer players during the summer preparation period. *Fizička kultura*, *64*(1), 35-45.
11. Kaplan, T., Erkmen, N., & Taskin, H. (2009). The evaluation of the running speed and agility performance in professional and amateur soccer players. *The Journal of Strength & Conditioning Research*, *23*(3), 774-778.
12. Kotzamanidis, C., Chatzopoulos, D., Michalidis, C., Papaiakovou, G., & Patikas, D. (2005). The effect of a combined high-intensity strength and speed training program on the running and jumping ability of soccer players. *Journal of Strength and Conditioning Research*, 19(2), 369-375.
13. Lee, J., Park, E., & del Pobil, A. P. (2025). We know who wins: graph-oriented approaches of passing networks for predictive football match outcomes. *Journal of Big Data*, *12*(1), 147.
14. Lolić, V., Goranović, S., Vukajlović, V., & Lolić, D. (2006). The changes made to the basic-motor abilities and the special motor abilities of young soccer players during the preliminary period. *Glasnik Antropološkog društva Jugoslavije*, 41, 231-235.
15. Jelaska, P., Katić, R., & Jelaska, I. (2013). Morphological and motor characteristics of Croatian first league female football players. *Collegium Antropologicum*, *37*(2), 69-76.
16. Martin-Garcia, A., Castellano, J., Diaz, A. G., Cos, F., & Casamichana, D. (2019). Positional demands for various-sided games with goalkeepers according to the most demanding passages of match play in football. *Biology of sport*, *36*(2), 171-180.
17. Milenković, D. (2011). Speed as an important component of football game. *Acta Kinesiologica*, *5*(1), 57-61.
18. Molnar, G. (2007). Hungarian football: a socio-historical overview. *Sport in History*, *27*(2), 293-317.
19. Rowe, D. (2018). Football, diplomacy and Australia in the Asian century. In *Sport and diplomacy* (pp. 147-166). Manchester University Press.
20. Schlegel, P., Křehký, A., & Hiblbauer, J. (2022). Physical Fitness Improvement after 8 Weeks of High-intensity Interval Training with Air Bike. *Sport Mont*, *20*(3).
21. Sheppard, J. M., & Young, W. B. (2006). Agility literature review: Classifications, training and testing. *Journal of sports sciences*, *24*(9), 919-932.

22. Shrier, I. (2004). Does stretching improve performance?: a systematic and critical review of the literature. *Clinical Journal of Sport Medicine*, *14*(5), 267-273.
23. Smajić, M., Molnar, S., & Radoman, M. (2008). The differences between winning and defeated football teams while performing various activities with a ball. *Sport Scientific and Practical Aspects, 5*(1&2).
24. Sun, M., Soh, K. G., Ma, S., Wang, X., Zhang, J., & Yaacob, A. B. (2025). Effects of speed, agility, and quickness (SAQ) training on soccer player performance—a systematic review and meta-analysis. *PloS one*, *20*(2), e0316846.
25. Vasileiadis, I. (2020). Injury Prevention Strategies in Football: A Systematic Review. *Sport Mont*, *18*(3).
26. Welden, B. D. (1998). The effect of static stretch and dynamic range of motion training on the flexibility of the hamstring muscles. *Journal of Orthopaedic & Sports Physical Therapy, 27*(4), 295–300.
27. Williams, J. (2006). 'Protect me from what I want': Football fandom, celebrity cultures and 'new'football in England. *Soccer & Society*, *7*(1), 96-114.
28. Young, W., & Farrow, D. (2013). The importance of a sport-specific stimulus for training agility. *Strength & Conditioning Journal*, *35*(2), 39-43.

УТИЦАЈ КОМПОНЕНТИ ФИЗИЧОГ ФИТНЕСА НА ПЕРФОРМАНСЕ ФУДБАЛЕРА – СИСТЕМАТСКИ ПРЕГЛЕД

Stojković Dejan, Utvić Nikola

Сажетак: *Фудбал захтева висок ниво физичког фитнеса, а кључне компоненте кондиције директно утичу на перформансе играча. Аеробна издржљивост омогућава играчима да одрже висок интензитет игре и брже се опораве, док је анаеробна снага кључна за извођење експлозивних покрета, спринтева и брзих промена правца. Циљ овог истраживања био је испитати утицај различитих фитнес компоненти — снаге, издржљивости, брзине и флексибилности — на перформансе фудбалера. Систематски преглед је спроведен коришћењем релевантних научних база података, укључујући PubMed, Scopus, Web of Science, Google Scholar и SportDiscus, како би се обухватиле најновије и најрелевантније студије у области спортске науке и физичке кондиције фудбалера. Брзина, агилност, снага и експлозивност побољшавају стабилност, дуеле и прецизност шута, док флексибилност смањује ризик од повреда. Ефикасне методе тренинга укључују високо интензивни интервални тренинг (HIIT), спринт тренинг са плиометријом, тренинг снаге, игре на малом простору и фартлек тренинг. Ове методе побољшавају аеробни и анаеробни капацитет, експлозивну снагу и техничке и тактичке вештине. Тренинг стабилизације језгра и флексибилности доприносе превенцији повреда и оптималној биомеханици покрета. Даља истраживања треба да се фокусирају на индивидуализоване приступе тренингу прилагођене специфичним захтевима позиционе игре. Кључне речи: фудбал, физичка кондиција, аеробна издржљивост, анаеробна издржљивост, снага, експлозивност, агилност, флексибилност.*

Кључне речи: *фудбал, физички фитнес, аеробна издржљивост, анаеробна издржљивост, снага, агилност, флексибилност.*

ОДНОС РЕЗУЛТАТА НА ТЕСТОВИМА МОТОРИЧКИХ СПОСОБНОСТИ И УСПЕХА У УСВАЈАЊУ ОШТЕОБРАЗОВНИХ ЗНАЊА УЧЕНИКА СТАРИЈЕГ ШКОЛСКОГ УЗРАСТА

Марковић Живорад[1], Игњатовић Александар[1], Антонов Антонио[2]
[1]Факултет педагошких наука, Универзитета у Крагујевцу, Јагодина, Србија
[2]Национална Спортска Академија "Вассил Левски", Софија, Бугарска

ORIGINAL SCIENTEFIC ARTICLE
DOI: 10.5937/ATAVPA25190M

Сажетак: *Настава физичког васпитања, као и сваки други наставни процес, представља научно заснован и систематски организован институционални образовно-васпитни рад, намењен ученицима, односно полазницима одређеног узраста и диференцираног ступња образовања, који је темељен на педагошким принципима. Ученици кроз наставни процес стичу знања, вештине и навике; развијају своје психичке и физичке способности и свестрано се развијају. У настави физичког васпитања се поред три битна методичка фактора – ученик, наставник и наставно градиво, у настави физичког и здравственог васпитања, појављује још један значајан фактор, а то је обимна материјална основа за наставу физичког васпитања, што није случај у толикој мери у настави у осталим наставним предметима у школи. Циљ истраживања је био да се истражи однос резултата на тестовима моторичких способности и успеха ученика из општеобразовних предмета, тј. утврдити колико је успех из општеобразовних предмета у вези са резултатима постигнутим на тестовима моторичких способности, а самим тим и колики је утицај физичке активности на развој интелектуалних способности ученика и њихов свестрани развој. Истраживање је трансверзалног карактера и реализовано је О.Ш. „Јован Јовановић Знај" у Свилајнцу у првом полугодишту школске 2024/2025. Узорак варијабли обухватио је четири моторичка задатка и оцене из пет општеобразовних предмета. Узорак испитаника обухватио је 113 испитаника старијег школског узраста, који је био подељен на два карактеристична субузорка у односу на пол и то: субузорак од 54 ученика и 59 ученица од петог до осмог разреда. Истраживање је трајало десет дана. За обраду добијених података, поред дескриптивне статистике примењен је Пирсонов коефицијент корелације. Добијени резултати указују да не постоји статитички значајна повезаност између академског успеха ученика старијег школског узраста и резултата на тестовима моторичких способности.*
Кључне речи*: моторичке способности, општеобразовна знања, старији школски узраст*

УВОД

Појам моторичка способност различито се схвата и тумачи од стране стручњака у физичкој култури. Користе се изрази попут: „физичка способност", „биомоторичка димензија", „психофизичка способност", „антропомоторичка својства", „кинезиолошке способности" и други. Да би се појаснило речено, послужиће нам дефиниције стручњака из области физичке културе. Моторичке (физичке) способности су једна страна човекових кретних могућности или димензија личности, које учествују у решавању моторичких задатака (Крсмановић и Берковић, 1999: 218). Моторичке способности „представљају 'conditio sine qua non' у сваком учењу кретних задатака неке одређене технике, па се може сматрати да представљају базичну вредност у укупном простору човекове моторике. Моторичка способност је онај део опште психофизичке способности који се односи на одређени ниво развијености основних кретних латентних димензија човека, које условљавају успешно извршавање кретања, без обзира да ли су те способности стечене тренингом или не" (Курелић и сар, 1975: 9). Једна од одредница указује да се: „Моторичке (*физичке*) способности дефинишу као латентне моторичке структуре које одређују бесконачан број манифестних моторичких реакција и могу се измерити и описати" (Фиидак, 1999: 218).

У свету и у Србији примењиване су и примењују се различите батерије тестова за праћење моторичких способности деце. Куперов институт и AAHPERD су 1993. године оформили савез за промоцију физичке активности код младих, тзв. „*Фитнесграм*", који постаје официјална батерија тестова за процену физичке и здравствене способности. Претходила јој је батерија коју је сачинио

Амерички савез за здравље, физичко васпитање, рекреацију и плес (American Alliance of Health, Physical Education, Recreation and Dance, AAHPERD).

У Словенији од 1989/1990. године постоји организовано систематско праћење раста и развоја деце и младих путем батерије тестова *Sports educational chart* и компјутерског програма *GRAPH* sports educational chart. Еурофит батерија је стандардизована батерија тестова препоручена од стране Савета Европе (Council of Europe, Committee for the development of sport European test of physical fitness) која служи за процену физичког развоја и моторичких способности деце школског узраста. Батерија за процену моторичких способности обухвата девет моторичких тестова.

У Србији су се батерије тестова мењале да би 2019. Завод за вредновање квалитета образовања и васпитања издао Приручник за праћење физичког развоја и развоја моторичких способности ученика у настави физичког васпитања са батеријом од шест тестова (претклон са досезањем у седу, скок у даљ из места, лежање-сед за 30 секунди, издржај у згибу на вратилу, чунасто трчање на 4 х 10 м и истрајно чунасто трчање на 20 м) (Миланович и сар, 2016). Пет тестова су из Еурофит батерије, а чунасто трчање на 4 х 10 м је из батерије тестова коју је презентовао Зациорски на Међународном конгресу спортских наука, одржаном у Токију 1964. Један од разлога неприхватања, примене батерије, нарочито на основношколском узасту је непознавање протокола теста од стране учитеља и наставника.

Доказано је да интелектуалне способности зависе од бројних синапси (веза између неурона, тј. нервних ћелија). Највећи број синапси, преко 70%, формира се до седме године живота. До дванаесте године формира се 95% синапси, а касније, до краја живота, подмлађује се 1-2% синапси. Пијаже и Инхелдар (1978) сматрају да сензомоторни развој има кључну улогу у раном когнитивном развоју деце. Особе са сметњама у менталном развоју имају везу између интелектуалног и моторичког функционисања у односу на децу без ових проблема, а то је повезано са координацијом, брзином и експлозивном снагом (Орлић и сар, 2010). Разлике у моторичким способностима у односу на когнитивне способности произилазе из претпоставке да се инфериорност особа са мањим когнитивним способностима види у решавању сложених моторичких задатака, вероватно због нижег нивоа интегритета ЦНС-а, што утиче на брзину протока информација, односно проводљивост нервних влакана. У процесу извођења веома сложених моторичких задатака укључено је и когнитивно функционисање, чији утицај расте са порастом нивоа сложености моторичких задатака, што указује на значајне везе између моторичких и когнитивних способности (Гаџић и сар, 2011). Глигоровић и сар, (2011) указују на значај перцептивно-моторичких функција за развој способности које су предуслов за стицање академских вештина. Наставници физичког васпитања и спортски научници пронашли су позитивну корелацију између перцептивно-моторног развоја и академског успеха код деце. Свакодневно телесно кретање-вежбање или спортска активност значајно доприноси бољем успеху у школи (Dwyer, et al, 1983; Hollar, et al, 2010. & Starc et al, 2017). Ово потврђују и резултати Фратрића и сар, (2012) на основу којих је констатовано да ученици и ученице који су имали боље резултате на процени интелектуалних способности имали су и боље резултате на процени моторичких способности и обрнуто.

Nourbakhsh (2006) такође указује на значајну позитивну везу између моторичких способности и академског успеха, односно когнитивног развоја, и препоручује обогаћивање и унапређење програма и наставних техника физичког васпитања са циљем побољшања моторичких и радних способности ученика како би се директно и позитивно утицало на развој интелектуалних способности ученика. Моторичке способности статистички су значајно повезане са закључним оценама из математике, словенског и страног језика у свом истраживању констатује Јарош (2023). Развојем неуропсихологије доступне су нове информације о везама између моторичких и когнитивних способности које се заснивају на активности и структури мозга. На основу резултата неких истраживања увидело се да се стицање интелектуалних и моторичких способности одвија на веома сличан начин (Rosenbaum, Carlson, & Gilmore, 2001; Paz, Wise & Vaadia, 2004) и да су моторички и когнитивни развој вероватно међусобно фундаментално повезани (Diamond, 2000).

Циљ истраживања је био да се истражи однос резултата на тестовима моторичких способности и успеха ученика из општеобразовних предмета, тј. утврдити колико је успех из општеобразовних предмета у вези са резултатима постигнутим на тестовима моторичких способности, а самим тим и колики је утицај физичке активности на развој интелектуалних способности ученика и њихов свестрани развој.

МЕТОД

Истраживање је било трансверзалног карактера и реализовано је у О.Ш. „Јован Јовановић Знај" у Свилајнцу у првом полугодишту школске 2024/2025. Узорак варијабли обухватио је четири моторичка задатка и то: Скок удаљ из места – за процену експлозивне снаге опружача ногу, Одбијање лопте од зида – за процену спретности, Лежање-сед за 30 секунди – за процену репетитивне снаге трбушних мишића и прегибача у зглобу кука и Трчање на 30 метара – за процену спринтерске брзине и оцене из пет општеобразовних предмета: Српски језик и књижевност, Математика, Историја, Биологија, Географија и Физичко и здравствено васпитање, које су преузете из есДневника. Узорак је обухватио 113 испитаника старијег школског узраста, који је био подељен на два карактеристична субузорка у односу на пол и то: субузорак од 54 ученика и субузорак од 59 ученица од петог до осмог разреда. За обраду добијених података, поред дескриптивне статистике примењен је Пирсонов коефицијент корелације.

РЕЗУЛТАТИ ИСТРАЖИВАЊА СА ДИСКУСИЈОМ

На основу дескриптивних показатеља код ученика просечне вредности у Скоку у даљ из места су 165,13 цм, код Одбијање лопте од зида 9,39 понављања, код Лежање-сед за 30 секунди 15,81 понављања и код Трчања на 30 метара 4,93 секунди.

Просечне оцене из општеобразовних предмета су следеће: Физичко и здравствено васпитање 4,13, Српски језик и књижевност 3,54; Математика 3,22; Историја 3,72; Географија 3,80 и Биологија 3,56.

Табела 1 Однос моторичких способности и академског успеха дечака

Тест	ФИЗВ	СЈК	МАТ	ИСТ	ГЕО	БИО
Скок удаљ из места	0,076	0,100	0,174	0,288	-0,068	0,146
Одбијање лопте од зида	0,157	0,213	0,189	0,126	-0,011	0,248
Лежање-сед за 30 секунди	0,261	0,099	0,301*	0,155	-0,093	0,206
Трчање на 30 метара	-0,260	-0,153	-0,167	-0,261	0,049	-0,216

Легенда: ФИЗВ – Физичко и здравствено васпитање; СЈК – Српски језик и књижевност; МАТ – математика; ИСТ – Историја; ГЕО – Географија; БИО – Биологија; * корелација је значајна на нивоу од p<0,05; ** корелација је значајна на нивоу од p<0,01.

Код ученика утврђена је статистички значајна умерена корелација (r = 0,301*) између успеха на тесту Лежање-сед за 30 секунди и оцене из Математике. Ученик је успешнији ако за 30 секунди направи што већи број подизања трупа, док виша оцена из математике означава бољи успех, тако да на основу добијене корелације може се констатовати да бољи успех на тесту Лежање- сед за 30 секунди подразумева и вишу оцену из Математике. Између резултата на осталим тестовима моторичких способности и успеха из осталих општеобразовних предмета је слаба повезаност, која није на нивоу статистичке значајности, нису утврђене статистички значајне корелације (Табела 1).

Ученице су у Скоку у даљ из места остварile просечан резултат од153,95 цм, што је за 11,18 цм слабији резултат у односу на ученике. При Одбијању лопте од зида просечан број одбијања је 8.31, што је за 1,08 одбијања просечно слабији резултат у односу на ученике. При процени репетитивне снаге прегибача трупа тестом Лежање-сед за 30 секунди просечно су остварile 14,15 понављања, што је за 1,66 понављања просечно слабији резултат у односу на ученике. У тесту Трчање на 30 метара просечне вредности ученица су 5,01 секунда, што је само за 0,08 секунди просечно бољи резултат код ученика. Мала разлика се приписује слабим резултатима

код неколико ученика који су остварили знатно слабије резултате од најслабијих резултата ученица. Што се тиче успеха просечне оцене из општеобразовних предмета су следеће: Физичко и здравствено васпитање 4,34, Српски језик и књижевност 4,08; Математика 3,85; Историја 4,174,47; Географија 3,80 и Биологија 4.22.

Табела 2 Однос моторичких способности и академског успеха девојчица

Тест	ФИЗВ	СЈК	МАТ	ИСТ	ГЕО	БИО
Скок удаљ из места	0,313*	0,245	0,186	0,299*	0,218	0,236
Одбијање лопте од зида	0,358**	0,052	0,039	0,061	0,064	0,123
Лежање-сед за 30 секунди	0,346**	0,123	0,112	0,206	0,035	0,166
Трчање на 30 метара	-0,225	-0,294*	-0,178	-0,361**	-0,365**	-0,186

Између резултата на тестовима Скок удаљ из места, Одбијање лопте од зида и Лежање-сед за 30 секунди и оценом из Физичког и здравстеног васпитања констатована је умерена корелација. Умерена негативна корелација констатована је између Трчања на 30 метара и оцене из Историје и Географије. То указује да што је мањи резултат у Трчању на 30 метара, већа је оцена из Историје и Географије (Табела 2).

Даља анализа упоређује однос моторичких способности и академског успеха ученика и ученица по разредима.

Табела 3 Однос моторичких способности и академског успеха ученика петог разреда

Тест	ФИЗВ	СЈК	МАТ	ИСТ	ГЕО	БИО
Скок удаљ из места	0,181	0,348*	0,290	0,448*	0,339*	0,358*
Одбијање лопте од зида	0,243	0,276	0,039	0,260	0,227	0,178
Лежање-сед за 30 секунди	0,268	-0,055	-0,029	-0,061	-0,161	-0,069
Трчање на 30 метара	-0,550**	-0,265	-0,091	-0,338*	-0,303	-0,281

Добијени резултати указују на умерену негативну корелацију између академског успеха ученика петог разреда из предмета Физичко и здравствено васпитање и резултата на тесту Трчање на 30 метара (r = -0,550**). То указује да ученици који имају бољи академски успех из предмета Физичко и здравствено васпитање имају мање време на тесту трчања, што би значило и бољи резултат. Између Скока удаљ из места постоји умерена корелација са Српским језиком и књижевношћу (r = 0,348*), Историјом (r = 0,448*), Географијом (r = 0,339*) и Биологијом (r = 0,358*). Резултати на тестовима Одбијање лопте од зида и Лежање-сед за 30 секунди су са оценама из свих пет предмета у слабој корелацији. Резултати у Трчању на 30 метара су у умерено негативној корелацијји са оценама из Историје (r=-0,338*) и Географије (r=-0,303) (Табела 3).

Увидом у Табелу 4. добијене вредности Пирсоновог коефицијента корелације између академског успеха ученика шестог разреда и њихових резултата постигнутих на тестовима моторичких способности указују да оцене из предмета Физичко и здравствено васпитање зависе од резултата постигнутих на тестовима процене моторичких способности. Дакле, ученици имају бољи академски успех из предмета Физичко и здравствено васпитање ако имају боље резултате на тестовима моторичких способности и обрнуто. Највећа корелација је између академског успеха из Физичког и здравственог васпитања и резултата на тесту Одбијање лопте од зида (r = 0,533**)

Табела 4 Однос моторичких способности и академског успеха ученика шестог разреда

Тест	ФИЗВ	СЈК	МАТ	ИСТ	ГЕО	БИО
Скок удаљ из места	0,422**	0,260	0,453**	0,252	-0,135	0,320*
Одбијање лопте од зида	0,533**	0,319*	0,305*	0,206	-0,130	0,350*
Лежање-сед за 30 секунди	0,429**	0,240	0,415**	0,226	-0,204	0,349*
Трчање на 30 метара	-0,513**	-0,351*	-,0416**	-0,297*	-0,014	-0,327*

Српски језик и књижевност су у умерено позитивној корелацији са тестом Одбијање лопте од зида (r = 0,319*) и умерено негативној корелацији са тестом Трчање на 30 метара (r = -0,351*). Математика је у умереној корелацији са Скоком у даљ из места (r = 0,453**), Одбијањем лопте од зида (r = 0,305*), Лежањем-сед за 30 секунди (r = 0,415**), и умерено негативној корелацији са Трчањем на 30 метара (r = -0,416**). Историја и Географија су са резултатима на моторичким тестовима у слабој корелацији, док је Биологија у умерено позитивној корелацији са Скоком у даљ из места, Одбијањем лопте од зида, Лежањем-сед за 30 секунди и умерено негативној корелацији са Трчањем на 30 метара.

Табела 5 Однос моторичких способности и академског успеха ученика седмог разреда

Тест	ФИЗВ	СЈК	МАТ	ИСТ	ГЕО	БИО
Скок удаљ из места	0,753**	0,088	0,323	0,156	0,189	0,184
Одбијање лопте од зида	0,625**	0,133	0,367	0,233	0,198	0,224
Лежање-сед за 30 секунди	0,724**	-0,166	0,111	-0,185	0,046	0,041
Трчање на 30 метара	-0,690**	-0,247	-0,416	-0,306	-0,290	-0,322

Добијени резултати Пирсоновог коефицијента корелације указују на јаку корелацију између академског успеха ученика седмог разреда из предмета Физичко и здравствено васпитање и Скока у даљ из места (r = 0,753**) и Лежање-сед за 30 секунди (r = 0,724**). Док је Физичко и здравствено васпитање у умереној корелацији са тестом Одбијање лопте од зида (r = 0,625**) и умерено негативној корелацији са тестом Трчање на 30 метара (r = -0,690**) са нивоом статистичке значајности од p < 0,01. Српски језик и књижевност и Географија су у слабој корелацији са резултатима на тестовима. Математика је у умерено позитивној корелацији са Скоком у даљ из места и Одбијањем лопте од зида и умерено негативној корелацији са Трчањем на 30 метара. Историја (r =.-0,306) и Биологија (r =.-0,322) су у умерено негативној корелацији са Трчањем на 30 метара (Табела 5).

Табела 6 Однос моторичких способности и академског успеха ученика осмог разреда

Тест	ФИЗВ	СЈК	МАТ	ИСТ	ГЕО	БИО
Скок удаљ из места	0,109	0,044	-0,288	0,398	-0,022	-0,120
Одбијање лопте од зида	0,355	0,121	0,129	-0,098	0,358	0,263
Лежање-сед за 30 секунди	0,197	0,084	0,089	0,578*	0,265	0,187
Трчање на 30 метара	-0,091	-0,059	0,210	-0,430	-0,063	0,072

Увидом у Табелу 6. Скок у даљ из места је само са Историјом у умерено позитивној корелацији. Одбијање лопте од зида је у умерно позитивној корелацији са Физичким и здравственим васпитањем и Географијом. Ове корелације нису на нивоу статистичке значајности p > 0.05. Лежање - сед за 30 секунди је у умерено позитивној корелацији само са Историјом (r = 0,578*) и она је на нивоу статистичке значајности. Резултати у Трчању на 30 метара су у умерено негативној корелацији само са Историјом (r = -0,430), са осталим предметима су у слабој корелацији.

Табела 7 Повезаност резултата на тестовима моторичких способности

Тест	СУДМ	ОЛОЗ	ЛС30	Т30
Скок удаљ из места	1	0,572**	0,705**	-0,802**
Одбијање лопте од зида	0,572**	1	0,508**	-0,502**
Лежање-сед за 30 секунди	0,705**	0,508**	1	-0,669**
Трчање на 30 метара	-0,802**	-0,502**	-0,669**	1

Легенда: СУДМ – Скок удаљ из места; ОЛОЗ – Одбијање лопте од зида; ЛС30 – Лежање-сед за 30 секунди; Т30 – Трчање на 30 метара

У оквиру додатне анализе утврђена је повезаност између појединих тестова. Скок удаљ из места је у јакој негативној корелацији са Трчањем на 30 метара (r = -0,802) и јакој позитивној корелацији са Лежање-сед за 30 секунди (r = 0,705**), као и умерено позитивној корелацији са Одбијањем лопте од зида (r = 0,572**). Све три повезаности су на нивоу статистичке значајности од p<0,01. Одбијање лопте од зида је у умерено позитивној корелацији са Скоком удаљ из места (0,572**) и Лежање-сед за 30 секунди (0,508**) и умерено негативној корелацији са Трчањем на 30 метара (-0,502**). Све три корелације су на нивоу статистичке значајности. Лежање-сед за 30 секунди је у јакој позитивној корелацији са Скоком удаљ из места (0,705**) и умерено позитивној са Одбијањем лопте од зида (0,508**) и умерено негативној са Трчањем на 30 метара (-0,669**). Трчање на 30 метара је са осталим тестовима у негативној корелацији и то са Скоком удаљ са јаком, а са Одбијањем лопте од зида и Лежање-сед за 30 секунди у умереној. Све три су на нивоу статистичке значајности (p > 0.01). Наведено указује да мање вредности на Трчању на 30 метара условиће боље резултате у наведеним тестовима и обрнуто, добри резултати на тестовима условиће мање вредности на Трчању на 30 метара (Табела 6).

ЗАКЉУЧНА РАЗМАТРАЊА

Однос моторичких и интелектуалних способности је одувек привлачио пажњу психолога, а исто тако и стручњака из простора физичке културе. Већина досадашњих истраживања указује на њихову повезаност, како код предшколског узраста, исто тако и код основношколског узраста. Циљ истраживања је био да се истражи однос резултата на тестовима моторичких способности и успеха ученика из општеобразовних предмета, тј. утврдити колико је успех из општеобразовних предмета у вези са резултатима постигнутим на тестовима моторичких способности. На узорку од 113 испитаника старијег школског узраста однос моторичких способности и успеха из општеобразовних предмета истражен је батеријом од четири моторичка теста и оценама из пет општеобразовних предмета. Увидом у резултате моторичких способности ученици су остварили боље просечне резултате у свим моторичким тестовима. Када се посматра успех из пет општеобразовних предмета ситуација је у корист ученица које имају боље просечне оцене из свих пет предмета.

Код ученика утврђена је статистички значајна умерена корелација само између успеха на тесту Лежање-сед за 30 секунди и оцене из Математике. Код ученица ситуација је другачија, просечна оцена из Физичког и здравстеног васпитања и резултати на тестовима из Скока удаљ из места, Одбијање лопте од зида и Лежање-сед за 30 секунди су у умереној корелацији. Просечне оцене из Историје и Географије и просечни резултати Трчања на 30 метара су у умерено негативној корелацији.

Даљом анализом на комплетном узорку испитаника код петог разреда највећа умерена негативна корелација је између академског успеха из предмета Физичко и здравствено васпитање и резултата на тесту Трчање на 30 метара. Код ученика шестог разреда највећа корелација је између академског успеха из Физичког и здравственог васпитања и резултата на тесту Одбијање лопте од зида. Јака корелација код ученика седмог разреда констатвана је између академског успеха из предмета Физичко и здравствено васпитање са Скоком удаљ из места и Лежање-сед за 30 секунди. Коралација на нивоу статистичке значајности констатована је код ученика осмог разреда између теста Лежање - сед за 30 секунди и академског успеха из Историје. Анализом односа моторичких тестова добијена је јака негативна корелација између Скока удаљ из места и Трчања на 30 метара. Ова корелација је најача у односу на остале и још једном потврђује повезаност експлозивне снаге ногу и спринтерске брзине.

Добијени резултати упућују на даља истраживања и потврђују позитиван утицај моторичких способности на успех из општеобразовних предмета, боље моторичке способности условиће и бољи академски успех.

ЛИТЕРАТУРА

1. Gadžić, A., Živanović, N., & Milojević, A. (2012). Motoričke i kognitivne sposobnosti učenika osnovne škole, u: N. Živanović, S. Bubanj (ur.), *FIS komunikacije 2011 u sportu, fizičkom vaspitanju i rekreaciji*, XV međunarodni naučni skup, Niš (str. 40–48). Niš: Fakultet sporta i fizičkog vaspitanja.
2. Gligorović, M., Radić Šestić, M., Nikolić, S., & Ilić Stošović, D. (2011). Perceptivno-motoričke sposobnosti i preduslovi za razvoj akademskih veština. *Specijalna edukacija i rehabilitacija*, *10*(3), 405–434.
3. Diamond, A. (2000). Close interrelation of motor development and cognitive development and of the cerebellum and prefrontal cortex. *Child Development*, *71*(1),44–56.
4. Dwyer, T., Coonan, W. E., Leitch, D. R., Hetzel, B. S., & Baghurst, R. A. (1983). An investigation of the effects of daily physical activity on the health of primary school students in South Australia. *International Journal of Epidemiology*, *12*(3), 308–313. https://academic.oup.com/ije/article-abstract/12/3/308/811907
5. Jaroš, U. (2023). Povezanost uspjeha u učenju s motoričkim (kretnim) sposobnostima. *Digitalni stručni časopis za odgoj i obrazovanje*, *6*(11), 941–945.
6. Крсмановић, Б., & Берковић, Л. (1999). *Теорија и методика физичког васпитања*. Нови Сад: Факултет физичке културе.
7. Курелић, Н., Момировић, К., Стојановић, М., Штурм, Ј., Радојевић, Ђ., & Вискић Шталец, Н. (1975). *Структура и развој морфолошких и моторичких димензија омладине*. Београд: Институт за научна истраживања, Факултет физичког васпитања.
8. Милановић, И., Јанић Радисављевић С., Чапрић Г., & Мирков Д. (2016). *Приручник за праћење физичког развоја и развоја моторичких способности ученика у настави физичког васпитања*. Београд: Завод за вредновање квалитета образовања и васпитања.
9. Nourbakhsh, P. (2006). Istraživanje povezanosti preceptivno-motoričkih sposobnosti i akademskog uspjeha učenika petog razreda osnovne skole te usporedba dobivenih vrijednosti sa Oseretsyjevom skalom motoričkog razvoja. *Kineziologija, 38*(1) 40–48.
10. Орлић, Д., Цветковић, М., & Јакшић, Д. (2010). Разлике у моторичким и когнитивним способностима код девојчица узраста 7 година. *Спорт Монт*, (21, 22), 141–148. Подгорица: Црногорска спортска академија и Монтенгроспорт.
11. Paz, R., Wise, S.P., & Vaadia, E. (2004). Viewing and doing: similar corticalmechanisms for perceptual and motor learning. *TRENDS in Neurosciences*, *27*(8), 496–503.
12. Pijaže, Ž., & Inhelder, B. (1978). *Intelektualni razvoj djeteta*. Beograd: Zavod za udžbenike i nastavna sredstva.
13. Rosenbaum, D.A., Carlson, R.A., & Gilmore, R.O. (2001). Acquisition of intellectualand perceptual-motor skills. *Annual Review Psychology*, (52), 453–470.
14. Starc, G., Gril, M., & Černilec, P. (2017). Učna uspešnost najbolj in najmanj gibalno učinkovitih otrok. *Sodobna pedagogika*, *68*(134), 34–48.
15. Shi, P., Feng, X. (2022). Motor skills and cognitive benefits in children and adolescents: Relationship mechanism and perspectives. *Front Psychol*, 13:1017825.
16. https://doi.org/10.3389/fpsyg.2022.1017825
17. Hollar, D., Lombardo, M., Lopez Mitnik, G., Hollar, T. L., Almon, M., Agatston, A. S., & Messiah, S. E. (2010). Effective multi-level, multi-sector, schoolbased obesity prevention programming improves weight, blood pressure, and academic performance, especially a monglow-income, minority children. *Journal of Health Care for the Poor and Underserved*, *21*(2), 93–108. https://www.ncbi.nlm.nih.gov/pubmed/20453379
18. Carlson, A. G., Rowe, E., & Curby, T. W. (2013). Disentangling fine motor skills' relation to academic achievement and the links to language, attention and memory. *Journal of Applied Developmental Psychology*, *34*(5), 215–225.
19. Findak, V. (1999). *Metodika tjelesne i zdravstvene kulture*. Zagreb: Grafički zavod Hrvatske d. o. o.
20. Fratrić, F., Orlić, D., Vukašin, B., Nešić, M., Goranović, K., & Bojić, I. (2012) Relacije intelektualnih i motoričkih sposobnosti mlađe školske dece. *Facta Universitatis, Series: Physical Education and Sport, 10*(1), 49–57.

RELATIONSHIP BETWEEN RESULTS ON MOTOR SKILLS TESTS AND SUCCESS IN ACQUIRING EDUCATIONAL KNOWLEDGE IN OLDER SCHOOL-AGE STUDENTS

Marković Živorad, Ignjatović Aleksandar, Antonov Antonio

Abstract: *Physical education teaching, like any other teaching process, represents a scientifically based and systematically organized institutional educational and pedagogical work, intended for students, that is, students of a certain age and differentiated level of education, which is based on pedagogical principles. Students acquire*

knowledge, skills and habits through the teaching process; they develop their mental and physical abilities and develop comprehensively. In addition to three important methodological factors – student, teacher and teaching material, in physical and health education teaching, another significant factor appears, and that is the extensive material basis for teaching physical education, which is not the case to such an extent in teaching other subjects at school. The aim of the research was to investigate the relationship between the results of motor skills tests and the success of students in general education subjects, i.e., to determine how much success in general education subjects is related to the results achieved in motor skills tests, and therefore the impact of physical activity on the development of students' intellectual abilities and their comprehensive development. The research is of a transversal nature and was carried out in the Primary School "Jovan Jovanović Znaj" in Svilajnac in the first semester of the 2024/2025 school year. The sample of variables included four motor tasks and grades from five general education subjects. The sample of respondents included 113 respondents of older school age, which was divided into two characteristic subsamples in relation to gender: a subsample of 54 boys and 59 girls from fifth to eighth grade. The research lasted ten days. In order to process the obtained data, in addition to descriptive statistics, the Pearson correlation coefficient was applied. The obtained results indicate that there is no statistically significant relationship between the academic success of older school age students and the results of motor skills tests.

Key words: *motor skills, general education knowledge, older school age*

THE IMPACT OF SLEEP ON SPORTS PERFORMANCE: CONSEQUENCES OF SLEEP DEPRIVATION AND OPTIMIZATION STRATEGIES

Golubović Anđela, Arsenijević Radenko, Stanković Veroljub
Faculty of Sport and Physical Education, University of Priština – Kosovska Mitrovica, Leposavić, Serbia

REVIEW ARTICLE
DOI: 10.5937/ATAVPA25198G

***Abstract**: Sleep is a critical physiological process that influences recovery, cognitive functions, and overall athletic performance. It plays a vital role in numerous physiological and psychological processes, including hormonal regulation, metabolism, motor skill acquisition, decision-making, and recovery following physical exertion. Given the high energy demands of sports, adequate sleep is essential for replenishing depleted energy stores and maintaining peak athletic performance. However, many athletes fail to achieve the recommended duration of sleep, which can disrupt physiological homeostasis, increase the risk of injury, and negatively affect sports outcomes. This review synthesizes current research and provides practical recommendations for effective sleep management, emphasizing its role in enhancing recovery, reducing fatigue, and optimizing athletic performance. The primary aim is to analyze the existing literature on the impact of sleep on sports performance, with a particular focus on the consequences of sleep deprivation and strategies for its optimization. Research indicates that insufficient sleep can impair athletic performance and, in some cases, increase injury risk. To address these challenges, targeted interventions have been developed to improve sleep quality and, consequently, athletic outcomes.*
***Key words:** sleep quality, rest, recovery, circadian rhythm*

INTRODUCTION

Sleep represents one of the key physiological processes that allows for the maintenance of the body's internal balance, restoration of energy resources, and effective recovery after physical exertion. In the field of sports, adequate sleep duration and quality are crucial for the normal functioning of athletes, their adaptation to training loads, and the achievement of optimal athletic performance. During sleep, numerous processes occur that contribute to the regeneration of the body—from muscle repair and regulation of the hormonal system to consolidation of motor skills, improvement of cognitive functions, and stabilization of emotional responses (Fullagar et al., 2015; Watson, 2017).

Despite clear evidence of the importance of sleep, numerous studies indicate that athletes often do not get sufficient sleep. Inadequate sleep duration may result from various factors: early or late training schedules, frequent travel and time zone changes, competitive stress, academic obligations, as well as daily use of electronic devices immediately before bedtime (Lastella et al., 2015). Research shows that between 40% and 70% of athletes experience an inadequate sleep pattern, shortened sleep, or reduced subjective sleep quality during the season (Samuels, 2008).

Sleep deprivation can significantly impair athletic performance. Experimental studies clearly show that sleep restriction leads to reductions in maximal strength, endurance, and explosiveness, slows reaction time, increases subjective feelings of fatigue, and decreases movement precision (Reyner & Horne, 2013). Cognitive functions—such as attention, concentration, information processing speed, tactical reasoning, and decision-making—are particularly sensitive to sleep loss. These abilities represent key elements of performance in sports requiring quick reactions and complex motor coordination (Mah et al., 2011).

In addition to the negative impact on performance, an increasing number of studies indicate a link between reduced sleep and a higher risk of sports injuries. A study by Milevski et al. (2014) showed that athletes who sleep less than eight hours per day have a significantly higher likelihood of injury compared to athletes who achieve optimal sleep duration. Mechanisms that may explain this relationship include slower reactions, reduced neuromuscular control, increased stress hormone secretion, and greater fatigue, which can lead to impaired movement biomechanics and decreased athletic performance.

For this reason, modern sports science places growing importance on developing programs and interventions aimed at improving sleep hygiene among athletes. Strategies such as education on proper sleep habits, extending sleep duration, individualizing daily schedules according to circadian rhythms,

structured daytime rest, and controlling exposure to light stimuli have shown increasingly positive results (Bonnar et al., 2018; Walsh et al., 2020). In parallel, the use of modern sleep monitoring methods—such as actigraphy, validated questionnaires, and sleep diaries—has become an important tool for tracking recovery and optimizing the training process.

Considering all of the above, as well as the fact that modern sports require a high level of physical and mental readiness, the aim of this paper is to analyze contemporary scientific findings on the impact of sleep deprivation on athletic performance and to present empirically validated strategies for sleep optimization in athletes. Particular emphasis is placed on the effects of inadequate sleep on physical, cognitive, and technical performance, injury risk, and practical recommendations for the training process.

THE IMPACT OF SLEEP ON ATHLETIC PERFORMANCE

Sleep is a complex biological process that plays a crucial role in maintaining physiological balance, regeneration, and adaptation of the body, which is particularly important for athletes exposed to high training and competitive loads. During sleep, recovery processes occur that include muscle fiber regeneration, protein synthesis, replenishment of energy reserves, hormone regulation, and immune system stabilization, with the deep stages of NREM (Non-Rapid Eye Movement) sleep being especially important (Fullagar et al., 2015). Deep NREM sleep is associated with increased secretion of growth hormone and a reduction in inflammatory processes, which play a critical role in muscle repair and recovery after intense training (Dattilo et al., 2011).

The REM (Rapid Eye Movement) sleep phase contributes to learning and consolidation of motor skills, emotional regulation, and cognitive stability, which is particularly important in sports requiring precise and complex technical execution (Walker, 2009). Despite the clear importance of sleep, the modern lifestyle of athletes often involves reduced sleep duration. Factors such as intense training, competitions late at night or early in the morning, travel and time zone changes, mental stress, and academic obligations particularly affect young athletes (Lastella et al., 2015). A large number of athletes get less sleep than the recommended 7–9 hours, leading to cumulative sleep deprivation and reduced recovery quality (Samuels, 2008).

Sleep deprivation negatively affects athletes' physical performance, including reductions in strength, endurance, and explosiveness, as well as earlier onset of fatigue (Reyner & Horne, 2013). Lack of sleep leads to impaired muscle recovery, disrupted energy metabolism, and increased cortisol levels, making it difficult to maintain optimal training intensity (Oliver et al., 2009). In addition to physical changes, there is a noticeable decline in motor precision, stability, and coordination, which particularly affects sports with high technical demands. Cognitive abilities are also significantly impaired under conditions of reduced sleep. Athletes with insufficient sleep demonstrate slower reaction times, reduced attention, slower information processing, and impaired decision-making (Mah et al., 2011). In sports requiring tactical reasoning and quick responses, these changes can directly influence competitive outcomes.

Sleep deprivation also affects athletes' emotional stability, increasing irritability and reducing the ability to adapt to stress. One of the most significant findings in the literature relates to injury risk. It has been shown that athletes who sleep less than eight hours per day have a significantly higher risk of injury compared to those with optimal sleep duration, with this risk increasing up to 1.7 times (Milewski et al., 2014). The causes include reduced proprioception, slower neuromuscular reactions, impaired movement biomechanics, and higher levels of physical and mental fatigue.

In practice, strategies to optimize sleep are increasingly applied to improve recovery and athletic performance. Common interventions include improving sleep hygiene, reducing evening screen exposure, planning short daytime naps, extending total sleep duration, and individualizing training according to athletes' circadian rhythms (Bonnar et al., 2018). The implementation of modern sleep monitoring methods, such as actigraphy, validated questionnaires, and sleep diaries, enables precise tracking of sleep quality and quantity, contributing to more effective recovery planning (Walsh et al., 2020).

Sleep physiology and its importance for athletes

Sleep is a fundamental biological process that allows the body to recover, regenerate, and maintain balance after physical and mental exertion. During the night, two main sleep phases alternate—NREM and REM—each with a specific role in athlete recovery. In the deep stages of NREM sleep, intense physiological regeneration occurs: growth hormone secretion increases, protein synthesis accelerates, muscle fibers are repaired, and inflammatory processes resulting from strenuous training and competitions are reduced (Dattilo, 2011). These processes are essential for muscle recovery, adaptation to physical load, and the development of new functional capacities.

REM sleep primarily serves a cognitive function. During this phase, motor memory consolidation, information processing, and emotional stabilization occur. For athletes, REM sleep is particularly important due to its role in learning new movements, refining technical skills, and maintaining concentration during training and competition. Lack of REM sleep can lead to reduced precision, poorer coordination, and difficulty acquiring new motor patterns (Walker, 2009).

High-quality sleep is also associated with proper immune system functioning and hormonal balance. Athletes who consistently achieve the necessary duration and quality of sleep have more stable stress hormone levels, better energy regulation, faster recovery, and a greater ability to tolerate training loads. Studies confirm that sleep affects athletic performance as much as proper nutrition and well-planned training periodization, as it allows the body to adapt to exertion and maintain an optimal level of physical and mental readiness (Fullagar et al., 2015).

In modern sports, sleep is considered a fundamental element of athlete recovery and preparation. Understanding sleep physiology enables coaches and athletes to recognize factors that affect recovery quality and to adjust the training process to allow for optimal body functioning.

Sleep restriction and its impact on athletic performance

Sleep deprivation refers to a state of reduced sleep duration or impaired sleep quality and can be acute (short-term) or chronic (long-term). In a sports environment, chronic deprivation is more common, arising as a consequence of intensive training demands, travel, time zone changes, late competitions, and psychological stress. This condition leads to cumulative fatigue and a reduced ability of the body to recover adequately between training sessions and competitions.

Numerous scientific studies confirm that lack of sleep has a direct negative impact on athletes' physical performance. Sleep deprivation decreases maximal strength, power, and endurance while simultaneously increasing the subjective perception of effort. Athletes suffering from insufficient sleep fatigue, more often struggle to maintain high intensity during training, and experience impaired muscle regeneration due to disrupted hormone secretion and reduced metabolic capacity (Reyner & Horne, 2013). It has also been shown that sleep deprivation affects glycogen synthesis, further reducing energy availability during physical exertion (Oliver et al., 2009).

Sleep deprivation also impacts neuromuscular coordination, precision, and technical execution. Athletes who sleep less than recommended exhibit greater movement variability, poorer stability, and an increased number of technical errors, which is particularly pronounced in sports requiring fine motor skills and high levels of precision, such as basketball, tennis, gymnastics, and volleyball. Lack of sleep also reduces reaction speed and the ability to quickly adapt to situational changes, potentially negatively affecting tactical decisions and the ability to anticipate the flow of play.

One of the elements most sensitive to sleep deprivation is cognitive function. Insufficient sleep leads to reduced attention, concentration, information processing, and decision-making ability. Research shows that athletes with shortened sleep have slower reaction times, make more errors in tasks requiring speed and accuracy, and perform less effectively under high-pressure situations (Mah et al., 2011). This is particularly evident in team sports and sports with complex situational demands, where decisions must be made in fractions of a second.

Sleep deprivation negatively affects overall athletic performance, impairs training quality, and increases the risk of injuries and overuse. Therefore, recognizing, monitoring, and preventing sleep deficiency is crucial in planning the training process and enhancing athletes' performance.

METHODS

This paper is designed as a review article with the aim of synthesizing current scientific knowledge on the impact of sleep and sleep deprivation on athletic performance. The methodological approach involved a systematic search of the available scientific literature in relevant electronic databases: PubMed, Web of Science, and Scopus.

The literature search was conducted using keywords and their combinations: "sleep or sleep deprivation or sleep quality and athletes and sports performance and recovery and injury risk and sleep extension or sleep interventions." The review included original research studies, review articles, and systematic analyses published in English up to 2024.

Inclusion criteria encompassed studies that:

- examined sleep or sleep deprivation in athletes,
- addressed physical, cognitive, or technical performance, as well as injury risk,
- used valid sleep assessment methods (actigraphy, polysomnography, questionnaires, or sleep diaries) or quantitative performance measures,
- involved athletes of various levels—recreational, competitive, or elite.

Studies that did not include a sports population, lacked sufficient data, or were not available in full text were excluded. After identifying relevant sources, a thematic content analysis was conducted, with results classified into four areas:

1. sleep physiology in athletes,
2. effects of sleep deprivation on performance,
3. sleep and injury risk,
4. sleep optimization strategies.

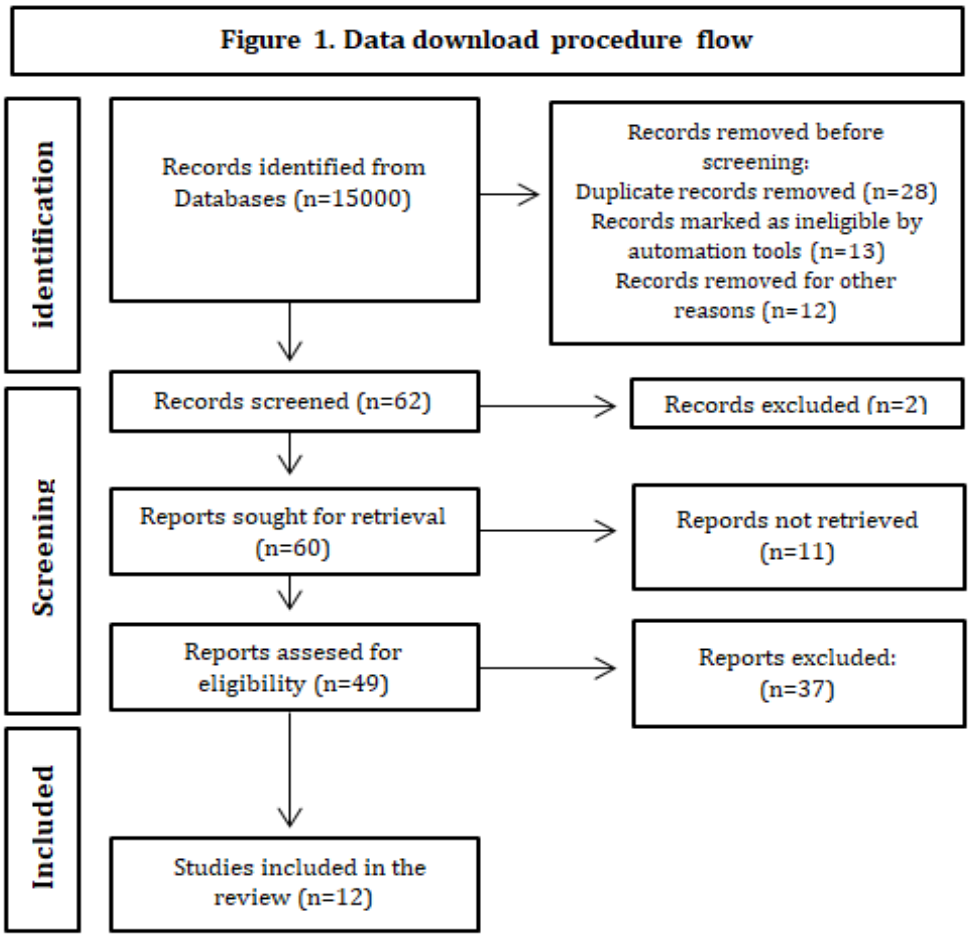
Data were synthesized using a qualitative approach without statistical pooling due to methodological heterogeneity.

Characteristics of the literature

The presented diagram illustrates the process of searching, selecting, and including studies in the final corpus of analyzed literature. The process began with the identification of 15,000 records in the specified databases. During the initial filtering, 53 records were removed due to duplicates, technical errors, or automatically flagged irrelevance.

In the screening phase, 62 studies were assessed, of which 2 were excluded after reviewing titles and abstracts. The remaining 60 studies proceeded to the full-text retrieval phase; however, 11 sources were unavailable, leaving 49 studies for eligibility assessment.

After a detailed evaluation of methodology, content, and relevance, 15 studies were excluded. The final corpus consists of 12 studies that met all inclusion criteria and represent a methodologically consistent sample for drawing conclusions.



RESULTS

An analysis of a total of ten studies included in the presented table (Table 1) provided data on the impact of sleep on athletic performance, injury risk, and physiological responses in athletes. In studies with clearly specified participant numbers, at least 143 subjects were recorded, while systematic reviews and review articles included larger, but undefined, numbers of athletes from multiple independent studies. The age range of participants in quantitative studies varied from 12 to 22 years, whereas review articles also included adult athletes without specifying ages, indicating that the overall sample comprised both adolescent and adult athletes across different age groups.

The athletes' experience level varied across studies. Several studies focused on elite athletes, including investigations assessing performance, sleep variability, and responses to sleep extension or restriction. Some studies analyzed young competitors and developing athletes, while intervention and review studies also included recreational athletes. The sports examined included basketball in experimental conditions, while other studies covered a wide range of sports, including individual and team disciplines, allowing for generalization of the findings across different athletic populations.

Table 1 Overview of Relevant Studies on Sleep and Athletic Performance

Author(s) and Year	Study Design	Participants/ Sport	Sleep Assessment	Main objective of the study	Main findings
Mah et al. (2011)	Experimental Study (Sleep Extension)	11 basketball players (18–22 years)	Actigraphy, sleep diaries	To examine the effect of sleep extension on sports performance	Sleep extension to 9–10 hours improved shooting, sprint, and reaction time

Milewski et al. (2014)	Prospective cohort study	112 young athletes (12–18 years old)	Self-reported sleep duration	To examine the relationship between sleep duration and injuries	<8 hours of sleep is associated with a 1.7× increased risk of injury
Reyner & Horne (2013)	Experimental study	20 athletes	Sleep restriction (laboratory conditions)	To determine the impact of reduced sleep on physical performance	Reduced sleep impairs endurance, strength, and explosiveness
Oliver et al. (2009)	Randomized controlled trial	10 competitive runners	Controlled sleep deprivation	To examine aerobic capacity after one night of sleep deprivation	One night of sleep deprivation reduces endurance and VO_2max
Lastella et al. (2015)	Observational study	Elite athletes from team and individual sports	Actigraphy, questionnaires	Analysis of sleep habits in athletes	Large variations in sleep duration; 40–70% of athletes have poor sleep
Fullagar et al. (2015)	Systematic review	Various sports	—	To summarize evidence on sleep and performance	Sleep deprivation affects physical, cognitive, and technical performance
Bonnar et al. (2018)	Systematic review of interventions	Competitors and recreational athletes	Various methods	To examine the effectiveness of sleep interventions	Interventions improve sleep and recovery
Walsh et al. (2020)	Expert consensus	Elite athletes	—	To develop sleep recommendations for athletes	Comprehensive practice guidelines have been issued
Watson (2017)	Review article	Various sports	—	To analyze the impact of sleep on mental functions	Sleep deprivation reduces attention, reaction speed, and decision-making
Walker (2009)	Review article	General population + athletes	—	To investigate the role of sleep in cognition	REM sleep is crucial for motor learning and emotional stability

Table 2 presents the results of five relevant studies that investigated the impact of sleep deprivation on various domains of athletic performance and recovery processes. The included studies analyzed physical capacities, cognitive functions, technical skills, and injury risk in athletes. Across the observed studies, it was evident that sleep loss leads to reduced explosiveness, strength, and endurance, while simultaneously impairing attention, concentration, coordination, and the precision of technical execution.

The findings indicate that sleep deprivation is consistently associated with a negative impact on the quality of sports performance, with some studies also reporting a significant increase in injury risk, further emphasizing the importance of adequate recovery. It was observed that shortened or inadequate sleep patterns adversely affect athletes of varying training levels, including those engaged in sports that demand a high level of physical and mental readiness.

Table 2 Effects of Sleep Deprivation on Performance and Recovery

Study	**Physical performance**	**Cognitive functions**	**Technical skills**	**Risk of injury**	**Conclusion**
Mah et al. (2011)	↑ Explosiveness, ↑ sprint	↑ focus	↑ Shooting accuracy	N/A	Extended sleep improves all aspects of athletic performance
Milewski et al. (2014)	↓ Endurance	↓ focus	↓ Stability	×1.7 higher risk	Sleep deprivation is a significant injury risk factor

Reyner & Horne (2013)	↓ Strength, ↓ endurance	↓ attention	↓ coordination	Increased	Sleep restriction impairs physical performance
Oliver et al. (2009)	↓ VO_2max	—	—	N/A	One night of sleep deprivation reduces athletic performance
Lastella et al. (2015)	Variable	↓ Mental alertness	Variable	Increased	Athletes often do not achieve the recommended sleep duration

Table 3 presents a total of five interventions that have been examined for optimizing sleep in athletes of various profiles. The interventions included athletes from multiple disciplines, including basketball, elite sports, as well as various sports in general populations. The duration of interventions ranged from short-term protocols, such as 20–30 minute daytime naps, to long-term programs conducted over several weeks or continuously throughout the training process.

The most effective interventions included sleep extension, applied over 5–7 weeks in basketball players, which resulted in improved shooting accuracy, sprint performance, and reaction time. Sleep hygiene programs, implemented over 2–6 weeks in elite athletes, showed significant improvements in subjective sleep quality and faster recovery. Short daytime naps following exposure to acute stress partially compensated for fatigue, particularly in high-intensity sports.

Additionally, circadian-based individualization of training, which involved adjusting training loads according to athletes' chronotypes, led to more stable sports performance throughout the season. Continuous sleep monitoring, applied across various sports, enabled timely identification of issues related to low sleep quality or insufficient duration, facilitating the creation of individualized corrective plans.

These findings indicate that interventions aimed at optimizing sleep can have significant acute and chronic effects on performance, recovery, and stability of training responses in athletes of different experience levels.

Table 3 Interventions for Sleep Optimization in Athletes

Intervention	**Target group**	**Duration**	**Implementation method**	**Effect**
Sleep extension (Mah et al., 2011)	Basketball players	5–7 weeks	Extending nightly sleep to 9–10 hours	Improvement in shooting accuracy, sprinting, and reaction speed
Sleep hygiene (Bonnar et al., 2018)	Elite athletes	2–6 weeks	Education, light regulation, routine	Improved sleep quality and recovery
Nap 20-30min	Athletes under acute stress	Short-term	Daytime rest	Partial fatigue compensation
Circadian-based individualized training (Walsh et al., 2020)	Elite athletes	Constant	Training according to chronotype	More consistent performance
Sleep monitoring	Various sports	Continuous	Actigraphy, questionnaires	Timely problem identification

DISCUSSION

The authors of this study aimed to analyze contemporary scientific evidence regarding the influence of sleep quality on athletic performance and to present empirically validated strategies for optimizing sleep in athletes. The analysis highlights the impact of inadequate sleep on physical, cognitive, and technical performance, injury risk, and practical recommendations for training processes. The reviewed studies consistently demonstrate that sleep plays a crucial role in athletic performance, recovery, and injury prevention.

Although individual studies differ in methodology, sample size, duration, and sleep assessment methods, their findings are complementary and provide a comprehensive understanding of the

importance of sleep in the sporting context. A common limitation across most studies was the method of data collection for sleep quality, with reliance primarily on subjective assessments rather than laboratory-based measures.

In studies addressing sleep and athletic performance, the primary focus was on how sleep quality influences sprint performance, reaction time, endurance, strength, cognitive functions, injury risk, and psychological aspects (Mah et al., 2011; Reyner & Horne, 2013; Milewski et al., 2014; Oliver et al., 2009; Fullagar et al., 2015). Additionally, quality sleep positively affects emotional stability and attention (Watson et al., 2017; Walker et al., 2009). Notably, experimental studies examining sleep extension indicate that even simple interventions, such as increasing total nocturnal sleep, can significantly improve performance outcomes, including shot accuracy, reaction time, sprint performance, and technical execution. These findings confirm that sleep is a modifiable variable that can be strategically optimized to enhance performance without increasing physical training load.

Conversely, studies investigating sleep deprivation reveal a range of negative consequences. Insufficient sleep leads to decreased physical capacities, reduced strength, endurance, and explosiveness, as well as increased subjective fatigue (Reyner & Horne, 2013; Oliver et al., 2009). Other studies have shown that inadequate sleep negatively affects injury incidence, athletic performance, and overall career progression, as athletes often fail to achieve sufficient sleep quality (Mah et al., 2011; Milewski et al., 2014; Reyner & Horne, 2013; Oliver et al., 2009; Lastella et al., 2015). Longitudinal research demonstrates that athletes sleeping less than eight hours per night have a significantly higher risk of injury, attributed to slower neuromuscular reactions, reduced stability, impaired coordination, and increased fatigue, all of which elevate the likelihood of acute and chronic injuries (Milewski et al., 2014).

Finally, studies focused on sleep optimization interventions—such as sleep hygiene improvements, short daytime naps, regulation of electronic device use before bedtime, and chronotype-based individualized training—have shown positive effects (Mah et al., 2011; Bonnar et al., 2018; Walsh et al., 2020). These results confirm that structured sleep management is a critical component of the training and recovery process.

Overall, the literature supports the conclusion that sleep is a key determinant of athletic success. Sleep quality and duration affect physical, technical, and cognitive performance, emotional stability, and injury risk. Consequently, sleep optimization should be an integral part of athletic training, on par with nutrition, hydration, recovery, and training periodization.

In terms of theoretical application, this review provides practitioners with insights into the role of sleep in performance and recovery, as well as evidence-based methods for sleep intervention and optimization. Practically, it highlights how targeted strategies can improve sleep quality, thereby enhancing overall athletic outcomes. A limitation of this review is the absence of sex-specific analyses, which future research should address to refine sleep recommendations for male and female athletes.

CONCLUSION

Based on the analysis of current scientific literature, sleep emerges as a fundamental factor in maintaining and enhancing athletic performance, facilitating recovery, and preventing injuries. Numerous studies consistently demonstrate that sufficient high-quality sleep positively influences athletes' physical capacities, including strength, endurance, explosiveness, and motor precision. Moreover, sleep plays a critical role in cognitive functions essential for sports, such as rapid reaction, decision-making, attention, and information processing. Sleep deprivation leads to diminished athletic performance, impaired technical execution, delayed recovery, and an increased risk of injury. These effects underscore that inadequate sleep is not merely a consequence of intense training or competition schedules but a significant factor directly impacting both health and athletic success.

Proper planning and optimization of sleep should be an integral part of any training program. Educating athletes on sleep hygiene, individualizing training schedules according to biological rhythms, regulating pre-sleep light exposure, and implementing short daytime naps represent effective strategies for improving sleep quality. It is particularly important that coaches, sports professionals, and athletes recognize sleep as an essential component of recovery, alongside nutrition, hydration, and active

regeneration. The findings of this review confirm that enhancing sleep represents one of the simplest, most accessible, and most effective approaches to improving athletic performance, reducing injury risk, and preserving long-term functional stability. Future research should focus on precisely defining optimal sleep protocols and their application across different sports while considering individual variability among athletes.

REFERENCES

1. Bonnar, D., Bartel, K., Kakoschke, N., & Lang, C. (2018). Sleep interventions designed to improve athletic performance and recovery: A systematic review of current approaches. *Sports Medicine*, 48(3), 683–703.
2. Dattilo, M., Antunes, H. K., Medeiros, A., Mônico-Neto, M., Souza, H. S., Lee, K. S., & Tufik, S. (2011). Sleep and muscle recovery: Endocrinological and molecular basis for a new and promising hypothesis. *Medical Hypotheses*, 77(2), 220–222.
3. Fullagar, H. H. K., Skorski, S., Duffield, R., Hammes, D., Coutts, A. J., & Meyer, T. (2015). Sleep and athletic performance: The effects of sleep loss on exercise performance, and physiological and cognitive responses to exercise. *Sports Medicine*, 45(2), 161–186.
4. Lastella, M., Roach, G. D., Halson, S. L., & Sargent, C. (2015). Sleep/wake behaviors of elite athletes from individual and team sports. *European Journal of Sport Science*, 15(2), 94–100.
5. Mah, C. D., Mah, K. E., Kezirian, E. J., & Dement, W. C. (2011). The effects of sleep extension on the athletic performance of collegiate basketball players. *Sleep*, 34(7), 943–950.
6. Milewski, M. D., Skaggs, D. L., Bishop, G. A., Pace, J. L., Ibrahim, D. A., Wren, T. A., & Barzdukas, A. (2014). Chronic lack of sleep is associated with increased sports injuries in adolescent athletes. *Journal of Pediatric Orthopaedics*, 34(2), 129–133.
7. Oliver, S. J., Costa, R. J., Laing, S. J., Bilzon, J. L., & Walsh, N. P. (2009). One night of sleep deprivation decreases treadmill endurance performance. *European Journal of Applied Physiology*, 107(2), 155–161.
8. Reyner, L. A., & Horne, J. A. (2013). Sleep restriction and performance: A review of physiological and psychological effects. *Journal of Sleep Research*, 22(4), 398–405.
9. Samuels, C. (2008). Sleep, recovery, and performance: The new frontier in high-performance athletics. *Clinical Sports Medicine*, 27(1), 195–204.
10. Walker, M. P. (2009). The role of sleep in cognition and emotion. *Annals of the New York Academy of Sciences*, 1156(1), 168–197.
11. Walsh, N. P., Halson, S. L., Sargent, C., Roach, G. D., Nédélec, M., Gupta, L., Leeder, J., ... & Bender, A. (2020). Sleep and the athlete: Narrative review and 2020 expert consensus recommendations. *International Journal of Sports Physiology and Performance*, 15(7), 956–978.
12. Watson, N. F. (2017). Sleep and athletic performance. *Current Sports Medicine Reports*, 16(6), 413–418.

UTICAJ SNA NA SPORTSKE PERFORMANSE: POSLEDICE SMANJENJA DUŽINE I KVALITETA SNA I STRATEGIJE ZA OPTIMIZACIJU

Golubović Anđela, Arsenijević Radenko, Stanković Veroljub

***Sažetak**: San je ključan fiziološki proces koji utiče na oporavak, kognitivne funkcije i celokupne sportske performanse. On igra vitalnu ulogu u različitim fiziološkim i psihološkim procesima, uključujući regulaciju hormona, metabolizam, motorčke veštine, donošenje odluka i oporavak nakon fizičkog napora. S obzirom na visoke energetske zahteve sporta, adekvatan san je neophodan za obnavljanje iscrpljenih energetskih resursa i održavanje vrhunskih sportskih performansi. Međutim, mnogi sportisti ne postižu preporučenu dužinu sna, što može narušiti fiziološku ravnotežu, povećati rizik od povreda i negativno uticati na sportske rezultate. Ovaj pregledni rad sintetizuje aktuelna istraživanja i pruža praktične preporuke za efikasno upravljanje snom, naglašavajući njegovu ulogu u poboljšanju oporavka, smanjivanju zamora i optimizaciji sportskih performansi. Primarni cilj je analiza postojeće literature o uticaju sna na sportske performanse, sa posebnim osvrtom na posledice nedostatka sna i strategije za njegovu optimizaciju. Istraživanja pokazuju da nedovoljan san može negativno uticati na sportske performanse i u određenim slučajevima povećati rizik od povreda. Kako bi se ovi izazovi prevazišli, istraživači su razvili ciljane strategije za poboljšanje kvaliteta sna, a time i sportskih rezultata.*

***Ključne reči**: kvalitet sna, odmor, oporavak, cirkadijalni ritam*

PRE- AND POST-COMPETITION ANALYSIS OF LEVEL OF SELF-ESTEEM, ACTIVITY AND MOOD IN 10-14-YEAR-OLD ORIENTEERING COMPETITORS

Sirakova Kristina
Faculty of Education, St. Cyril and St. Methodius University of Veliko Tarnovo, Bulgaria

ORIGINAL SCIENTEFIC ARTICLE
DOI: 10.5937/ATAVPA25207S

Abstract: *This study investigates the state of confidence, activity, and mood in young orienteering competitors aged 10-14 years, using Self-esteem, activity, mood test (Leonova, 1984) applied before and after a competition. Orienteering, a demanding sport requiring both physical and cognitive skills, provides a unique context to explore how competition influences young athletes' emotional and mental states. Results revealed significant changes in participants' psychological states post-competition, with notable shifts in confidence and mood levels. These findings highlight the impact of competitive pressure on young athletes and provide insights into the emotional dynamics of youth sports. The study underscores the importance of psychological monitoring and support for young competitors to enhance their performance and well-being in demanding sports like orienteering.*
Key words: *young competitors, orienteering, psychological testing.*

INTRODUCTION

The psychological well-being of young athletes is a critical factor in their overall development, performance, and enjoyment of sports. As children and adolescents engage in competitive sports, they are exposed to unique pressures that can influence their emotional and mental states. Understanding these psychological dynamics is particularly important in demanding sports like orienteering, which require a combination of physical endurance, cognitive skills, and emotional resilience. Orienteering, a sport that involves navigating through unfamiliar terrain using a map and compass, places significant demands on young competitors. While traditionally a forest-based sport, its modern development includes accessible urban formats in parks, which are specifically designed to introduce the sport to beginners in a fun and engaging way, fostering initial positive experiences. This study examines how young athletes who have embarked on this pathway then cope with the psychological demands of formal competition (Sirakov, Ivanova & Belomazheva-Dimitrova, 2023).

Orienteering places unique psychological demands on young competitors due to its requirement for continuous decision-making, spatial orientation, and error correction under time pressure. Unlike many traditional sports, performance in orienteering is highly dependent on cognitive processes such as map reading, attention control, and rapid problem solving. Decision-making under physical fatigue has been shown to increase mental strain and emotional vulnerability, which may amplify negative affective responses during and after competition (Johnson, 2025; McCormick et al., 2015).

Competitive sport has been widely recognized as a significant psychological stressor for children and adolescents. In orienteering, this pressure exists within a clear performance pathway; research on elite university competitors in Bulgaria indicates that high-level achievement is often predicated on long-term development within supportive institutional frameworks that foster a culture of excellence. For young athletes aspiring to this level, the pressure of competition is thus intertwined with early developmental experiences that can shape their long-term relationship with the sport (Sirakov, 2025). Other research has shown that competitive environments can elicit stress, anxiety, and fluctuations in self-perception, particularly among younger athletes whose psychological coping mechanisms are still developing (Gould et al., 1993). These stress responses are often intensified in sports that combine physical exertion with complex cognitive demands, increasing the overall psychological load experienced during competition.

Self-esteem, activity, and mood are key psychological constructs that can be profoundly affected by competitive experiences. Self-esteem reflects an individual's perception of their own worth and capabilities, while activity levels indicate their energy and readiness to engage in tasks. Mood, on the other hand, represents the emotional state that can fluctuate in response to external and internal stimuli.

These factors are not only crucial for athletic performance but also for the overall well-being of young athletes. Previous research has shown that competitive sports can lead to both positive and negative psychological outcomes, depending on factors such as the level of support, the nature of the competition, and the individual's coping mechanisms.

Self-esteem in childhood and early adolescence is considered a relatively unstable and context-dependent construct, strongly influenced by situational feedback and perceived success or failure (Makelele, 2024; Harter, 1986). Self-esteem in youth is particularly sensitive to performance feedback. Theoretical models posit that physical activity influences self-esteem through perceptions of competence and social belonging, making competitive outcomes a potent source of fluctuation (Mazereel et al., 2021). In sport settings, young athletes often base their self-worth on performance outcomes, making them particularly vulnerable to decreases in self-esteem following unsatisfactory results. Performance-related self-evaluations may therefore fluctuate considerably before and after competition, reflecting the dynamic nature of self-esteem in youth sport contexts.

Mood represents a transient psychological state that is particularly sensitive to situational factors such as physical exertion, perceived performance, and competitive stress. In youth sport, post-competition mood has been identified as an important indicator of athletes' immediate emotional adjustment to competitive experiences. Negative mood states following competition may reflect disappointment, mental fatigue, or stress-related responses and can influence motivation and subsequent engagement in sport (Lane & Terry, 2000).

This study focuses on young orienteering competitors aged 10-14 years, a developmental period characterized by significant physical, emotional, and cognitive changes. Using the Self-esteem, Activity, and Mood Test (Leonova, 1984), we aimed to investigate how participation in an orienteering competition influences these psychological states. By administering the test before and after the competition, we sought to capture the immediate impact of competitive pressure on the participants' self-esteem, activity levels, and mood.

The findings of this study are expected to contribute to a deeper understanding of the emotional and psychological dynamics of youth sports. By highlighting the changes in self-esteem, activity, and mood that occur as a result of competition, this research underscores the importance of psychological monitoring and support for young athletes. Such insights can inform the development of strategies to enhance the performance and well-being of young competitors, ensuring that they not only succeed in their sport but also enjoy a positive and fulfilling athletic experience.

METHODS

Participants

The study involved 21 orienteering competitors aged 10-14 years, who participated in a regional orienteering competition held in March 2025 in Bulgaria. Participants were recruited through local orienteering clubs and had little to no competitive experience. Written informed consent was obtained from both the participants and their parents or guardians prior to their involvement in the study. Ethical approval for the research was obtained from the relevant institutional review board.

Psychological Assessment

To assess the psychological states of the participants, the Self-esteem, Activity, and Mood test was administered. The original questionnaire, developed by Leonova (1984), is presented in its English translation in Figure 1. The validated instrument consists of 30 items. For the purposes of the present study, a minor modification was introduced by replacing the original bipolar 7-point scale (3-2-1-0-1-2-3) with a unipolar 7-point scale ranging from 1 (worst) to 7 (best), where 1 represents the lowest and 7 the highest possible score for each item and, respectively, for each of the three assessed constructs. The questionnaire comprises three subscales – self-esteem, activity, and mood – each containing 10 items. Subscale scores were calculated by summing the responses to the corresponding items, yielding separate total scores for self-esteem, activity, and mood. Higher scores indicate higher levels of self-esteem, activity, and more positive mood.

Name..... Age..... Team.....

⇨ **Before / After**

Test Self-esteem, Activity, Mood

Please circle the number that most accurately reflects your current state. Each pair of words on a row represents opposite concepts. Zero indicates a neutral state, while the numbers to the left and to the right of zero represent the degree of the respective state.

1	Good self-esteem	3 2 1 0 1 2 3	Poor self-esteem
2	I feel strong	3 2 1 0 1 2 3	Weak
3	Passive	3 2 1 0 1 2 3	Active
4	Low mobility / Not very active	3 2 1 0 1 2 3	Mobile / Physically active
5	Cheerful	3 2 1 0 1 2 3	Sad
6	Good mood	3 2 1 0 1 2 3	Bad mood
7	Able to work / Efficient	3 2 1 0 1 2 3	Exhausted
8	Full of energy	3 2 1 0 1 2 3	Weakened
9	Slow	3 2 1 0 1 2 3	Fast
10	Inactive	3 2 1 0 1 2 3	Active (engaged)
11	Happy	3 2 1 0 1 2 3	Unhappy
12	Joyful	3 2 1 0 1 2 3	Gloomy
13	Tense	3 2 1 0 1 2 3	Relaxed
14	Healthy	3 2 1 0 1 2 3	Ill
15	Uninvolved	3 2 1 0 1 2 3	Engrossed / Absorbed
16	Indifferent	3 2 1 0 1 2 3	Excited
17	Enthusiastic	3 2 1 0 1 2 3	Dejected
18	Glad / Joyful	3 2 1 0 1 2 3	Sorrowful
19	Rested	3 2 1 0 1 2 3	Tired
20	Fresh	3 2 1 0 1 2 3	Exhausted
21	Sleepy	3 2 1 0 1 2 3	Aroused
22	I need rest	3 2 1 0 1 2 3	I want to work
23	Calm	3 2 1 0 1 2 3	Concerned
24	Optimistic	3 2 1 0 1 2 3	Pessimistic
25	Enduring / Resilient	3 2 1 0 1 2 3	Not enduring / Low endurance
26	Alert	3 2 1 0 1 2 3	Sluggish
27	I find it hard to concentrate	3 2 1 0 1 2 3	I think easily / I comprehend easily
28	Distracted	3 2 1 0 1 2 3	Attentive
29	Full of hope	3 2 1 0 1 2 3	Disappointed
30	Satisfied	3 2 1 0 1 2 3	Dissatisfied

Fig. 1 Questionnaire: Self-esteem, Activity, and Mood Test – originally in Russian (Leonova, 1984)

Procedure

The psychological test was administered twice: once immediately before the orienteering competition and once immediately after the competition. The pre-competition assessment was conducted 30 minutes prior to the start of the event, while the post-competition assessment was completed within 15 minutes of the participants finishing the event. This timing was chosen to capture the immediate psychological impact of the competitive experience. Participants completed the questionnaire in a quiet and controlled environment to minimize distractions and ensure accurate responses.

DISCUSSION AND RESULTS

The findings of this study highlight the significant psychological impact of competitive orienteering on young athletes aged 10-14 years. The results illustrated in Figure 2 indicate a decline in self-esteem, activity, and mood following the competition, suggesting that the demands and pressures of the event may have negatively influenced the participants' emotional and mental states.

The pronounced decline in self-esteem observed after the competition may be explained through the concept of performance-contingent self-worth. Young athletes often evaluate their personal value based on competitive outcomes, making unsuccessful performances particularly detrimental to their self-perception. According to Crocker and Wolfe (2001), when self-worth is closely tied to achievement, failure experiences can result in immediate reductions in self-esteem, especially in developmental stages

characterized by heightened sensitivity to external evaluation.

The observed declines in activity and mood align with recent research on mental fatigue in orienteering. Studies have shown that the sport's high cognitive load – from constant navigation and decision-making – induces acute mental fatigue that impairs mood and perceived energy, with effects lasting up to 48 hours post-event (Lam et al., 2024).

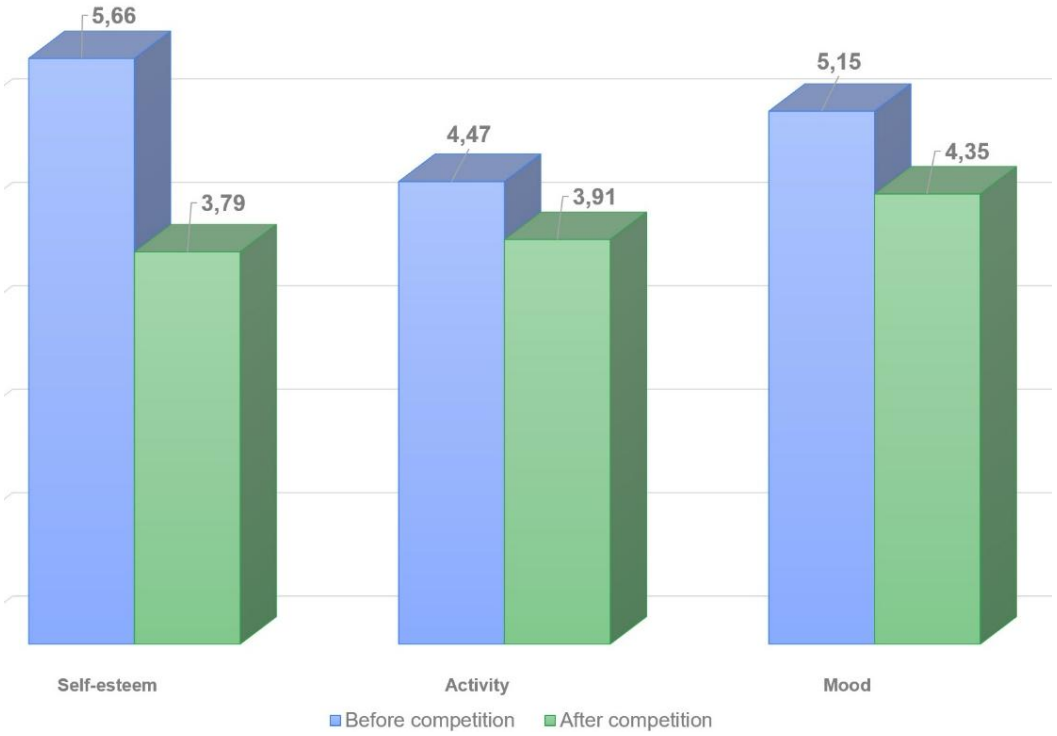


Fig. 2 Psychological test: Self-esteem, activity and mood - before and after a competition with 10-14 aged orienteers

Self-esteem showed the most pronounced decrease, dropping from 5.66 to 3.79. This decline may reflect the heightened self-criticism that arises when young athletes feel they have failed to execute complex cognitive tasks under pressure. This is supported by elite athletes who link self-confidence directly to the mastery of specific cognitive skills, such as map memorization and strategic simplification. For novices, a poor competitive performance may thus feel like a failure in these fundamental skills, leading to a sharp drop in self-evaluated worth (Belomazheva-Dimitrova & Sirakov, 2019).

Activity levels also decreased, albeit to a lesser extent, from 4.47 to 3.91. This reduction in perceived energy and readiness to engage in tasks may be attributed to the physical and mental fatigue associated with the competition. This connection is underscored by research with elite orienteers, which establishes a clear consensus that physical fitness is directly linked to technical performance during a competition, suggesting that physical fatigue can directly impair the cognitive resources needed for navigation (Sirakov & Belomazheva-Dimitrova, 2018).

The decrease in activity levels following the competition may reflect not only physical fatigue but also cognitive and emotional exhaustion. This cognitive load specifically targets executive functions; studies show that technical orienteering training primarily enhances concentration and sustained attention, meaning that competition likely drains these very resources, leading to a measurable drop in perceived energy (Sirakov & Belomazheva-Dimitrova, 2021). Mental exhaustion has been shown to reduce perceived energy levels and motivation, particularly in endurance-based sports involving high cognitive engagement (Kellmann, 2002).

Mood scores declined from 5.15 to 4.35, indicating a shift toward a less positive emotional state. This change may be linked to the stress and disappointment that can accompany competitive events,

particularly if participants faced challenges such as difficult terrain, navigation errors, or unfavorable competition outcomes. The emotional toll of competition, combined with physical exhaustion, likely contributed to the observed decline in mood.

The observed decline in mood is consistent with previous findings indicating that competitive stress and perceived underperformance can negatively affect affective states in young athletes. Mood disturbances following competition may be exacerbated in sports such as orienteering, where navigation errors are highly salient and often perceived as personal mistakes. Such experiences may intensify emotional reactions and contribute to short-term reductions in positive affect (Lane & Terry, 2000).

These findings align with foundational research demonstrating that competitive sports can be a significant source of stress, anxiety, and self-doubt for young athletes, particularly when they perceive their performance as inadequate (Gould et al., 1993). However, it is crucial to distinguish the specific pressures of formal competition from the broader experience of the sport. Research in educational settings shows that orienteering introduced as a physical education activity yields very high levels of student satisfaction, with participants reporting enjoyment and perceived benefits for their intellectual development (Sirakov, 2024). This suggests that the negative psychological shifts observed in the present study are likely tied to the acute evaluative pressure of competition, rather than to the inherent nature of orienteering activities. The results of this study also underscore the importance of providing psychological support to young orienteering competitors to help them manage the emotional and mental challenges of competition.

Compared to many team and individual youth sports, orienteering presents a distinctive psychological profile due to its emphasis on individual responsibility and continuous problem solving. Previous research has indicated that sports involving high levels of personal accountability may increase emotional pressure and stress responses in young athletes (Fraser-Thomas et al., 2008). This characteristic may partially explain the substantial post-competition declines observed in the present study.

Practical Implications

The observed declines in self-esteem, activity, and mood highlight the need for interventions aimed at supporting young athletes' psychological well-being. Coaches and parents can play a crucial role in fostering a positive competitive environment by emphasizing effort and improvement over outcomes, providing constructive feedback, and helping athletes develop coping strategies for dealing with stress and disappointment. Additionally, incorporating post-competition recovery activities, such as relaxation techniques or team debriefings, may help mitigate the negative psychological effects of competition.

Furthermore, psychological support and preparation should be considered alongside the quality of event organization. Since factors like clear map presentation, well-designed courses, and effective pre-event communication are known to enhance participant satisfaction and reduce pre-competition uncertainty (Sirakov & Minoiu, 2025), organizers and coaches can mitigate some environmental stressors. Optimizing these organizational aspects can create a more supportive competitive framework, potentially buffering the sharp psychological declines documented here.

Limitations and Future Research

This study has several limitations. First, the sample size was relatively small (n = 21), which may limit the generalizability of the findings. Second, the study focused on a single competition, and the psychological effects of repeated competitive events over time remain unexplored. Future research could investigate longitudinal changes in self-esteem, activity, and mood across multiple competitions, as well as the role of individual differences (e.g., age, gender, experience level) in shaping athletes' psychological responses.

CONCLUSION

This study explored the psychological impact of competitive orienteering on young athletes aged 10-14 years with little to no experience in racing, focusing on changes in self-esteem, activity, and mood before and after a competition. The results revealed significant declines in all three psychological

constructs following the event, with self-esteem showing the most pronounced decrease, followed by mood and activity. These findings highlight the emotional and mental challenges that young orienteering competitors face in a demanding and high-pressure environment.

The observed declines in self-esteem, activity, and mood underscore the importance of providing psychological support to young athletes to help them navigate the stresses of competition. Coaches, parents, and sports organizations play a critical role in fostering a positive and supportive environment that prioritizes effort, growth, and well-being over outcomes. By implementing strategies such as constructive feedback, stress management techniques, and post-competition recovery activities, stakeholders can help young athletes build resilience and maintain a healthy psychological state.

By addressing these challenges through proactive support and monitoring, we can ensure that young athletes not only perform at their best but also enjoy a positive and fulfilling sporting experience. This is particularly important given that orienteering, at its core, is an activity that new participants find highly engaging and intellectually rewarding. The role of coaches and parents, therefore, is to build a bridge that allows young competitors to carry this initial enjoyment and sense of competence forward into the competitive realm (Sirakov, 2024).

While this study provides valuable insights into the immediate psychological effects of competition, further research is needed to explore the long-term impact of repeated competitive events and the role of individual differences in shaping athletes' responses. Understanding these dynamics can inform the development of targeted interventions to support young athletes' mental and emotional well-being.

In conclusion, competitive orienteering, while offering numerous benefits, also poses significant psychological challenges for young unexperienced competitors. By addressing these challenges through proactive support and monitoring, we can ensure that young athletes not only perform at their best but also enjoy a positive and fulfilling sporting experience. A follow-up study with the same participants is planned once they have gained competitive experience, to determine whether the outcomes differ.

REFERENCES

1. Belomazheva-Dimitrova, S., Sirakov, I. (2019). Memory Training as a Preparation Method in Orienteering – For or Against: Study of the Opinion of World Elite Orienteering Competitors. *Proceedings "Tourism and Sport",* Sofia: NSA Press, 2019, 5-11. (in Bulgarian)
2. Crocker, J., & Wolfe, C. T. (2001). Contingencies of self-worth. *Psychological Review*, 108(3), 593–623. https://doi.org/10.1037/0033-295X.108.3.593
3. Fraser-Thomas, J., Côté, J., & Deakin, J. (2008). Understanding dropout and prolonged engagement in adolescent competitive sport. *Psychology of Sport and Exercise*, 9(5), 645-662. https://doi.org/10.1016/j.psychsport.2007.08.003
4. Gould, D., Wilson, C. G., Tuffey, S., & Lochbaum, M. (1993). Stress and the Young Athlete: The Child's Perspective. *Pediatric Exercise Science*, 5(3), 286-297. https://doi.org/10.1123/pes.5.3.286
5. Harter, S. (1986). Processes underlying the construction, maintenance and enhancement of the self-concept in children. *Psychological perspectives on the self*, 3, 136-182.
6. Johnson, J. G. (2025). Decision making in sports, *Psychology of Sport and Exercise*, Volume 80, 2025, 102919, ISSN 1469-0292, https://doi.org/10.1016/j.psychsport.2025.102919.
7. Kellmann, M. (2002). *Enhancing Recovery: Preventing Underperformance in Athletes*. Human Kinetics.
8. Lam, H.K.N., Sproule, J., Turner, A.P., Phillips, S.M,]. (2024). Changes in perceived mental fatigue, physical fatigue and mood state during a 4-day national junior orienteering competition preparation camp. *Eur J Sport Sci*. 2024 Feb 5;24(2):226–38. doi: 10.1002/ejsc.12071. PMCID: PMC11235969.
9. Lane, A. M., & Terry, P. C. (2000). The Nature of Mood: Development of a Conceptual Model with a Focus on Depression. *Journal of Applied Sport Psychology*, 12(1), 16–33. https://doi.org/10.1080/10413200008404211
10. Leonova, A. B. (1984). *Psychodiagnostics of human functional states.* Moscow: Moscow University Press*.* (in Russian)
11. Makelele, B. M. (2024). Self-Esteem in School Management Students with Special Reference to Gender and Age. American Journal of Applied Psychology, 12(1), 1-13.
12. Mazereel, V., Vansteelandt, K., Menne-Lothmann, C., Decoster, J., Derom, C., Thiery, E., Rutten, B. P.F., Jacobs, N., van Os, J., Wichers, M., De Hert, M. Vancampfort, D., van Winkel, R. (2021). The complex and dynamic interplay between self-esteem, belongingness and physical activity in daily life: An experience sampling study

in adolescence and young adulthood. *Mental Health and Physical Activity*, Volume 21, 2021, 100413, https://doi.org/10.1016/j.mhpa.2021.100413
13. McCormick, A., Meijen, C., Marcora, S. (2015). Psychological Determinants of Whole-Body Endurance Performance. *Sports Med*. 2015 Jul;45(7):997-1015. doi: 10.1007/s40279-015-0319-6. PMID: 25771784; PMCID: PMC4473096.
14. Sirakov, I. (2025). A Performance Analysis of Bulgarian University Orienteering: The Sustained Male Dominance of St. Cyril and St. Methodius University of Veliko Tarnovo. *Proceedings Problems and prospects of physical education and sports in the conditions of globalization*, Veliko Tarnovo: St. Cyril and St. Methodius University Press, volume 6, 31-39.
15. Sirakov, I. (2024). St. Cyril and St. Methodius University students' satisfaction of their attendance in physical education and sports classes – orienteering. *Proceedings Problems and prospects of physical education and sports in the conditions of globalization*, Veliko Tarnovo: St. Cyril and St. Methodius University Press, volume 4, 43-50. (in Bulgarian)
16. Sirakov, I., Belomazheva-Dimitrova, S. (2021). Effect of the training program on mental qualities in elite orienteers. *Journal of Physical Education and Sport*, Vol. 21, Issue 3, Art 190, 1498–1504, https://doi.org/10.7752/jpes.2021.03190
17. Sirakov, I., Belomazheva-Dimitrova, S. (2018). Value of technical trainings, their analysis and effects on the preparation process of world elite orienteering competitors. *Journal of Physical Education and Sport*, Vol. 18, Issue 5, 2127–2133, https://doi.org/10.7752/jpes.2018.s5321
18. Sirakov, I., Ivanova, K., Belomazheva-Dimitrova, S. (2023). Orienteering as an Urban Sport. *Proceedings Problems and prospects of physical education and sports in the conditions of globalization*, Veliko Tarnovo: St. Cyril and St. Methodius University Press, volume 2, 63-70. (in Bulgarian)
19. Sirakov, I., Minoiu, V. (2025). Evaluating the Organization of the 2024 Bulgarian Orienteering Championships: A Focus on Forest Distances. *Sport, Science, Education,* vol. 1, issue 2, 150-157. https://doi.org/10.54664/YLDP8162

ANALIZA NIVOA SAMOPOUZDANJA, AKTIVNOSTI I RASPOLOŽENJA KOD ORIJENTIRISTA UZRASTA 10-14 GODINA PRE I POSLE TAKMIČENJA

Sirakova Kristina

Sažetak: *Ova studija istražuje psihološka stanja samopouzdanja, aktivnosti i raspoloženja kod mladih orijentirista uzrasta 10-14 godina, koristeći test samopouzdanja, aktivnosti i raspoloženja (Leonova, 1984) primenjen pre i posle takmičenja. Orijentiring, zahtevan sport koji zahteva i fizičke i kognitivne veštine, pruža jedinstven kontekst za istraživanje uticaja takmičenja na emocionalna i mentalna stanja mladih sportista. Rezultati su pokazali značajne promene u psihološkim stanjima učesnika nakon takmičenja, sa primetnim promenama u nivou samopouzdanja i raspoloženja. Ovi nalazi naglašavaju uticaj takmičarskog pritiska na mlade sportiste i pružaju uvid u emocionalnu dinamiku sporta mladih. Studija ističe važnost psihološkog praćenja i podrške mladim takmičarima kako bi se poboljšali njihov performans i dobrobit u zahtevnim sportovima poput orijentiringa.*
Ključne reči: *mladi takmičari, orijentiring, psihološko testiranje.*

ORIENTEERING AS A SOCIAL PHENOMENON

Yordanov Stefan
Faculty of Education, St. Cyril and St. Methodius University of Veliko Tarnovo, Bulgaria

ORIGINAL SCIENTEFIC ARTICLE
DOI: 10.5937/ATAVPA25214Y

Abstract: *Orienteering is a unique sport that combines physical endurance, cognitive skills, and navigation in natural and urban environments. Beyond its athletic aspects, orienteering functions as a social phenomenon that fosters community building, environmental awareness, and lifelong engagement in physical activity. This paper explores the social dimensions of orienteering, including its role in education, health promotion, and social integration. By analyzing existing literature and case studies, we highlight how orienteering contributes to personal development, teamwork, and inclusivity. The study also discusses the sport's impact on different age groups and its significance in modern society. Additionally, the report presents the results of a survey exploring attitudes towards orienteering as a social phenomenon, offering valuable insights into the public perception of the sport and its broader social implications.*
Key words: *orienteering, social phenomenon, sports culture, sports community, social integration*

INTRODUCTION

Orienteering is a sport that combines physical endurance, navigational skills, and rapid decision-making in a variety of natural and urban environments. Although it is often perceived primarily as an individual physical activity, orienteering has strong social characteristics. It brings together people of different ages, genders, and social and professional backgrounds, creating conditions for active communication, cooperation, and the formation of long-term social relationships. Through shared training and competition experiences, participants develop a sense of belonging and mutual support, which strengthens community ties and promotes social inclusion and equality (Vladimirov, 2025a; Vladimirov, 2025b). The arena, being the most visible and socially interactive space in an orienteering event, directly shapes both athlete experience and the public image of the sport (Sirakov & Minoiu, 2025).

Numerous studies highlight the positive impact of orienteering on participants' psycho-emotional and psycho-physical well-being. Structured training programs for adolescents, students, and adults contribute to improved emotional balance, reduced stress levels, and enhanced overall quality of life, which in turn leads to higher personal satisfaction and social adaptability (Galan et al., 2016; Blagii et al., 2018). These communicative and health-related functions position orienteering as an effective means for personal development, social integration, and the cultivation of a positive sport culture.

In recent years, orienteering has also undergone significant transformation due to the integration of modern technologies. The use of GPS tracking systems and specialized analytical software has fundamentally changed the training and competition process, enabling detailed evaluation of route choices, technical performance, and decision-making errors. At the same time, these technological innovations have increased the attractiveness of the sport for spectators by allowing live broadcasting and in-depth visual analysis of competitions. As a result, orienteering is evolving from a relatively closed sporting discipline into an appealing media product, supporting its popularization and attracting new participants (Sirakov & Belomazheva-Dimitrova, 2016; Sirakov & Belomazheva-Dimitrova, 2019; Sirakov & Belomazheva-Dimitrova, 2021). Despite these advancements, research among elite orienteers confirms that a high level of physical fitness remains a key prerequisite for maintaining technical accuracy and effective decision-making under competitive load (Sirakov & Belomazheva-Dimitrova, 2018; Minoiu & Minoiu, 2019).

Beyond its technological and physical dimensions, orienteering represents a powerful environment for cognitive and personal development. Regular training, particularly focused on technical skills and map interpretation, has been shown to positively influence mental processes such as attention, spatial thinking, and the ability to make rapid decisions in stressful situations (Zsheliaskova-Koynova, 1993; Belomazheva-Dimitrova, 2020; Batista et al., 2021; Robazza et al., 2018). The unique combination of

intense physical effort and complex cognitive activity makes orienteering not only a competitive sport but also a valuable educational tool. Its application in school and university settings supports the development of essential life skills among young people and students, including problem-solving, autonomy, responsibility, and resilience (Sirakov & Belomazheva-Dimitrova, 2019; Vaskan et al., 2019; Sirakov & Ivanova, 2023; Sirakov, Ivanova & Belomazheva-Dimitrova, 2023; Baytaş et al., 2024). Evidence from Bulgarian university orienteering further supports the role of the sport as a stable social and educational environment. Long-term analyses of national university championships demonstrate that sustained institutional engagement in orienteering contributes not only to competitive success, but also to the formation of cohesive student communities and enduring athlete involvement over multiple academic cycles (Sirakov, 2025).

In this context, the present study aims to examine orienteering as a social phenomenon by presenting empirical data obtained through a survey among active participants in the sport and by outlining its role in socialization, community building, and sustainable engagement in an active and healthy lifestyle.

METHODS

The study was conducted using a structured online survey targeting individuals who practice orienteering from different age groups and levels of experience. A total of 280 respondents participated in the study, including both athletes with many years of competitive experience and recreational participants.

The questionnaire consisted of 16 questions, incorporating both multiple-choice items and statements evaluated using a five-point Likert scale (from “strongly disagree” to “strongly agree”).

The main objective of the study was to examine social attitudes and perceptions toward orienteering, with a particular focus on:

- the degree of perceived sense of belonging to the sporting community;
- the social interactions arising from participation in the sport;
- the perceived impact of orienteering on personal and social development;
- opinions regarding the promotion and social accessibility of the sport.

The collected data were analyzed quantitatively and presented through charts and figures illustrating trends in the social aspects of orienteering.

RESULTS AND DISCUSSION

The study confirms that orienteering is perceived by participants not merely as an individual sport, but as an activity with a clearly pronounced social dimension. One of the most strongly emphasized aspects in the survey was precisely the social function of the sport. Nearly three quarters of the respondents reported that through their participation in orienteering they had established meaningful new social connections, while almost another quarter fully or partially supported this statement. Only a very small proportion of participants were uncertain or did not perceive a link between orienteering and social bonding (Figure 1). This indicates that the sport not only motivates participation through physical activity but also plays an important role as a social platform that fosters interpersonal communication and a sense of belonging.

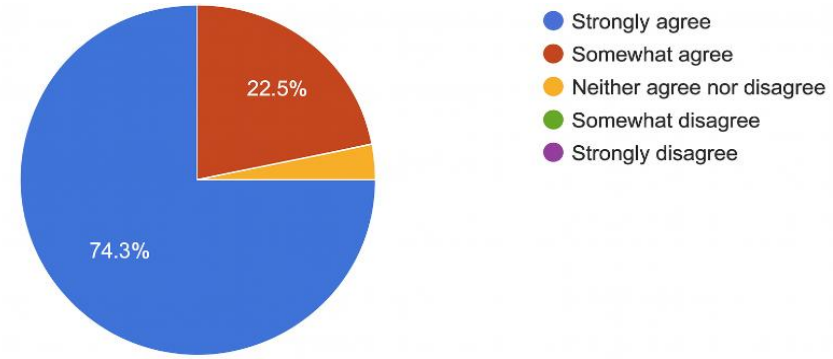


Fig. 1 Do you believe that orienteering helps you create new social contacts?

The results of the survey confirm that orienteering is perceived by the majority of participants not only as a sport, but also as a social practice that promotes communication, inclusion, and personal development. From the very beginning of the study, a clear tendency emerged to view orienteering as an open and inclusive environment. More than half of the respondents fully agree, and nearly one third partially agree, with the statement that there are no cultural or social barriers in the sport (Figure 2). This indicates that orienteering is perceived as an accessible and equitable space for interaction, in which participants share common values regardless of social, ethnic, or cultural differences.

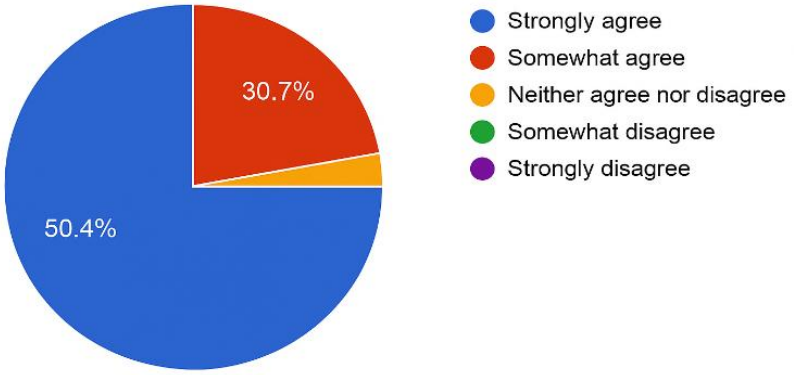


Fig. 2 Do you agree with the statement that there are no cultural and/or social barriers in orienteering?

This openness is further confirmed by attitudes toward socialization. Almost all respondents – 77.1% fully and 21.1% partially – believe that orienteering contributes to socialization among those who practice it (Figure 3). This demonstrates the sport's significant role in building a sense of community and a supportive social environment.

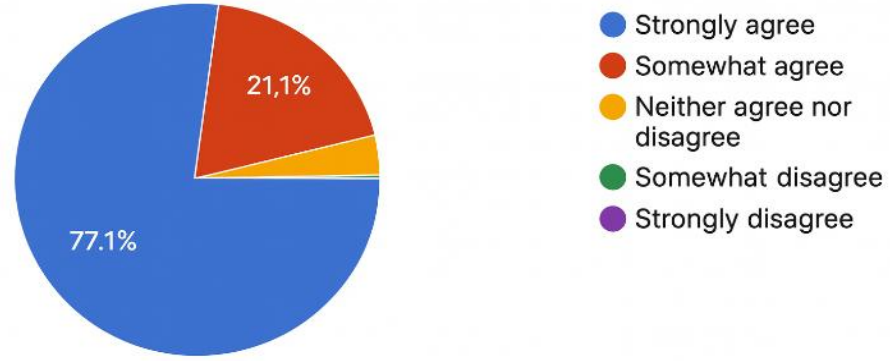


Fig. 3 Do you agree that orienteering contributes to socialization among people who practice it?

A similar trend is observed in the assessment of the accessibility of orienteering. A total of 72.9% of respondents fully agree and 21.4% partially agree that the sport is suitable for people with differences in ethnicity, gender, age, or physical abilities (Figure 4). This result emphasizes that orienteering provides one of the few platforms where equality is not merely a theoretical principle, but a lived experience.

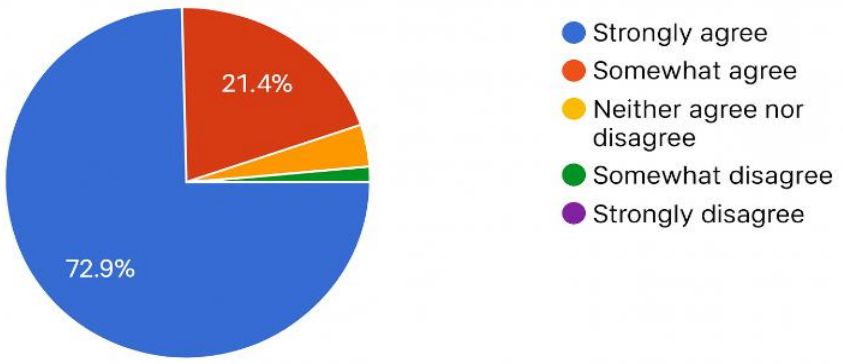


Fig. 4 Do you consider orienteering accessible to people with differences in ethnicity, race, gender, age, or physical abilities?

Regarding the perception of orienteering as a socializing activity, responses are nearly unanimous – 77.9% fully agree and 21.1% partially agree that the sport fulfills such a function (Figure 5).

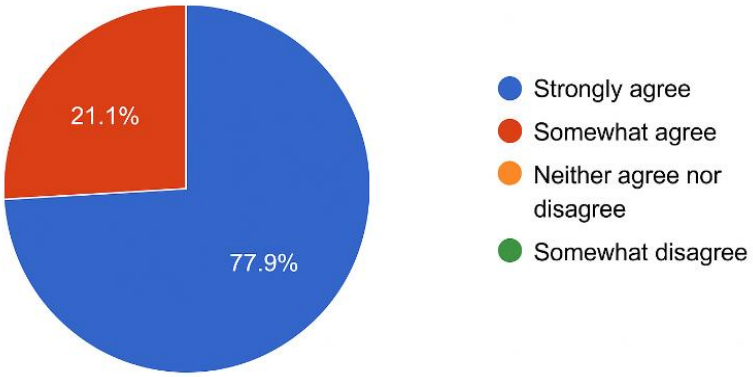


Fig. 5 Do you consider orienteering to be a socializing activity?

Even more noteworthy are the results of the following question, which examines the place of orienteering in comparison with other socializing activities (Figure 6). Approximately one third of respondents rank orienteering as the most important socializing activity in their lives, while an additional 40% place it in second position. This suggests that for many participants, orienteering occupies a leading role in their social lives, serving not only as a form of physical activity but also as a primary means of communication and shared experience.

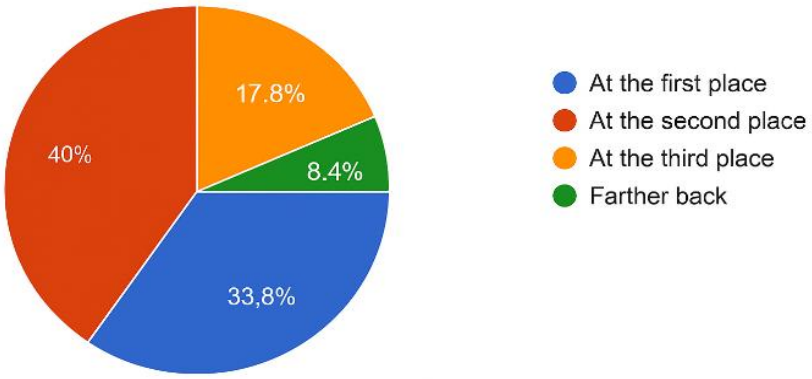


Fig. 6 If you consider orienteering a socializing activity, where does it rank in importance compared to other socializing activities in your life?

Finally, respondents demonstrate a high level of agreement with the idea of including orienteering as a mandatory component of physical education curricula in schools (Figure 7). More than 60% fully support this proposal, while nearly 28% partially approve it. This reflects an understanding that orienteering has not only physical, but also educational and social value, which can be effectively utilized in the school environment.

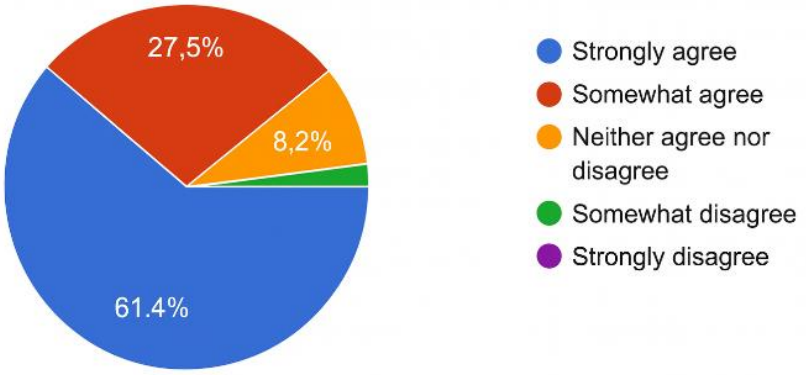


Fig. 7 Do you think that orienteering could be included as a mandatory content area in school physical education programs? (Currently, it is an optional component.)

CONCLUSION

The results of the survey clearly demonstrate that orienteering is far more than a sport – it represents a social phenomenon that fosters communication, inclusion, and social connectedness among people from diverse backgrounds. Participants perceive orienteering as an inclusive, friendly, and accessible environment that supports the development of social capital and long-term interpersonal relationships.

Based on the data, it can be concluded that orienteering possesses significant potential as a tool for social integration and education through movement. Its more active inclusion in school curricula, along with improved media visibility, could expand its impact and strengthen its role as a socially meaningful form of physical and social activity.

REFERENCES

1. Batista, M. M., Paludo, A. C., Silva, D. A., Martins, M. V., Pauli, P. H., Dal'maz, G., Stefanello, J. M., & Tartaruga, M. P. (2021). Effect of mental fatigue on performance, perceptual, and physiological responses in orienteering athletes. *Journal of Sports Medicine and Physical Fitness*, 61(5), pp. 673–679. https://doi.org/10.23736/S0022-4707.21.11334-9
2. Baytaş, E., Şahan, A., Erman, K. A., & Toktaş, N. (2024). Analysis of cognitive characteristics and factors affecting sprint and memory course performance in orienteers. *Kinesiologia Slovenica*, 29(3), pp. 87–100. https://doi.org/10.52165/kinsi.29.3.87-100
3. Belomazheva-Dimitrova, S. (2020). Influence of a specialized orienteering method for beginners on some mental qualities in students*. Modern Trends in Physical Education and Sport*, Sofia: St. Kliment Ohridski University Press, 157–166. (in Bulgarian)
4. Belomazheva-Dimitrova, S., & Sirakov, I. (2019). Memory training as a preparation method in orienteering - for or against: study of the opinion of world elite orienteering competitors. *Proceedings "Tourism and Sport",* Sofia: NSA PRESS, 5–11. (in Bulgarian)
5. Blagii, O., Berezovskyi, V., Balatska, L., Kyselytsia, O., Palichuk, Y., & Yarmak, O. (2018). Optimization of psychophysiological indicators of adolescents by means of sport orienteering. *Journal of Physical Education and Sport*, 18(Suppl. 1), Art. 75, 526–531. DOI:10.7752/jpes.2018.s175
6. Galan, Y., Zoriy, Y., Briskin, Y., & Pityn, M. (2016). Orienteering to optimize the psychophysical wellbeing of young teens (13–14 years old). *Journal of Physical Education and Sport*, 16(Suppl. 3), Art. 144, 914–920. DOI:10.7752/jpes.2016.03144
7. Minoiu, V., & Minoiu, G. E. (2019). Analysis of performance indices in urban sprint orienteering in relation to track running performance. *Journal of Sport and Kinetic Movement*, 34(2), 86–90.
8. Robazza, C., Izzicupo, P., D'Amico, M. A., Ghinassi, B., Crippa, M. C., Di Cecco, V., et al. (2018). Psychophysiological responses of junior orienteers under competitive pressure. *PLoS ONE*, 13(4), e0196273. https://doi.org/10.1371/journal.pone.0196273

9. Sirakov, I. (2025). A Performance Analysis of Bulgarian University Orienteering: The Sustained Male Dominance of St. Cyril and St. Methodius University of Veliko Tarnovo. *Problems and prospects of physical education and sports in the conditions of globalization*, Veliko Tarnovo, St. Cyril and St. Methodius University Press, Volume 6, 31-39.
10. Sirakov, I., & Belomazheva-Dimitrova, S. (2016). Modern resources for movement following of orienteering competitors*. Pedagogical Education – Traditions and Modernity*, Veliko Tarnovo, Ai & Bi, 324–329. (in Bulgarian)
11. Sirakov, I., & Belomazheva-Dimitrova, S. (2019). Examination of the possibilities for applying the GPS technologies and software products in orienteering. *Modern Trends in Physical Education and Sport,* Sofia, University Press "St. Kliment Ohridski", 288–298. (in Bulgarian)
12. Sirakov, I., & Belomazheva-Dimitrova, S. (2018). Value of technical training, its analysis and effects on the preparation process of world elite orienteering competitors. *Journal of Physical Education and Sport*, 18(5), 2127–2133. https://doi.org/10.7752/jpes.2018.s5321
13. Sirakov, I., & Belomazheva-Dimitrova, S. (2021). Effect of the training program on mental qualities in elite orienteers. *Journal of Physical Education and Sport*, 21(3), Art. 190, 1498–1504. https://doi.org/10.7752/jpes.2021.03190
14. Sirakov, I., & Ivanova, K. (2023). Orienteering as a new sport practice at St. Cyril and St. Methodius University of Veliko Tarnovo. *Problems and prospects of physical education and sports in the conditions of globalization,* Veliko Tarnovo: St. Cyril and St. Methodius University Press, Volume 1, 101–108. (in Bulgarian)
15. Sirakov, I., Ivanova, K., & Belomazheva-Dimitrova, S. (2023). Orienteering as an urban sport. *Problems and prospects of physical education and sports in the conditions of globalization,* Veliko Tarnovo: St. Cyril and St. Methodius University Press, Volume 2, 63-70. (in Bulgarian)
16. Sirakov, I., Minoiu, V. (2025). Evaluating the Organization of the 2024 Bulgarian Orienteering Championships: A Focus on Forest Distances. *Sport, Science, Education,* Vol. 1, Issue 2, 150-157. https://doi.org/10.54664/YLDP8162
17. Vaskan, I., Koshura, A., Kurnyshev, Y., Moseychuk, Y., Tsybanyuk, O., Yarmak, O., & Galan, Y. (2019). Orienteering in the system of recreational and health-improving activities of student youth. *Journal of Physical Education and Sport*, 19(Suppl. 2), Art. 71, 489–494. DOI:10.7752/jpes.2016.03144
18. Vladimirov, D. (2025a). Analysis of the existing statistically significant difference between the indicators of the initial and final measurement after the implementation of a comprehensive programme of sport improvement in orienteering for students from the Technical University of Sofia, Plovdiv branch. *Strategies for Educational and Scientific Policy*, 33(2S), 134–146. https://doi.org/10.53656/str2025-2s-11-dan (in Bulgarian)
19. Vladimirov, D. (2025b). Study of connections concerning the physical and technical training of students from Technical University – sofia, branch plovdiv, participating in sports improvement in orienteering. *Modern Trends in Physical Education and Sport*, Sofia, St. Kliment Ohridski University Press, 203–208. (in Bulgarian)
20. Zsheliaskova-Koynova, Z. (1993). The relationships between different personality characteristics and coping styles with stress in elite orienteers. *Scientific Journal of Orienteering*, 9, 43–48.

STUDENTS' EVALUATION OF TEACHING AND LEARNING IN PRACTICAL SKI EDUCATION

Sirakov Ivan, Belomazheva-Dimitrova Stefaniya, Vidinovski Milen, Stefanov Svetoslav, Denev Stoyan
Faculty of Education, St. Cyril and St. Methodius University of Veliko Tarnovo, Bulgaria

ORIGINAL SCIENTEFIC ARTICLE
DOI: 10.5937/ATAVPA25220S

Abstract: *Evaluating the quality of teaching and learning is essential for improving both processes. Students' feedback provides valuable insights into the effectiveness of teachers and the learning experience. Practical ski training is a well-established component of sports and physical education university programs worldwide. It is also a mandatory course in the Physical education and sports bachelor's degree program at St. Cyril and St. Methodius University of Veliko Tarnovo, Bulgaria. Every student undergoes a seven-day skiing training course, although most have no previous experience before attending ski education. The purpose of this research is to assess students' opinions on the quality of teaching and learning in practical ski education, focusing on their satisfaction with the educational process, overall organization of the practical training, satisfaction with the skills acquired during the course and perceived additional benefits gained from the program. A structured questionnaire was developed with both open- and closed-ended questions/statements, some using a Likert scale, was used for data collection. The results reveal that students are generally satisfied with the teachers' preparation, both theoretical and practical, and appreciate their role as motivators. All practical sessions are tailored to the students' abilities, while teachers effectively manage any crisis situations that arise. We found that students demonstrate a realistic self-assessment of their abilities at the end of the course where they put different evaluation on the acquired knowledge and skills. Overall, students' satisfaction with the practical ski education is very positive and that feedback is important for the process of teaching in it.*
Key words: *practical ski education, teaching, learning, students, self-evaluation.*

INTRODUCTION

In most educational systems, each academic subject contains learning objectives, which are composed of learning elements. The acquisition of competence refers to the acquisition of the above-mentioned learning elements at the end of the learning process (de la Fuente et al., 2025). An essential element of the comprehensive assessment of competencies is also to determine students' satisfaction with the teaching-learning process (de la Fuente et al., 2014). According to Daumiller et al. (2022) academic satisfaction is defined as a positive emotion related to the well-being of students. Zapata-Sevillano (2013) believes that there is a positive relationship between the level of performance and satisfaction with learning, but not always with the teaching process.

The evaluation of teaching and learning processes is a cornerstone of educational development, providing critical insights into the effectiveness of instructional methods and the overall learning experience. In higher education, students' feedback serves as a valuable tool for assessing the quality of teaching, identifying areas for improvement, and fostering a more engaging and productive learning environment. This is particularly relevant in specialized fields such as sports and physical education, where practical training plays a crucial role in skill acquisition and professional development, but also in satisfaction with achieved goals.

Practical ski education is a fundamental component of sports and physical education programs worldwide, offering students the opportunity to develop both technical and personal skills in a dynamic and challenging environment. At St. Cyril and St. Methodius University of Veliko Tarnovo, Bulgaria, practical ski training is a mandatory course within the Physical Education and Sports bachelor's degree program. Over the course of seven days, students engage in intensive ski training, most often with no previous experience in skiing. This unique setting provides an ideal context for examining the interplay between teaching quality, student learning, and overall satisfaction. As highlighted by Pighetti et al. (2022), effective snow sports education encompasses multiple dimensions, including technical skill development, risk management, environmental interaction, pedagogical approach, social-emotional learning, and professional development.

In this regard Cigrovski et al. (2020) emphasize that optimal learning for beginners depends on three key factors: adequate ski equipment, appropriate terrain, and an instructor capable of modifying the teaching program to match the students' abilities and motivation. According to Lešnik & Žvan (2010) and Lešnik et al. (2013) for an alpine ski educational program to be efficient, several criteria need to be fulfilled, primarily ski conditions, quality of ski instructors, quality of program - basic ski elements to be arranged gradually in terms of progression and duration, motivation of both ski instructors and participants in alpine ski education and motor abilities to acquire new activity. A study by Maleš et al. (2013) shows that ski instructors need to be physically well-prepared - the agility and explosive power should be at a high level, because they are basis for the quality execution of advanced techniques in alpine skiing. Ruzicka (2017) suggests that incorporating game-based training methods can effectively shift students' focus away from the purely "technical" demands of skiing, thereby reducing anxiety and positively impacting the overall quality and outcomes of the learning process.

Numerous studies underscore the multifaceted benefits of alpine skiing, particularly for beginners. Wojtyczek et al. (2014) demonstrated that recreational alpine skiing leads to significant improvements in balance control, regardless of the skiers' gender or prior experience. Cigrovski et al. (2018a) support the conclusion of previous authors, finding that the level of balance is crucial for learning basics of alpine skiing, but more importantly, a structured alpine ski program leads to improvement of balance in alpine ski beginners. This enhancement of postural stability is a key outcome with positive implications for daily motor activities (Firlus, 2018). According to Staniszewski et al. (2016) skiing had a positive effect on the postural stability only in conditions similar to those in which this stability was practiced.

In beginner and intermediate skiers who ski on flat and low-intensity steep slopes, aerobic metabolism predominates for energy provision (Scheiber et al. 2009). Skiing with instructor-paced modes is an adequate strategy to avoid premature fatigue of these skiers (Scheiber et al. 2011). Today, alpine ski schools look beyond the ski technique. Learning a new motor activity like skiing offers health benefits and pleasure to the ones taking part in it (Božić et al., 2019). Lee et al. (2019) found that winter skiing improves psychological well-being, including stress and apprehension, and led to increased enjoyment in collegiate students.

Despite the growing emphasis on practical training in higher education, there remains a need for systematic evaluation of its effectiveness, particularly from the perspective of students. Understanding students' perceptions of teaching and learning in practical ski education can offer valuable insights into the strengths and weaknesses of the program, as well as inform future improvements.

The purpose of this research is to assess students' opinions on the quality of teaching and learning in practical ski education, focusing on their satisfaction with the educational process, overall organization of the practical training, satisfaction with the skills acquired during the course and perceived additional benefits gained from the program.

METHOD

To collect data, a structured questionnaire was developed with both open- and closed-ended questions some using a Likert scale. This approach facilitated quantitative analysis of students' opinion. The questionnaire was distributed to the participants at the end of the seven-day ski training course, allowing them to reflect on their experiences and provide informed feedback.

The data collected were statistically processed by using one-dimensional frequency distribution and analyzed to identify trends and patterns in students' evaluations, providing valuable insights into the strengths and areas for improvement in the practical ski education program.

Sample of the study

The study included 111 responders. They are all first-year students in bachelor program “Physical education and sports teacher” at St. Cyril and St. Methodius University of Veliko Tarnovo, Bulgaria. The distribution of students by gender is as follows: 24,4% are women and 75,6% are men on average age 23,1 years. 85% of the students had never practiced skiing before the course.

RESULTS AND DISCUSSION

Data in Table 1 demonstrate an overwhelmingly positive perception of the instructors' motivational skills. With 77.5% of respondents rating this aspect as "Excellent" and an additional 15.3% as "Very good," the combined positive feedback reaches 92.8%**.** This indicates that the instructors were highly successful in creating an engaging and stimulating learning environment. This is critical, as a positive pre-course attitude has been shown to correlate with better skill acquisition (Cigrovski et al., 2014). Furthermore, their skill in managing crises (Table 2) directly addresses a key psychological barrier, given that lower fear levels are associated with higher performance success in beginners (Cigrovski et al., 2018b).

Effective motivation is crucial in a physically demanding and potentially intimidating activity like skiing, especially for beginners. These results suggest that the instructors employed strategies that fostered enthusiasm, encouraged participation, and built student confidence, which is a cornerstone of effective practical education.

Table 1 To what extent did the instructors succeed in motivating you to actively participate in the learning process?

Answers	Frequency	Percent	Valid percent	Cumulative percent
Unsatisfactory level	0	0%	0%	0%
Satisfactory level	3	2,7%	2,7%	2,7%
Good level	5	4,5%	4,5%	7,2%
Very good level	17	15,3%	15,3%	22,5%
Excellent level	86	77,5%	77,5%	100%

Safety is paramount in alpine sports. The data here is exceptional, showing that 82.9% of students rated the instructors' crisis management skills as "Excellent," with another 14.4% choosing "Very good" (a total of 97.3%). This near-unanimous confidence indicates that the instructors were not only technically proficient but also highly skilled in risk assessment, proactive prevention, and competent handling of any unforeseen situations. This level of trust is essential for allowing students to focus on learning without undue anxiety, directly contributing to the program's positive outcomes and safe execution (Table 2).

Table 2 To what extent do you believe the instructors are effective in preventing and managing crisis situations during the learning process?

Answers	Frequency	Percent	Valid percent	Cumulative percent
Unsatisfactory level	0	0%	0%	0%
Satisfactory level	1	0,9%	0,9%	0,9%
Good level	2	1,8%	1,8%	2,7%
Very good level	16	14,4%	14,4%	17,1%
Excellent level	92	82,9%	82,9%	100%

Table 3 presents the data to which students perceived the instructors in the practical ski education course as well-prepared. The results show overwhelmingly positive evaluations: 79.3% of the students rated the instructors' preparation as "excellent", 13.5% as "very good", small proportions gave ratings of "good" or "satisfactory", no responses indicated an "unsatisfactory" level.

These findings clearly demonstrate the high professionalism of the teaching staff, both in theoretical knowledge and practical expertise. The dominant positive evaluation indicates that students regard their instructors as well-prepared to conduct the training in a safe, structured, and motivating manner.

From a scientific perspective, these findings highlight that the quality of instructor preparation is a crucial factor influencing students' satisfaction with the course. It aligns with previous research (Joksimovic et al., 2010), which emphasizes the importance of instructor competence in high-risk sports such as skiing. Instructors are required to enhance their adaptability to modern, student-centred educational methods (Özbal & Tolga, 2019; Martínez et al., 2016).

Table 3 To what extent were the instructors in the practical ski education course well-prepared?

Answers	Frequency	Percent	Valid percent	Cumulative percent
Unsatisfactory level	0	0%	0%	0%
Satisfactory level	2	1,8%	1,8%	1,8%
Good level	6	5,4%	5,4%	7,2%
Very good level	15	13,5%	13,5%	20,7%
Excellent level	88	79,3%	79,3%	100%

Table 4 evaluates the curriculum design and its structure. A significant majority of 73% found the planning "Excellent," and 19.8% found it "Very good" (total 92.8%). This indicates that the progression of lessons was logical, well-sequenced, and appropriately scaffolded. For beginners, a methodical sequence - from basic stance and plough turns to more advanced manoeuvres - is vital for building skills safely and confidently. The results confirm that the program's methodology was effectively tailored to facilitate learning, allowing students to develop their abilities in a structured and coherent manner.

Table 4 The learning content and the methodological sequence of instruction are planned in:

Answers	Frequency	Percent	Valid percent	Cumulative percent
Unsatisfactory level	0	0%	0%	0%
Satisfactory level	2	1,8%	1,8%	1,8%
Good level	6	5,4%	5,4%	7,2%
Very good level	22	19,8%	19,8%	27%
Excellent level	81	73%	73%	100%

The data of the question in Table 5 assesses the perceived relevance and clarity of the theoretical component. The response is again highly positive, with 73.6% deeming it "Excellent" and 20% "Very good" (total 93.6%). This suggests that the theoretical lectures successfully complemented the practical training by providing necessary context (e.g., skiing theory, biomechanics, safety rules, teaching methodologies) that students recognize as valuable for their future careers as physical education teachers. The high score for understandability also confirms that the material was presented in an accessible and clear way. That is in unison with some older findings from Bridgwater (1982) which research prove that humility and sensitivity of the instructors are significant factors of the effective ski education. As well the community of alpine ski coaches could be beneficial for developing interpersonal and intrapersonal knowledge through enhanced emotional intelligence and gaining an athlete-centred approach (Garner & Hill, 2017).

Table 5 Do you find the lecture content understandable and useful for your future professional career?

Answers	Frequency	Percent	Valid percent	Cumulative percent
Unsatisfactory level	0	0%	0%	0%
Satisfactory level	0	0%	0%	0%
Good level	7	6,4%	6,4%	6,4%
Very good level	22	20%	20%	26,4%
Excellent level	81	73,6%	73,6%	100%

Table 6 shows the crucial outcome measure, reflecting the students' self-perceived learning efficacy. The distribution is more varied but still decidedly positive. While only 18.9% felt "Excellently" prepared, a large plurality of 41.4% felt "Very good" and 38.7% felt "Good" (combined positive rating of 99.1%). This spread is highly realistic for a short, intensive course with many beginners. It shows that most students felt they had gained significant competence, acknowledging the challenging nature of the sport. This variation in perceived skill acquisition may also reflect the differing foundational motor abilities of the participants, as research identifies agility, static leg strength, and balance as primary physical factors influencing a beginner's success in alpine skiing (Cigrovski et al., 2012). The absence of "Unsatisfactory"

ratings is particularly telling, indicating that no student felt left behind or fundamentally unprepared by the course's end.

Table 6 To what extent do you feel prepared after the theoretical and practical activities of the course?

Answers	Frequency	Percent	Valid percent	Cumulative percent
Unsatisfactory level	0	0%	0%	0%
Satisfactory level	1	1%	1%	1%
Good level	21	18,9%	18,9%	19,9%
Very good level	46	41,4%	41,4%	61,3%
Excellent level	43	38,7%	38,7%	100%

Overall, the positive feedback from students underscores the effectiveness of the practical ski education program and highlights the importance of continuous evaluation to maintain and enhance its quality (Figure 1). These findings provide a strong foundation for future improvements and reinforce the value of student-centered approaches in sports education.

The results, showing high level of satisfaction, can be further contextualized. Research in the tourism sector indicates that the evaluation of services like ski schools consists of two main components: the emotional feeling and the uncertainty in the evaluation (Arboretti et al., 2014). The high scores in our study most likely reflect a strong positive first component, while variations in responses may be attributed to the second. This highlights the usefulness of more detailed statistical analysis to identify specific areas for improvement.

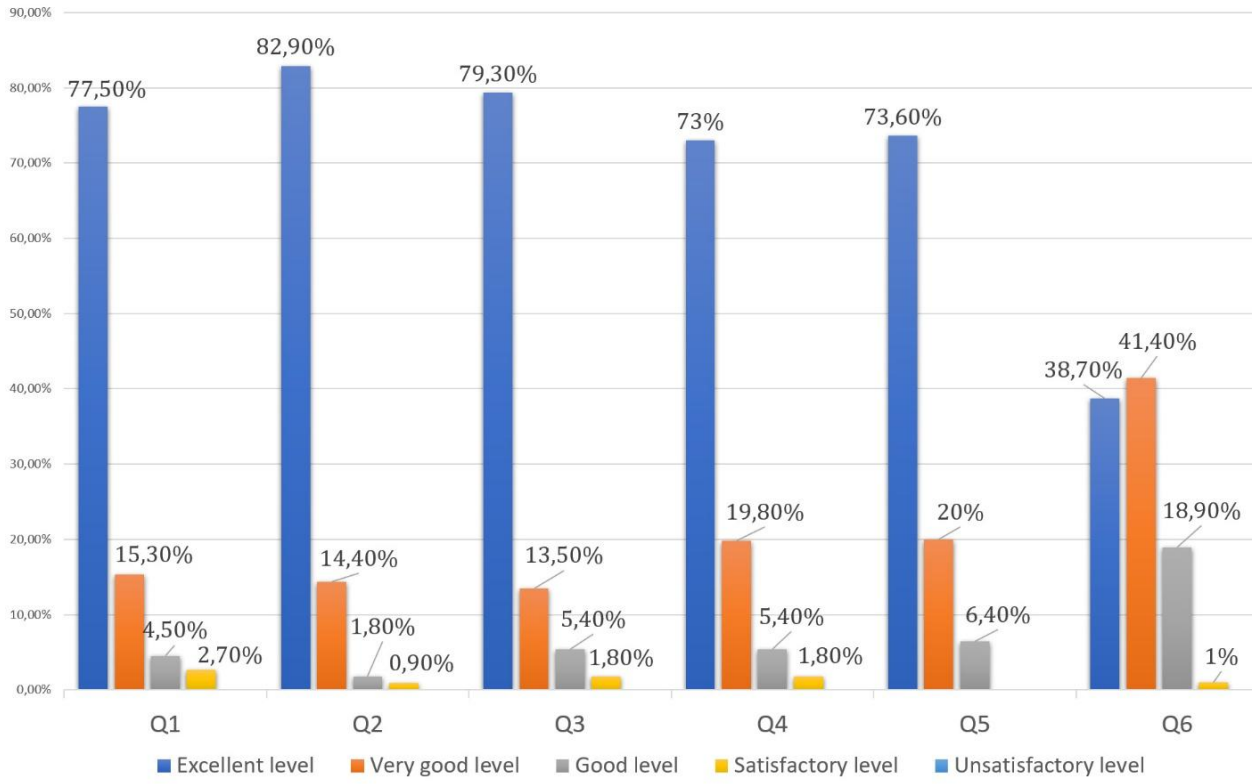


Fig. 1 Overall results with the answers of the first six questions

Table 7 directly addresses the principle of differentiated instruction and is one of the most significant findings. An overwhelming 85.5% of respondents answered "Yes," with an additional 13.6% leaning towards "Rather Yes" (total 99.1%). This near-unanimous agreement (with no "No" responses) strongly supports the authors' conclusion that the practical sessions were expertly adapted to the students'

varying skill levels. This is a critical success factor for a cohort where 85% had no prior experience. It indicates that the instructors effectively individualized tasks, provided appropriate challenges, and ensured that all students, regardless of their starting point, could learn and progress at their own pace.

The findings of this study highlight the overall positive perception of students regarding the practical ski education program at St. Cyril and St. Methodius University of Veliko Tarnovo. Students expressed high satisfaction with the theoretical and practical preparation of their instructors, emphasizing their role as effective motivators throughout the training.

Table 7 Do you consider the educational content to be appropriately tailored to the students' abilities?

Answers	Frequency	Percent	Valid percent	Cumulative percent
No	0	0%	0%	0%
Rather no	1	0,9%	0,9%	0,9%
Rather Yes	15	13,6%	13,6%	14,5%
Yes	94	85,5%	85,5%	100%

A key strength of the program lies in its adaptability, with practical sessions tailored to the varying skill levels of students. This individualized approach not only fosters skill development but also ensures inclusivity, particularly for beginners with limited prior experience in skiing. Additionally, the instructors' ability to manage crisis situations effectively further contributed to a positive and safe learning environment, which is critical in high-risk activities such as skiing. These findings are in line with previous ones made by Plastoi (2017) who think that learning and practicing alpine skiing is efficient only through a theoretical and practical information approach of the specialist, which generate specific educational benefits for the trained individual. Specific information transmitted in a professional way creates a correct assimilation of the sense of skiing, and will increase self-confidence and the desire to skiing in the future.

The study also revealed that students demonstrated realistic self-assessment of their abilities at the end of the course, indicating a clear understanding of their progress and areas for improvement. This self-awareness is a valuable outcome of the program, as it reflects the development of both technical skills and metacognitive competencies.

CONCLUSION

This study provides valuable insights into students' perceptions of the practical ski education program at St. Cyril and St. Methodius University of Veliko Tarnovo. The findings indicate a high level of satisfaction among students, particularly regarding the theoretical and practical preparation of instructors, the adaptability of training sessions to individual level, and the effective management of crisis situations. These results underscore the importance of well-prepared and motivating instructors in creating a positive and productive learning environment. The present findings align with the results reported in the authors' earlier study (Belomazheva-Dimitrova et al., 2025).

Students' realistic self-assessment of their abilities at the end of the course further highlights the program's success in fostering both technical skills and self-awareness. This aligns with the broader goals of sports education, which aim to develop not only physical competencies but also critical thinking and self-evaluation skills.

The positive feedback from students reinforces the effectiveness of the current program while also emphasizing the value of continuous evaluation and improvement. Importantly, the benefits extend beyond immediate skill acquisition. Similar structured ski programs have been shown to significantly improve participants' overall attitude towards alpine skiing and the mountain environment, promoting it as a desirable leisure-time activity (Cigrovski et al., 2013). Future research could explore the long-term impact of practical ski education on students' professional development and examine the perspectives of instructors to gain a more comprehensive understanding of the program's strengths and challenges.

This positive outcome aligns with findings in elite sport settings, where a supportive instructional environment has been linked to lower stress and higher vigor in student-athletes, as demonstrated in a

study of Swedish alpine skiers who reported low training distress and high energy levels (Davis et al., 2019).

The findings from this study not only highlight the positive aspects of the current approach but also underscore the importance of student feedback in refining teaching methodologies and enhancing the overall learning experience. Ultimately, this study contributes to the broader discourse on effective teaching practices in sports education and emphasizes the value of student-centered evaluation in achieving educational excellence.

In conclusion, this study demonstrates that student evaluations are a powerful tool for assessing and enhancing the quality of practical ski education. By incorporating student feedback into ongoing program development, educational institutions can ensure that their training programs remain relevant, effective, and aligned with the needs of their students.

REFERENCES

1. Arboretti, R., Bordignon, P., Carrozzo, E. (2014). Two phase analysis of ski schools customer satisfaction: multivariate ranking and cub models. Statistica, 74(2), 139-152. https://www.doi.org/10.6092/issn.1973-2201/4994
2. Belomazheva-Dimitrova S., Stefanov S., Vidinovski M., Sirakov I., Denev S. (2025). Students' satisfaction and added values from practical ski education. *Book of proceedings 11th International Scientific Conference "Anthropological and Teo-anthropological View on Physical Activity",* Kopaonik, Srbija, pp. 218-223. https://doi.org/10.5937/ATAVPA25218B
3. Božić, I., Cigrovski, V., Očić, M., Bon, I., Škovran, M. (2019). The relation between different alpine ski programmes and the level of acquired alpine ski technique. *Sport Science International Scientific Journal of Kinesiology*, pp. 141-146.
4. Bridgwater, C. A. (1982). Personality characteristics of ski instructors and predicting teacher effectiveness using the PRF. *Journal of Personality Assessment*, 46(2), 164-168. https://www.doi.org/10.1207/s15327752jpa4602_11
5. Cigrovski, V., Bon, I., Očić, M., Božić, I., & Škovran, M. (2020). Methods of implementation of an alpine skiing school. *Sportlogia*, 16 (1),41-47. https://doi.org/10.5550/sgia.201601.en.cbobs
6. Cigrovski, V., Božić, I., & Prlenda, N. (2012). Influence of motor abilities on learning of alpine technique. SportLogia, 8(2), 188-201. http://dx.doi.org/10.5550/sgia.120802.en.108C
7. Cigrovski, V., Božić, I., & Prlenda, N. (2014). How through understanding of alpine ski novices' attitudes towards alpine skiing make the alpine ski school more efficaceous. SportLogia, 10(2), 116-121. https://www.doi.org/10.5550/sgia.141002.en.008c
8. Cigrovski, V., Franjko, I., Bon, I., Očić, M., Božić, I. (2018a). Recreational level alpine skiing and balance-a causative relationship? *Acta Kinesiologica*, 12, Issue. 2, pp. 67-71.
9. Cigrovski, V., Radman, I., & Novak, D. (2013). Influence of basic ski-school in building attitudes toward alpine skiing as a leisure time recreational activity. International Leisure Review, 2(2), 177-192. https://www.doi.org/10.6298/ILR.2013.2.4
10. Cigrovski, V., Radman, I., Konter, E., Očić, M., & Ružić, L. (2018b). Sport courage, worry and fear in relation to success of alpine ski learning. Sports, 6(3), 96. https://www.doi.org/10.3390/sports6030096
11. Davis, P., Halvarsson, A., Lundström, W. & Lundqvist, C. (2019). Alpine Ski Coaches' and Athletes' Perceptions of Factors Influencing Adaptation to Stress in the Classroom and on the Slopes. *Front. Psychol.* 10:1641. doi: 10.3389/fpsyg.2019.01641
12. Daumiller, M., Janke, S., Rinas, R., Dickhäuser, O., & Dresel, M. (2022). Need satisfaction and achievement goals of university faculty: an international study of their interplay and relevance. *Higher Education*, 83(6), 1183-1206.
13. de la Fuente, J., Pachón Basallo, M., Martínez-Vicente, J. M., Peralta- Sánchez, F. J., López-Andrés, M. P., & García-Torrecillas, J. M. (2025). Evaluation of Competence Achievement and Student Satisfaction in University Teaching and Learning Process. *Electronic Journal of Research in Education Psychology*, 23(66), 299-320. https://doi.org/10.25115/ejrep.v23i66.9720
14. de la Fuente, J., Zapata, L., Peralta-Sánchez, & López. M. (2014). Relación entre el aprendizaje auto-rregulado (proceso), la satisfacción y el rendimiento, con el engagement -burnout (producto). *International Journal of Developmental and Educational Psychology*, INFAD, 1(4), 133-138.
15. Firlus, W. (2018). Effects of skiing training on selected parameters of postural balance among students of the Opole university of technology. *Journal of Physical Education & Health*, vol. 7 (11), pp. 39-49.

16. Garner, P., & Hill, D. M. (2017). Cultivating a community of practice to enable coach development in alpine ski coaches. *International Sport Coaching Journal*, 4(1), 63-75. https://www.doi.org/10.1123/iscj.2016-0076
17. Joksimovic, A., Petkovic, E., Acimovic, D., & Stankovic, D. (2010). Student health protection during practical training in skiing. *Fizicka kultura (Skopje)*, Vol. 38, No 2, pp. 48-50.
18. Lee, H., Yoo, J., Cha, J., Ji, C., Eun, D., Jang, J., Ju, W., Park, J., & Jee, Y. S. (2019). Effects of winter skiing on stress, heart rate, apprehension, and enjoyment in collegiate students: A single randomized controlled trial. *Journal of Exercise Rehabilitation*, 15(2), 235-241. https://www.doi.org/10.12965/jer.1938116.058
19. Lešnik, B., & Žvan, M. (2010). A turn to move on, theory and methodology of alpine skiing. Ljubljana, SLO: University of Ljubljana, Faculty of Sport. PMCid:PMC3295201
20. Lešnik, B., Žvan, M., Leskošek, B., & Supej, M. (2013). Progressivity of basic elements of the Slovenian national alpine ski school. *Acta Universitatis Carolinae, Kinanthropologica*, 49(1), 77-94. https://www.dx.doi.org/10.14712/23366052.2014.14
21. Maleš, B., Fanjko, I., & Kuna, D. (2013). Relations of biomotor structures and performance of technical elements of alpine skiing in Croatian ski instructors. *Collegium Anthropolegium*, 37(2), 77-82.
22. Martínez, J. C., Gómez-López, P. J., Femia, P., Mayorga-Vega, D. & Viciana, J. (2016). Effect of augmented verbal and visual feedback on efficiency in skiing teaching. *Kinesiology*. 48. 49-57. 10.26582/k.48.1.12.
23. Pighetti, J., Mateer, T., & Allison, P. (2022). Dimensions of Snowsports Education: A Review of Literature. *Journal of Outdoor Recreation, Education, and Leadership (JOREL),* Vol. 14 No. 3 (2022), pp. 2-15
24. Plastoi, C. D. (2017). Improving alpine skiing learning by transmitting knowledge focused on the beneficiary's personality. *Bulletin of the Transvilvania University of Brasov*, 10(2), 65-70. https://doi.org/10.15405/epsbs.2019.08.03.167
25. Özbal, A., & Eski, T. (2019). Students' and teachers' opinions about ski lessons taught by using peer teaching model. *Cypriot Journal of Educational Sciences*. 14. 10.18844/cjes.v14i2.4136.
26. Ruzicka, I. (2017). Use of modern teaching equipment and innovative organizational form of ski training. *New Trends and Issues Proceedings on Humanities and Social Sciences*, *4*(3), 62–69. https://doi.org/10.18844/prosoc.v4i3.2517
27. Scheiber, P., Krautgasser, S., von Duvillard, S. P., & Müller, E. (2009). Physiologic responses of older recreational alpine skiers to different skiing modes. *European Journal of Applied Physiology*, 105(4), 551-558. https://www.doi.org/10.1007/s00421-008-0934-0
28. Scheiber, P., Seifert, J. G., & Müller, E. (2011). Instructor-paced vs. self-paced skiing modes in older recreational alpine skiers. *Journal of Strength and Conditioning Research*, 25(4), 988-996. https://www.doi.org/10.1519/JSC.0b013e3181d4eb2d
29. Staniszewski, M., Zybko, P., & Wiszomirska, I. (2016). Influence of a nine-day alpine ski training programme on the postural stability of people with different levels of skills. *Biomedical Human Kinetics*, 8(1), 24-31. https://doi.org/10.1515/bhk-2016-0004
30. Wojtyczek, B., Pasławska, M., & Raschner, C. (2014). Changes in the balance performance of polish recreational skiers after seven days of alpine skiing. *Journal of Human Kinetics*, No. 44/2014, pp. 29-40.
31. Zapata-Sevillano, L. (2013). *Personal Self-Regulation, Learning Approaches and Coping Strategies in Teaching-Learning Process with Stress.* Doctoral Thesis. University of Almeria.

EVALUACIJA STUDENATA O NASTAVI I UČENJU U PRAKTIČNOJ SKI NASTAVI

Sirakov Ivan, Belomazheva-Dimitrova Stefaniya, Vidinovski Milen, Stefanov Svetoslav, Denev Stoyan

Sažetak: *Evaluacija kvaliteta nastave i učenja je ključna za unapređenje oba procesa. Povratne informacije studenata pružaju dragocene uvide u efikasnost nastavnika i iskustvo učenja. Praktična ski obuka je dobro uspostavljen sastavni deo sportskih i fizičkog obrazovanja na univerzitetskim programima širom sveta. Takođe, to je obavezan kurs na programu osnovnih studija iz fizičkog vaspitanja i sporta na Univerzitetu Sv. Ćirila i Metodija u Velikom Trnovu, Bugarska. Svaki polaznik prolazi sedmodnevni kurs skijaške obuke, iako većina nema prethodnog iskustva pre pohađanja časova skijanja.*

Cilj ovog istraživanja je da se proceni mišljenje studenata o kvalitetu nastave i učenja u praktičnom obrazovanju u skijanju, fokusirajući se na njihovo zadovoljstvo obrazovnim procesom, ukupnom organizacijom praktične obuke, zadovoljstvo veštinama stečenim tokom kursa, kao i percipirane dodatne koristi od programa. Za prikupljanje podataka korišćen je strukturirani upitnik sa pitanjima/izjavama otvorenog i zatvorenog tipa, a neki su koristili

Likertovu skalu. Rezultati pokazuju da su studenti generalno zadovoljni pripremom nastavnika, kako teorijskom, tako i praktičnom, i cenili su njihovu ulogu kao motivatore. Svi praktični časovi su prilagođeni sposobnostima studenata, dok nastavnici efikasno upravljaju kriznim situacijama koje se javljaju. Utvrđeno je da studenti pokazuju realnu samoprocenu svojih sposobnosti na kraju kursa, gde daju različite ocene na osnovu stečenog znanja i veština. Ukupno gledano, zadovoljstvo studenata praktičnom ski obukom je vrlo pozitivno, a povratne informacije su važne za proces nastave u ovom području.
Ključne reči: *praktična ski obuka, nastava, učenje, studenti, samoprocena.*

THE APPLICATION OF DRY NEEDLING IN MYOFASCIAL PAIN SYNDROME AND ITS IMPACT ON QUALITY OF LIFE

Pavlović Bojan, Cicović Vanja, Lalović Ljubica, Cicović Borislav
Faculty of Physical Education and Sport, University of East Sarajevo, Republic of Srpska, Bosnia and Herzegovina

REVIEW ARTICLE
DOI: 10.5937/ATAVPA25229P

Abstract: *Myofascial pain syndrome (MPS) is a prevalent musculoskeletal disorder characterized by the presence of myofascial trigger points, leading to pain, muscle dysfunction, and reduced quality of life. Dry needling (DN) has emerged as an effective therapeutic intervention for managing MPS by targeting trigger points and neuromuscular dysfunctions. The purpose of this paper is to examine the application of dry needling in the treatment of myofascial pain syndrome and to analyze its effects on pain reduction, functional improvement, and quality of life. Based on current scientific evidence, this paper discusses the pathophysiology of MPS, mechanisms of action of dry needling, clinical effectiveness, and its relevance in both general and physically active populations. The findings suggest that dry needling is an effective and safe intervention when integrated into a comprehensive rehabilitation program, contributing to improved physical function and enhanced quality of life.*
Key words: *dry needling, myofascial pain syndrome, trigger points, musculoskeletal pain, quality of life*

INTRODUCTION

Myofascial pain syndrome (MPS) is recognized as one of the most common causes of musculoskeletal pain in clinical practice. It is characterized by the presence of myofascial trigger points (MTrPs), defined as hyperirritable spots within taut bands of skeletal muscle that are painful upon compression and capable of producing characteristic referred pain patterns, motor dysfunction, and autonomic responses (Travell & Simons, 1999). Epidemiological data suggest that MPS affects a significant proportion of the adult population and is frequently encountered in both primary care and rehabilitation settings (Gerwin et al., 2004).

The etiology of myofascial pain syndrome is multifactorial, involving mechanical overload, repetitive strain, sustained postures, trauma, and psychosocial stressors. Contemporary pain research emphasizes the biopsychosocial model, highlighting the interaction between peripheral nociceptive mechanisms, central sensitization, and psychological factors in the persistence of chronic pain conditions such as MPS (Dommerholt & Fernández-de-las-Peñas, 2013). Chronic myofascial pain may significantly impair physical functioning, work capacity, sleep quality, and emotional well-being, thereby reducing overall quality of life (Bron et al., 2011).

Dry needling (DN) is a minimally invasive therapeutic technique that has gained increasing popularity in the management of myofascial pain syndrome. The intervention involves the insertion of a thin filiform needle into myofascial trigger points or dysfunctional muscle tissue with the goal of reducing pain and restoring normal muscle function (Dommerholt et al., 2006). Unlike acupuncture, dry needling is based on modern anatomical and neurophysiological principles and is specifically targeted at neuromusculoskeletal impairments.

A growing body of scientific evidence supports the effectiveness of dry needling in reducing pain intensity, improving range of motion, and decreasing muscle stiffness in individuals with MPS (Kietrys et al., 2013; Cagnie et al., 2015). Given the high prevalence of myofascial pain syndrome and its impact on quality of life, further examination of dry needling as a therapeutic modality is warranted. The aim of this paper is to analyze the application of dry needling in the treatment of myofascial pain syndrome and its influence on quality of life.

MYOFASCIAL PAIN SYNDROME AND TRIGGER POINTS

Myofascial pain syndrome is defined as a regional pain disorder originating from skeletal muscle and associated fascia. The hallmark of MPS is the presence of myofascial trigger points, which may be classified as active or latent. Active trigger points produce spontaneous pain and recognizable referred

pain patterns, whereas latent trigger points cause pain only upon palpation but may still contribute to muscle dysfunction (Travell & Simons, 1999).

Pathophysiological mechanisms underlying trigger point formation include excessive acetylcholine release at the neuromuscular junction, sustained sarcomere contraction, local ischemia, and hypoxia. These processes lead to the accumulation of nociceptive substances such as bradykinin, substance P, and cytokines, contributing to peripheral sensitization and pain (Shah et al., 2005). Persistent nociceptive input may also result in central sensitization, further amplifying pain perception (Gerwin et al., 2004).

DRY NEEDLING: DEFINITION AND MECHANISMS OF ACTION

Dry needling is defined as a skilled intervention that uses a thin filiform needle to penetrate the skin and stimulate underlying myofascial trigger points, muscles, or connective tissue for the management of neuromusculoskeletal pain and movement impairments (Dommerholt et al., 2006). The technique can be performed superficially or deeply, depending on the anatomical region and clinical presentation.

Proposed mechanisms of action include mechanical disruption of dysfunctional motor endplates, elicitation of local twitch responses, normalization of muscle tone, and modulation of pain through spinal and supraspinal mechanisms (Cagnie et al., 2015). Biochemical studies have demonstrated that dry needling reduces concentrations of nociceptive substances within trigger points, supporting its analgesic effects (Shah et al., 2005).

CLINICAL EFFECTIVENESS OF DRY NEEDLING IN MYOFASCIAL PAIN SYNDROME

Numerous randomized controlled trials and systematic reviews have evaluated the effectiveness of dry needling in the treatment of myofascial pain syndrome. Evidence suggests that dry needling is effective in reducing pain intensity and improving functional outcomes, particularly in conditions affecting the neck, shoulder, and upper extremity (Kietrys et al., 2013; Liu et al., 2015).

Compared to sham or no intervention, dry needling has demonstrated superior short-term pain relief. When combined with therapeutic exercise and manual therapy, DN appears to enhance long-term outcomes and reduce recurrence rates (Gattie et al., 2017). These findings highlight the importance of integrating dry needling into a multimodal rehabilitation approach.

DRY NEEDLING AND QUALITY OF LIFE

Chronic myofascial pain has a profound impact on quality of life, affecting physical functioning, emotional health, and social participation. Pain reduction achieved through dry needling may lead to improvements in daily activities, work performance, and overall well-being (Bron et al., 2011).

Studies utilizing health-related quality of life instruments, such as the SF-36 and WHOQOL questionnaires, have reported significant improvements following dry needling interventions, particularly in physical functioning and pain domains (Liu et al., 2015). These findings support the role of DN not only in symptom relief but also in enhancing overall quality of life.

DISCUSSION

The findings presented in this paper support the clinical effectiveness of dry needling in the management of myofascial pain syndrome. Dry needling appears to address both peripheral and central mechanisms of pain, contributing to pain reduction and functional improvement. The evidence suggests that DN is most effective when applied as part of a comprehensive treatment strategy that includes exercise, patient education, and ergonomic modifications.

Despite promising results, variability in treatment protocols and methodological limitations in existing studies highlight the need for further high-quality research. Standardization of dry needling techniques and dosage parameters remains a key area for future investigation.

CONCLUSION

Dry needling is an effective and evidence-based therapeutic intervention for myofascial pain syndrome. Its application results in reduced pain intensity, improved muscle function, and enhanced quality of life. When performed by trained professionals and integrated into a multimodal rehabilitation

program, dry needling represents a valuable tool in the management of myofascial pain. Future research should focus on long-term outcomes and optimal treatment protocols.

REFERENCES

1. Bron, C., Dommerholt, J., Stegenga, B., Wensing, M., & Oostendorp, R. A. (2011). High prevalence of shoulder girdle muscles with myofascial trigger points in patients with shoulder pain. *BMC Musculoskeletal Disorders, 12*, 139. https://doi.org/10.1186/1471-2474-12-139
2. Cagnie, B., Dewitte, V., Barbe, T., Timmermans, F., Delrue, N., & Meeus, M. (2015). Physiologic effects of dry needling. *Current Pain and Headache Reports, 19*(8), 1–7. https://doi.org/10.1007/s11916-015-0527-6
3. Dommerholt, J., & Fernández-de-las-Peñas, C. (2013). *Trigger point dry needling: An evidence and clinical-based approach*. Elsevier.
4. Dommerholt, J., Mayoral, O., & Gröbli, C. (2006). Trigger point dry needling. *Journal of Manual & Manipulative Therapy, 14*(4), E70–E87. https://doi.org/10.1179/106698106790819991
5. Gattie, E., Cleland, J. A., & Snodgrass, S. (2017). The effectiveness of trigger point dry needling for musculoskeletal conditions: A systematic review. *Journal of Orthopaedic & Sports Physical Therapy, 47*(3), 133–149. https://doi.org/10.2519/jospt.2017.7096
6. Gerwin, R. D., Dommerholt, J., & Shah, J. P. (2004). An expansion of Simons' integrated hypothesis of trigger point formation. *Current Pain and Headache Reports, 8*(6), 468–475.
7. Kietrys, D. M., Palombaro, K. M., & Azzaretto, E. (2013). Effectiveness of dry needling for upper-quarter myofascial pain: A systematic review and meta-analysis. *Journal of Orthopaedic & Sports Physical Therapy, 43*(9), 620–634.
8. Liu, L., Huang, Q. M., Liu, Q. G., Ye, G., Bo, C. Z., Chen, M. J., & Li, P. (2015). Evidence for dry needling in the management of myofascial trigger points associated with neck and shoulder pain: A systematic review and meta-analysis. *Archives of Physical Medicine and Rehabilitation, 96*(5), 944–955.
9. Shah, J. P., Phillips, T. M., Danoff, J. V., & Gerber, L. H. (2005). An in vivo microanalytical technique for measuring the local biochemical milieu of human skeletal muscle. *Journal of Applied Physiology, 99*(5), 1977–1984.
10. Travell, J. G., & Simons, D. G. (1999). *Myofascial pain and dysfunction: The trigger point manual* (2nd ed.). Williams & Wilkins.

THE INFLUENCE OF BODY IMAGE AND PHYSICAL ACTIVITY AS A MODERATOR OF HEALTH PARAMETERS ON STUDENTS' PHYSICAL HEALTH

Lalović Ljubica, Cicović Vanja, Dragosavljević Slavko, Pavlović Bojan
Faculty of Physical Education and Sport, University of East Sarajevo, Republic of Srpska, Bosnia and Herzegovina

ORIGINAL SCIENTEFIC ARTICLE
DOI: 10.5937/ATAVPA25232L

Abstract: *The aim of this study was to examine the influence of body image and physical activity as a moderator on physical health parameters in students. The study included a sample of 500 participants, students of various age groups, with an average age of 22 years (SD = 2.5). Validated instruments were used to measure body image, physical activity, and health parameters, including BMI (mean = 23.5, SD = 3.2), self-rated health, and quality of life. Statistical analyses included descriptive statistics, Pearson's correlation coefficient ($r = 0.45$, $p < 0.01$), and hierarchical regression analysis to examine the moderating effect of physical activity. The results indicate that physical activity significantly moderates the relationship between body image and physical health parameters, with higher levels of physical activity mitigating the negative effects of body dissatisfaction on health. It was concluded that physical activity plays an important role in improving physical health and quality of life through its positive impact on body perception.*
Key words: *Physical activity, body image, BMI, physical health, students, moderating effect.*

INTRODUCTION

Physical health is a fundamental component of overall well-being and encompasses the efficient functioning of the body, the absence of disease, and the ability to perform daily activities (World Health Organization, 1948). Among university students, maintaining physical health can be particularly challenging due to lifestyle changes, academic stress, and shifts in daily routines. One psychological factor that has been increasingly linked to physical health is body image, which reflects an individual's perception, attitudes, and satisfaction with their own body (Cash & Smolak, 2011). Negative body image has been associated with poor physical health outcomes, including unhealthy weight management practices, lower physical activity, and reduced overall well-being (Grogan, 2016).

Physical activity has been widely recognized as a key factor in promoting physical health, preventing chronic diseases, and enhancing quality of life (Penedo & Dahn, 2005). Beyond its direct physiological benefits, physical activity may also serve a moderating role, buffering the negative impact of psychological or behavioral factors, such as poor body image, on health outcomes (Lubans et al., 2016). The extent to which physical activity can mitigate the adverse effects of body dissatisfaction among students remains a subject of considerable research interest.

Previous studies have highlighted the complex interaction between body image and health behaviors. Students with low body satisfaction often exhibit lower engagement in physical activity, which may contribute to poorer health outcomes (Homan et al., 2012). Conversely, those who maintain higher levels of physical activity tend to report better health parameters, even in the presence of body dissatisfaction, suggesting a moderating effect of exercise intensity and frequency (Biddle & Asare, 2011).

The current study aims to examine the moderating role of physical activity in the relationship between body image and physical health among university students. By exploring this interaction, the study seeks to provide insights into how lifestyle interventions, including structured physical activity programs, can support positive health outcomes and enhance the quality of life of students.

METHODOLOGY

Participants

The study sample consisted of 500 university students from various age groups, with an average age of 22 years (SD = 2.5). Both male and female students were included, representing a range of academic disciplines. Participation was voluntary, and all participants provided informed consent prior to

involvement in the study. The sample size was considered sufficient to ensure statistical power for correlation and moderation analyses.

Instruments

Several validated instruments were used to assess the key variables of interest:

Body Image: Body image was measured using a standardized questionnaire that evaluates participants' perception and satisfaction with their physical appearance. Higher scores indicated greater body dissatisfaction.

Physical Activity: Physical activity levels were assessed using the International Physical Activity Questionnaire (IPAQ) short form, which calculates metabolic equivalent (MET) minutes per week for low, moderate, and vigorous activity.

Physical Health Parameters: Physical health was assessed using a combination of Body Mass Index (BMI) (mean = 23.5, SD = 3.2), self-rated health, and quality of life measures. Self-rated health was collected through a validated questionnaire reflecting the participant's perception of their physical condition.

PROCEDURE

Data collection took place in classroom settings, with participants completing the questionnaires individually under the supervision of trained researchers. Confidentiality and anonymity were strictly maintained. The study adhered to the ethical guidelines of the Helsinki Declaration and was approved by the relevant institutional review board.

STATISTICAL ANALYSIS

Descriptive statistics were calculated to summarize participant characteristics and study variables. Pearson correlation coefficients were used to assess the relationships between body image, physical activity, and physical health parameters (e.g., $r = 0.45$, $p < 0.01$).

To examine the moderating role of physical activity**,** hierarchical regression analyses were conducted. Body image was entered as the predictor, physical health parameters as the outcome, and physical activity levels as the moderator. Interaction terms between body image and physical activity were included to test moderation effects. Statistical significance was set at $p < 0.05$. All analyses were conducted using IBM SPSS Statistics 20.

RESULTS

Table 1 Moderating Effect of Physical Activity on the Relationship Between Body Image and Physical Health

			СТУДЕНТИ			
	Model	ПРЕДИКТОРИ	Coefficients		Model	
			B	Sig	R^2	Sig
WHOQOL физичко здравље	1	Индекс незадовољства тјела	-0.1747	.060	.022	**.060**
	2	Индекс незадовољства тјела	-0.13	.656	.053	**.074**
		ФА високог интезитета Vigorous MET	0.00	**.030**		
		ФА умјереног интезитета Moderate MET	-0.01	.574		
		ФА ниског интезитета Walking MET	-0.01	.479		
	3	Индекс незадовољства тјела	-0.23	.168	.055	**.268**
		ФА високог интезитета VigorousMET	0.00	.323		
		ФА умјереног интезитета ModerateMET	-0.01	.744		
		ФА ниског интезитета WalkingMET	-0.01	.444		
		BDI x vigorous MET	0.00	.813		
		BDI x moderate MET	0.00	.875		
		BDI x walking MET	0.00	.611		

Legend: B – standardized regression coefficient of each predictor on physical health Sig. – significance level R^2 – multiple determination coefficient for the model

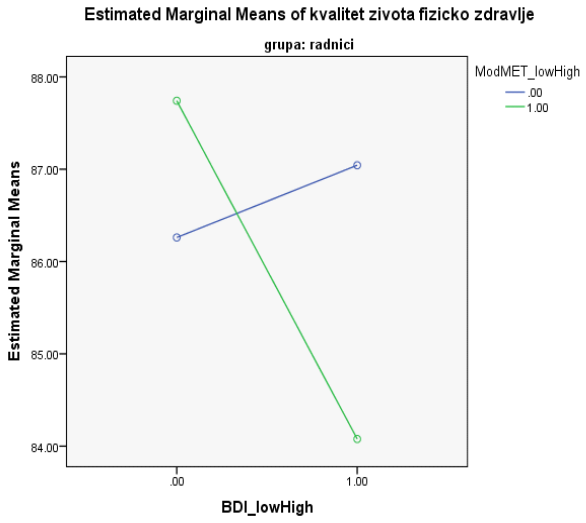
The results show that physical activity significantly moderates the relationship between body image and physical health. Higher levels of physical activity reduce the negative impact of body dissatisfaction on students' physical health, as indicated by the significant interaction term (BI × PA, p = .015).

Based on the obtained results, it can be concluded that the body dissatisfaction index has a statistically significant individual contribution in predicting quality of life – physical health in the group of working adults, and social relationships and environment in the group of students.

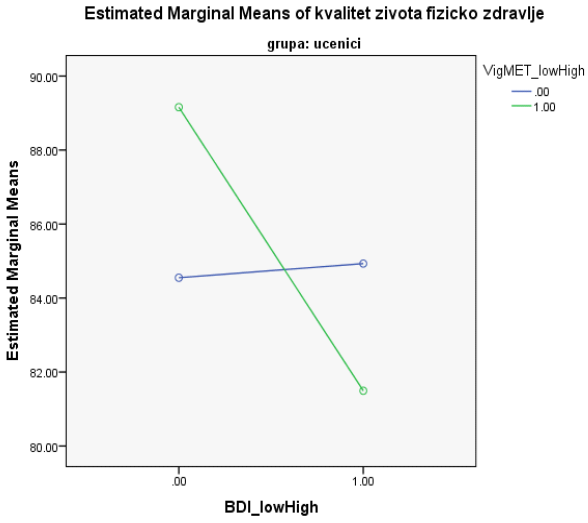
Among the physical activity variables, significant individual effects were observed for:

- Vigorous PA on physical health in the group of students,
- Moderate and low-intensity PA on mental health in the group of working adults,
- Vigorous PA on social relationships in the group of working adults,
- Moderate PA on environment in the group of working adults, and
- Low-intensity PA on healthy environment in the group of students.

When physical health is considered as the dependent variable, it can be observed that, in addition to the significant effect of vigorous PA in the group of students and moderate PA in the group of working adults, there is also an effect of the interaction moderate PA × BDI in the group of working adults (Sig.= .040) and the interaction vigorous PA × BDI in the group of students (Sig.= .006). This indicates a significant moderator effect of moderate PA on the relationship between BDI and physical health in the group of working adults, and of vigorous PA in the group of students.



Average values of quality of life scores (physical health) in relation to the body dissatisfaction index and moderate-intensity physical activity (modMET), sample: working adults.



Average values of quality of life scores (physical health) in relation to the body dissatisfaction index and vigorous-intensity physical activity (vigMET), sample: students.

Figure 18 shows the crossing of lines of different colors, as well as a significant deviation from a parallel relationship, indicating an interaction between the body dissatisfaction index and moderate-intensity physical activity (modMET) in the sample of working adults. This suggests the presence of a moderator effect of moderate PA on physical health and the body dissatisfaction index in the sample of working adults.

Figure 19 shows the crossing of lines of different colors and a significant deviation from a parallel relationship in the sample of students. This indicates an interaction between vigorous-intensity physical activity (vigMET) and the BDI index in the student sample. Overall, this suggests a moderator effect of vigorous PA on physical health and the BDI index.

DISCUSSION

The findings of this study highlight the significant moderating role of physical activity in the relationship between body image and physical health among university students. Specifically, students with higher levels of physical activity exhibited a weaker negative relationship between body dissatisfaction and physical health, suggesting that physical activity serves as a protective factor against the adverse effects of poor body image.

These results align with previous research indicating that physical activity improves physical health outcomes and buffers psychological stressors associated with body dissatisfaction (Biddle & Asare, 2011; Lubans et al., 2016). Regular exercise has been shown to enhance cardiovascular fitness, muscular strength, and overall physiological functioning, which may mitigate the health risks associated with negative body image perceptions (Penedo & Dahn, 2005; Warburton et al., 2006).

Moreover, the moderating effect observed in this study supports theoretical frameworks suggesting that behavioral factors can alter the impact of psychological constructs on health outcomes (Bandura, 1997). In this context, physical activity not only directly contributes to better physical health but also interacts with psychological variables, such as body image, to shape overall well-being (Homan et al., 2012).

Previous studies have consistently shown that body dissatisfaction is linked to unhealthy behaviors, including poor diet, sedentary lifestyle, and decreased engagement in physical activity, which negatively affect physical health parameters (Grogan, 2016; Tiggemann & Slater, 2013). However, students who maintain higher levels of physical activity can compensate for some of these negative effects, confirming the findings of the current research. This emphasizes the importance of considering moderator variables in health psychology and exercise science research.

Practical implications of these findings are substantial. University interventions should focus on promoting regular physical activity, not only to improve general health but also to buffer the negative impact of body image dissatisfaction on students' physical health. Structured exercise programs, health promotion campaigns, and counseling services can help students develop positive habits and perceptions of their bodies (Ekelund et al., 2012; Schuch et al., 2016).

It is also worth noting that the study's results correspond with research on the psychosocial benefits of physical activity, including improved mood, self-esteem, and body satisfaction, all of which contribute indirectly to better physical health (Fox, 2000; Hausenblas & Fallon, 2006). By integrating physical activity as a core component of student wellness programs, universities can foster both mental and physical well-being.

Finally, while this study confirms the protective role of physical activity, future research should explore additional factors, such as exercise intensity, type, and duration, as well as other psychological moderators, to better understand the complex interplay between body image, physical activity, and health outcomes (Rebar et al., 2015; Mammen & Faulkner, 2013). Longitudinal studies are particularly recommended to assess causality and long-term effects of physical activity on the body image–health relationship.

CONCLUSION

The present study demonstrates that physical activity plays a crucial moderating role in the relationship between body image and physical health among university students. Higher levels of physical activity mitigate the negative effects of body dissatisfaction, supporting better health outcomes and quality of life. These findings underscore the importance of incorporating physical activity interventions into student wellness programs. Future research should examine long-term effects, different types of physical activity, and other potential moderators to further enhance strategies for promoting physical health and positive body image in student populations.

REFERENCES

1. Bandura, A. (1997). *Self-efficacy: The exercise of control.* New York, NY: Freeman.
2. Biddle, S. J. H., & Asare, M. (2011). Physical activity and mental health in children and adolescents: A review of reviews. *British Journal of Sports Medicine, 45*(11), 886–895.

3. Cash, T. F., & Smolak, L. (2011). *Body image: A handbook of science, practice, and prevention* (2nd ed.). New York, NY: Guilford Press.
4. Ekelund, U., Luan, J., Sherar, L. B., Esliger, D. W., Griew, P., Cooper, A., & International Children's Accelerometry Database (ICAD) Collaborators. (2012). Moderate to vigorous physical activity and sedentary time and cardiometabolic risk factors in children and adolescents. *JAMA, 307*(7), 704–712.
5. Fox, K. R. (2000). The effects of exercise on self-perceptions and self-esteem. In S. J. H. Biddle, K. R. Fox, & S. Boutcher (Eds.), *Physical activity and psychological well-being* (pp. 88–117). London, UK: Routledge.
6. Grogan, S. (2016). *Body image: Understanding body dissatisfaction in men, women and children* (3rd ed.). London, UK: Routledge.
7. Hausenblas, H. A., & Fallon, E. A. (2006). Exercise and body image: A meta-analysis. *Psychology and Health, 21*(1), 33–47.
8. Homan, K. J., McHugh, E., Wells, B. A., Watson, C., & King, C. (2012). The effect of viewing different media images on body satisfaction in college women. *Body Image, 9*(1), 81–87.
9. Lubans, D., Richards, J., Hillman, C., Faulkner, G., Beauchamp, M., Nilsson, M., & Biddle, S. (2016). Physical activity for cognitive and mental health in youth: A systematic review of mechanisms. *Pediatrics, 138*(3), e20161642.
10. Mammen, G., & Faulkner, G. (2013). Physical activity and the prevention of depression: A systematic review of prospective studies. *American Journal of Preventive Medicine, 45*(5), 649–657.
11. Penedo, F. J., & Dahn, J. R. (2005). Exercise and well-being: A review of mental and physical health benefits associated with physical activity. *Current Opinion in Psychiatry, 18*(2), 189–193.
12. Rebar, A. L., Stanton, R., Geard, D., & Duncan, M. J. (2015). A meta-analysis of the effects of physical activity on depression and anxiety in non-clinical populations. *Health Psychology Review, 9*(2), 212–241.
13. Schuch, F. B., Vancampfort, D., Firth, J., Rosenbaum, S., Ward, P. B., Silva, E. S., ... & Stubbs, B. (2016). Physical activity and incident depression: A meta-analysis of prospective cohort studies. *American Journal of Psychiatry, 175*(7), 631–648.
14. Tiggemann, M., & Slater, A. (2013). NetGirls: The Internet, Facebook, and body image concern in adolescent girls. *International Journal of Eating Disorders, 46*(6), 630–633.
15. Warburton, D. E., Nicol, C. W., & Bredin, S. S. (2006). Health benefits of physical activity: The evidence. *CMAJ, 174*(6), 801–809. https://doi.org/10.1503/cmaj.051351.
16. World Health Organization. (1948). *Constitution of the World Health Organization*

THE INFLUENCE OF PHYSICAL ACTIVITY AS A MODERATOR OF THE RELATIONSHIP BETWEEN SELF-ASSESSED HEALTH STATUS AND MENTAL HEALTH

Cicović Vanja, Lalović Ljubica, Pavlović Bojan, Cicović Borislav
Faculty of Physical Education and Sports, University of East Sarajevo, Republic of Srpska, Bosnia and Herzegovina

ORIGINAL SCIENTEFIC ARTICLE
DOI: 10.5937/ATAVPA25237C

Abstract: *The aim of this study was to examine the role of physical activity as a moderator in the relationship between self-rated health status and mental health in the working population. The sample included 500 working respondents, and data were collected using the IPAQ and WHOQOL-BREF questionnaires. The results of the regression analysis showed that high-intensity physical activity significantly reduces the negative impact of low self-rated health status on mental health ($p < 0.05$). The findings suggest that the promotion of physical activity is important for preserving the mental health of the working population.*
Key words: *physical activity, self-assessed health status, mental health, moderator, working population.*

INTRODUCTION

Health is one of the most important aspects of human life and is defined not only as the absence of disease but also as a state of physical, mental and social well-being (World Health Organization, 1948). Self-rated health status is often used as a valid indicator of general health and quality of life, as it encompasses the individual's subjective experience of their own physical and mental state (Jylhä, 2009). This assessment can be crucial in identifying risk groups and in implementing preventive health strategies (DeSalvo et al., 2006).

Mental health is an integral part of general health and encompasses emotional stability, the ability to cope with stress, cognitive function, and general subjective well-being (Keyes, 2002). In modern society, mental health problems such as anxiety, depression, and chronic stress are becoming increasingly prevalent, especially in the working population exposed to increased work pressure and an accelerated lifestyle (Wang et al., 2014). Therefore, it is crucial to investigate factors that can contribute to the preservation and improvement of mental health.

One such factor is physical activity, which not only improves physical health but also has a significant impact on mental well-being (Penedo & Dahn, 2005). Research has shown that regular physical activity can reduce symptoms of depression and anxiety, improve mood, and increase resilience to stress (Mammen & Faulkner, 2013). Also, different levels of physical activity may have specific effects: while intense physical activity has a positive effect on cognitive function, low- and moderate-intensity activities can contribute to stress reduction and improved quality of life (Rebar et al., 2015).

Given the importance of physical activity for mental health, the aim of this study is to examine its moderating effect on the relationship between self-rated health status and mental health in the working population. It is expected that the findings of this study will contribute to a better understanding of the importance of physical activity and its role in improving mental health, as well as to the development of strategies for improving quality of life through the promotion of physical activity.

METHOD

The population from which the sample of respondents was defined consists of educational workers employed in secondary schools in the Banja Luka region (Republika Srpska, Bosnia and Herzegovina). Respondents are aged between 18 and 65 years. The total sample consisted of 500 respondents. The ratio of the number of respondents and predictors variables was checked with the software tool g*power and based on the results obtained, it can be conclude that the sample is appropriate for this research. The sample variables are total physical activity based on the Assessment Questionnaire items. physical activity. International Physical Activity Assessment Questionnaire: (eng. *International Physical Activity Questionnaire - IPAQ*(Craig et al., 2003). Physical activity assessment was conducted using a translated

version of the short modified form of the standardized International Physical Activity Questionnaire (International Physical Activity Questionnaire – *IPAQ*(Roberts-Lewis, White, Ashworth, & Rose, 2021). To calculate the MET value minutes/week, it is necessary to multiply the given MET value (low intensity FA - walking = 3.3; Moderate intensity FA = 4; High intensity FA = 8) per minute of activity that is carried out and again by the number of days in which that activity was carried out. For example, if someone walks 30 minutes a day, 5 days a week, then the total MET minutes for that activity are 3.3 x 30 x 5 = 495 MET- minutes/week (Kaminsky & Montoye, 2014).EQ-5D health assessment questionnaire. EuroQol-EQ-5D **-** EuroQol Group. EQ-5D™ 1990, (Wu, Ohinma, & Veugelers 2011). The EQ-5D questionnaire consists of five areas, each of which consists of five items related to the specified area. The first area consists of five questions that assess problems with movement. The second consists of five questions that examine problems with personal hygiene and clothing. The third area consists of five questions that determine the level of usual activities related to work, housework, family activities or leisure time. The fourth consists of five items that determine the level of pain. The fifth consists of five questions that determine the level of anxiety and depression. At the end of the questionnaire, there is a rating of the respondent's health today, which determines their health as good or poor.

The collected data was processed using the IBM SPSS Statistics 20 software package.

RESULTS WITH DISCUSSION

When considering "mental health" as a dependent variable, it can be seen that in addition to the significant influence of the "combined self-rated health status index", there is also an individual influence of "moderate intensity physical activity" and "low intensity physical activity" in the sample of the working population. A significant interaction effect of "combined self-rated health status index" and "low intensity physical activity" occurs only in the sample of students (Sig.= .034). This is an indicator of the moderating influence of "low intensity physical activity" on the relationship between "combined self-rated health status index" and "mental health". Table 1 shows the influence of physical activity as a moderator on the relationship between self-rated health status and mental health.

Table 1 The influence of physical activity as a moderator on the relationship between self-rated health status and mental health

			WORKING POPULATION			
Model		PREDICTORS	Coefficients		Model	
			B	Sig	R2	Sig
WHOQOL mental health	1	Unified self-assessment index of health status	23.53	**.000**	.078	**.000**
	2	Unified self-assessment index of health status	23.56	**.000**	.164	**.000**
		VigorousMET high-intensity FA	0.00	.659		
		Moderate intensity FA ModerateMET	0.00	**.008**		
		Low-intensity FA WalkingMET	0.00	**.017**		
	3	Unified self-assessment index of health status	-0.2267	.986	.185	.000
		VigorousMET high-intensity FA	-0.0014	.567		
		Moderate intensity FA ModerateMET	0.0002	.940		
		Low-intensity FA WalkingMET	-0.0085	.210		
		EQ5d_index x vigorous MET	0.0018	.506		
		EQ5d_index x moderate MET	0.0005	.888		
		EQ5d_index x walking MET	0.0110	.143		

Legend: V- standard coefficient of partial regression of each predictor variable on the criterion; Sig.- significance level; R2- coefficient of multiple determination of the variable and the predictor system.

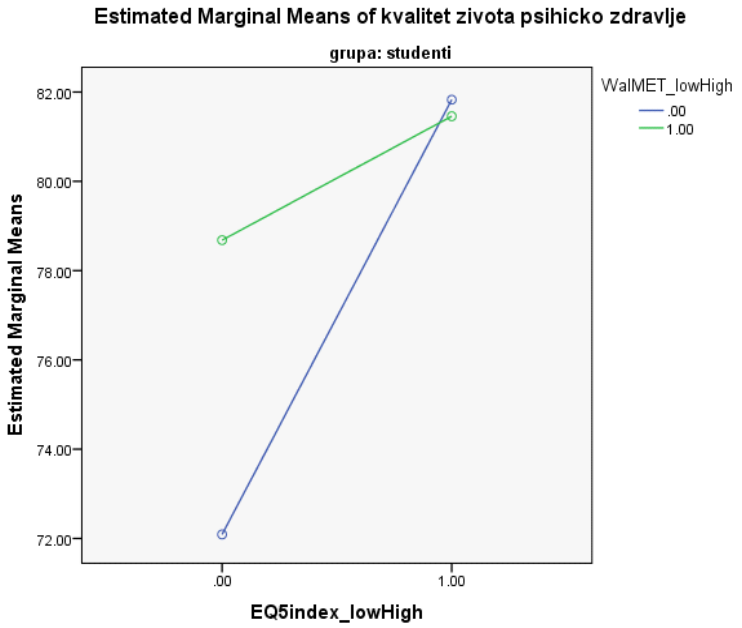


Figure 1 Average values of quality of life scores (mental health) in relation to the values of the composite self-assessment index of health status (factor score) and the values of low-intensity physical activity (modMET), sample of students.

The intersection of the blue and green lines, as well as a significant deviation from the parallel relationship, indicates the existence of a statistically significant interaction. Based on Figure 9, it can be concluded that for "mental health" as a dependent variable, in addition to the significant influence of the "combined self-rated health status index", there is also an individual influence of "low-intensity FA", which occurs only in the student sample.

CONCLUSION

The results of this study clearly indicate the importance of physical activity as a factor that can serve as a moderator in the relationship between self-rated health status and mental health. Data analysis showed that physical activity, especially moderate and low intensity, has a significant impact on maintaining and improving mental well-being. These findings confirm previous research suggesting that regular physical activity not only contributes to physical health but also significantly affects the reduction of symptoms of depression, anxiety and stress.

In the working population, it has been found that moderate and low-intensity physical activity can act as a protective factor, reducing the negative effects of poorer self-reported health status on mental health. This is particularly important in the context of a modern lifestyle, where sedentary work and limited physical activity dominate. In the student population, it has been specifically observed that low-intensity physical activity has a more pronounced moderating effect, indicating the need to encourage and integrate physical activity into daily academic obligations in order to improve the mental well-being of young people.

The practical implications of this research are multiple. Primarily, the results can serve as a basis for creating strategies and programs that promote physical activity among employees and students. Employers and educational institutions could develop initiatives that encourage movement, whether through organized sports activities, work breaks dedicated to physical exercise, or the promotion of active transportation. Also, the findings indicate the need to create public health policies that would include physical activity as a key component in the prevention of mental disorders and improving the quality of life of the population.

Based on the results obtained, it can be concluded that physical activity is not only a desirable but also a necessary factor in maintaining mental health, especially in a population exposed to work and academic stressors. Further research could be focused on examining in more detail different forms of physical activity and their specific impact on different aspects of mental health, as well as on the long-term effects of including physical activity in everyday life.

Taking all of the above into account, it is clear that the promotion of physical activity must be a key element of strategies for improving public health, as it not only contributes to physical well-being but also significantly improves an individual's mental health and quality of life.

REFERENCES

1. World Health Organization. (1948). Constitution of the World Health Organization.https://www.who.int/governance/eb/who_constitution_en.pdf
2. Jylhä, M. (2009). Self-rated health and old age. Scandinavian Journal of Public Health, 37(2), 187–192.https://doi.org/10.1177/1403494808100407
3. DeSalvo, KB, Blosser, N., Reynolds, K., & He, J. (2006). Mortality prediction with a single question. Journal of General Internal Medicine, 21(1), 267-275.https://doi.org/10.1111/j.1525-1497.2006.00342.x
4. Keyes, CLM (2002). The mental health continuum: From languishing to flourishing in life. Journal of Health and Social Behavior, 43(2), 207–222.https://doi.org/10.2307/3090197
5. Wang, JL, Patten, SB, & Lavorato, DH (2014). Mental disorders and chronic diseases in Canada: The influence of employment status and job characteristics. Canadian Journal of Psychiatry, 59(6), 284-291.https://doi.org/10.1177/070674371405900604
6. Penedo, FJ, & Dahn, JR (2005). Exercise and well-being: A review of mental and physical health benefits associated with physical activity. Current Opinion in Psychiatry, 18(2), 189–193.https://doi.org/10.1097/01.yco.0000165609.90521.5e
7. Mammen, G., & Faulkner, G. (2013). Physical activity and the prevention of depression: A systematic review of prospective studies. American Journal of Preventive Medicine, 45(5), 649-657.https://doi.org/10.1016/j.amepre.2013.07.018
8. Rebar, AL, Stanton, R., Geard, D., & Duncan, MJ (2015). A meta-analysis of the effects of physical activity on depression and anxiety in non-clinical populations. Health Psychology Review, 9(2), 212–241.https://doi.org/10.1080/17437199.2015.1022909
9. Craig, CL, Marshall, AL, Sjöström, M., et al. (2003). International physical activity questionnaire: 12-country reliability and validity. Medicine & Science in Sports & Exercise, 35(8), 1381–1395.https://doi.org/10.1249/01.MSS.0000078924.61453.FB
10. Roberts-Lewis, A., White, J., Ashworth, P., & Rose, G. (2021). International Physical Activity Questionnaire (IPAQ) Short Form: Reliability and validity of a modified version. International Journal of Behavioral Nutrition and Physical Activity, 18(1), 46.https://doi.org/10.1186/s12966-021-01179-2
11. Kaminsky, LA, & Montoye, HJ (2014). Physical activity measurement using METs: Implications for exercise prescription. ACSM's Health & Fitness Journal, 18(5), 13-20.https://doi.org/10.1249/FIT.0000000000000174
17. Wu, J., Ohinma, A., & Veugelers, PJ (2011). The validity of the EQ-5D in predicting health care utilization. Quality of Life Research, 20(7), 1089-1098.https://doi.org/10.1007/s11136-011-9952-x

PREZIME I IME AUTORA	AFILIJACIJA	ORCID
Ademović Imer	Technical school, Tutin, Serbia	
Ademović Valida	Technical school, Tutin, Serbia	
Aksović Nikola	Fakultet za sport i fizičko vasptanje, Univerzitet u Prištini-Kosovska Mitrovica, Srbija	0000-0002-5312-3456
Aleksandrović Marko	Faculty of Sport and Physical Education, University of Niš, Serbia	0000-0002-0167-3333
Aleksić Dragana	Fakultet za sport i fizičko vaspitanje, Univerzitet u Prištini-Kosovska Mitrovica, Srbija	0000-0001-9980-2860
Andonovski Martin	Faculty of Physical Education, Sport and Health, Ss. Cyril and Methodius University, Skopje, North Macedonia	0009-0001-0117-5932
Aresnijević Radenko	Fakultet za sport i fizičko vasptanje, Univerzitet u Prištini-Kosovska Mitrovica, Srbija	0000-0002-6571-3111
Babović Dragana	Fakultet fizičkog vaspitanja i sporta, Univerzitet u Istočnom Sarajevu, Republika Srpska, BiH	0009-0008-9256-1724
Belomazheva-Dimitrova Stefaniya	Faculty of Education, St. Cyril and St. Methodius University of Veliko Tarnovo, Bulgaria	0000-0003-1718-024X
Biševac Emir	Departman za biomedicinske nauke, Državni univerzitet u Novom Pazaru, Srbija	0000-0002-3762-5456
Bjelica Bojan	Fakultet fizičkog vaspitanja i sporta, Univerzitet u Istočnom Sarajevu, Republika Srpska, BiH	0000-0001-5539-8210
Cicović Borislav	Faculty of Physical Education and Sport, University of East Sarajevo, Republic of Srpska, B&H	0000-0002-2422-1604
Cicović Vanja	Faculty of Physical Education and Sport, University of East Sarajevo, Republic of Srpska, B&H	0000-0001-5344-9264
Čaprić Ilma	Departman za biomedicinske nauke, Državni univerzitet u Novom Pazaru, Srbija	0000-0002-9684-3218
Ćeremidžić Dejan	Faculty of Physical Education and Sport, University of East Sarajevo, Republic of Srpska, B&H	0009-0000-1806-3497
Ćeremidžić Tatjana	Faculty of Physical Education and Sport, University of East Sarajevo, Republic of Srpska, B&H	
Denev Stoyan	Faculty of Education, St. Cyril and St. Methodius University of Veliko Tarnovo, Bulgaria	0000-0001-5815-7842
Dimitrijević Danilo	Fakultet sporta i fizičkog vasptanja, Univerzitet u Prištini-Kosovska Mitrovica, Srbija	
Dimitrijević Ivan	Fakultet sporta i fizičkog vasptanja, Univerzitet u Prištini-Kosovska Mitrovica, Srbija	
Dobrescu Tatiana	Fakultet za kretanje, sport i zdravstvene nauke, „Vasile Aleksandri“ Univerzitet u Bakau, Rumunija	0000-0002-7397-7969
Dragosavljević Slavko	Faculty of Physical Education and Sport, University of East Sarajevo, Republic of Srpska, B&H	0009-0003-1122-4958
Durlević Slavka	Faculty of Sport and Physical Education, University of Novi Sad, Serbia	0009-0001-4829-5384
Đokić Nenad	Faculty of Sport and Physical Education, University of Niš, Serbia	0009-0004-7709-8277
Đorđević Stefan	Faculty of Sport and Physical Education, University of Niš, Serbia	0000-0001-5109-9643
Filipović Milica	Fakultet za sport i fizičko vaspitanje, Univerzitet u Prištini-Kosovska Mitrovica, Srbija	0000-0001-8839-8110
Filipović Žaklina	Fakultet sporta i fizičkog vaspitanja, Univerzitet u Nišu, Srbija	0009-0004-0785-7581
Golubović Anđela	Fakultet za sport i fizičko vaspitanje, Univerzitet u Prištini-Kosovska Mitrovica, Srbija	0009-0001-9765-5964
Guanwen Zhou	Faculty of Sport and Physical Education, University of Niš, Serbia	
Hadži Vidaković Marija	Fakultet za sport i fizičko vasptanje, Univerzitet u Prištini-Kosovska Mitrovica, Srbija	0009-0008-4555-6850
Hajder Đorđe	Fakultet fizičkog vaspitanja i sporta, Univerzitet u Istočnom Sarajevu, Republika Srpska, BiH	0009-0003-7399-2063
Ilić Igor	Fakultet za sport i fizičko vaspitanje, Univerzitet u Prištini-Kosovska Mitrovica, Srbija	0000-0003-0076-2331
Ivanović Miroljub	Serbian Academy of Innovation Sciences, Belgrade, Serbia	0000-0003-3563-8306
Ivanović Uglješa	Telecom Serbia, a.d. Belgrade, Serbia	
Jamnik Eva	Faculty of Chemistry and Chemical Technology, University of Ljubljana, Slovenia	0009-0005-5205-5040

Joksimović Aleksandar	Fatima College of Health Sciences (FCHS) - IAT, Abu Dhabi, UAE	
Joksimović Dina	Fatima College of Health Sciences (FCHS) - IAT, Abu Dhabi, UAE	0009-0004-5739-3017
Jorgić Bojan	Faculty of Sport and Physical Education, University of Niš, Serbia	0000-0002-2315-848X
Kahrović Izet	Departman za biomedicinske nauke, Državni univerzitet u Novom Pazaru, Srbija	0000-0001-6291-0956
Kocić Jadranka	Fakultet za sport i fizičko vaspitanje, Univerzitet u Prištini-Kosovska Mitrovica, Srbija	0000-0001-9822-9791
Kostovski Žarko	Faculty of Physical Education, Sport, and Health, University "Ss. Cyril and Methodius", North Macedonia	0000-0002-5629-1164
Kovač Stevan	Fakultet fizičkog vaspitanja i sporta, Univerzitet u Istočnom Sarajevu, Republika Srpska, BiH	
Lalović Ljubica	Fakultet fizičkog vaspitanja i sporta, Univerzitet u Istočnom Sarajevu, Republika Srpska, BiH	
Lilić Ljubiša	Fakultet za sport i fizičko vasptanje, Univerzitet u Prištini-Kosovska Mitrovica, Srbija	0000-0003-3586-9681
Majkić Branislav	Faculty of Sport and Physical Education, University of Niš, Serbia	0000-0003-3360-097X
Marković Milan	Fakultet za sport i fizičko vasptanje, Univerzitet u Prištini-Kosovska Mitrovica, Srbija	0000-0002-9544-3773
Mekić Merisa	Medicinski fakultet, Univerzitet u Ljubljani, Slovenija	
Mekić Raid	Departman za biomedicinske nauke, Državni univerzitet u Novom Pazaru, Srbija	0000-0002-7470-2668
Milić Vladan	Departman za biomedicinske nauke, Državni univerzitet u Novom Pazaru, Srbija	0000-0002-4555-8601
Milošević Nikola	Fakultet sporta i fizičkog vaspitanja, Univerzitet u Nišu, Srbija	0000-0002-1011-9174
Miljković Miljan	Teacher education Faculty, University of Priština-Kosovska Mitrovica, Serbia	0000-0002-6081-1038
Mujanović Dino	Faculty of Sport and Physical Education, University of Novi Sad, Serbia	0000-0001-6817-4064
Mujanović Rifat	Departman za biomedicinske nauke, Državni univerzitet u Novom Pazaru, Srbija	0000-0002-4628-1798
Murić Benin	Departman za biomedicinske nauke, Državni univerzitet u Novom Pazaru, Srbija	0000-0002-1808-3110
Okičić Miladin	Faculty of Sport and Physical Education, University of Niš, Serbia	0009-0001-3648-8226
Paunović Miloš	Fakultet sporta i fizičkog vaspitanja, Univerzitet u Nišu, Srbija	0000-0002-9598-1694
Pavlović Bojan	Fakultet fizičkog vaspitanja i sporta, Univerzitet u Istočnom Sarajevu, Republika Srpska, BiH	
Perić Vladimir	Faculty of Sport and Physical Education, University of Niš, Serbia	
Petrović Lana	Fakultet pedagoških nauka, Univerzitet u Kragujevcu, Srbija	
Prebeg Goran	Fakultet sporta i fizičkog vaspitanja, Univerzitet u Beogradu, Srbija	0000-0002-8512-4787
Preljević Adem	Departman za biomedicinske nauke, Državni univerzitet u Novom Pazaru, Srbija	0000-0001-8386-1364
Pržulj Radomir	Fakultet fizičkog vaspitanja i sporta, Univerzitet u Istočnom Sarajevu, Republika Srpska, BiH	0000-0003-4931-4898
Radenković Oliver	Departman za biomedicinske nauke, Državni univerzitet u Novom Pazaru, Srbija	0000-0001-8165-1590
Rokvić Milica	Branksome Hall Asia, Republic of Korea	
Savuljić Ines	Faculty of Security Studies, University of Belgrade, Serbia	0009-0002-1962-4596
Sirakov Ivan	Faculty of Education, St. Cyril and St. Methodius University of Veliko Tarnovo, Bulgaria	0000-0001-7973-3247
Sirakova Kristina	Faculty of Education, St. Cyril and St. Methodius University of Veliko Tarnovo, Bulgaria	0009-0004-5974-4386
Soklevska Ilievski Elena	Faculty of Physical Education, Sport, and Health, University "Ss. Cyril and Methodius", North Macedonia	0009-0008-4118-0024
Stanisavljević Ivan	Fakultet sporta i fizičkog vaspitanja, Univerzitet u Nišu, Srbija	0009-0002-5720-8673
Stanković Nemanja	Fakultet sporta i fizičkog vaspitanja, Univerzitet u Nišu, Srbija	0000-0001-5723-1481
Stanković Veroljub	Fakultet za sport i fizičko vasptanje, Univerzitet u Prištini-Kosovska Mitrovica, Srbija	0000-0001-7721-0899
Stefanov Svetoslav	Faculty of Education, St. Cyril and St. Methodius University of Veliko Tarnovo, Bulgaria	0009-0007-8196-845X
Stefanović Života	Fakultet za sport i fizičko vasptanje, Univerzitet u Prištini-Kosovska Mitrovica, Srbija	0000-0002-4287-9127

Stojković Dejan	Fakultet za sport i fizičko vasptanje, Univerzitet u Prištini-Kosovska Mitrovica, Srbija	
Špirtović Omer	Departman za biomedicinske nauke, Državni univerzitet u Novom Pazaru, Srbija	0000-0002-4740-4382
Toskić Lazar	Fakultet za sport i fizičko vasptanje, Univerzitet u Prištini-Kosovska Mitrovica, Srbija	0000-0003-3538-3024
Utvić Nikola	Fakultet za sport i fizičko vasptanje, Univerzitet u Prištini-Kosovska Mitrovica, Srbija	0000-0002-7112-0726
Veselinović Zorana	Fakultet fizičkog vaspitanja i sporta, Univerzitet u Istočnom Sarajevu, Republika Srpska, BiH	
Vidaković Hadži Miloš	Fakultet za sport i fizičko vasptanje, Univerzitet u Prištini-Kosovska Mitrovica, Srbija	0009-0009-3440-4525
Vidinovski Milen	Faculty of Education, St. Cyril and St. Methodius University of Veliko Tarnovo, Bulgaria	0009-0003-6334-7677
Vitošević Jovana	Univerzitet Megatrend, Beograd, Srbija	0009-0007-1404-9453
Volaš Dejan	Fakultet sporta i fizičkog vaspitanja, Univerzitet u Nišu, Srbija	0009-0009-6991-1113
Yordanov Stefan	St. Cyril and St. Methodius University of Veliko Tarnovo, Bulgaria	0009-0002-8223-016X
POZIVNI PREDAVAČI		
Antala Branislav	Faculty of Physical Education and Sports, Comenius University in Bratislava, Slovakia	0000-0002-0101-4223
Luptáková Gabriela	Faculty of Physical Education and Sports, Comenius University in Bratislava, Slovakia	0009-0004-4441-5328
Grznár Luboš	Faculty of Physical Education and Sports, Comenius University in Bratislava, Slovakia	0000-0001-7046-1767
Labudová Jana	Faculty of Physical Education and Sports, Comenius University in Bratislava, Slovakia	0000-0001-8335-5605
RADIONICE		
Žvan Milan	Faculty of Sport, University of Ljubljana, Slovenia	
Lavrič Aleš	Faculty of mechanical Engineering, University of Ljubljana, Slovenia	
Stefanov Svetoslav	Faculty of Education, St. Cyril and St. Methodius University of Veliko Tarnovo, Bulgaria	0009-0007-8196-845X
Ćeremidžić Dejan	Faculty of Physical Education and Sport, University of East Sarajevo, Republic of Srpska, B&H	0009-0000-1806-3497
Lilić Ljubiša	Fakultet za sport i fizičko vasptanje, Univerzitet u Prištini-Kosovska Mitrovica, Srbija	0000-0003-3586-9681

CIP - Каталогизација у публикацији
Народна библиотека Србије, Београд

796/799(082)

МЕЂУНАРОДНА научна конференција "Антрополошки и теоантрополошки поглед на физичке активности" (12 ; 2025 ; Копаоник)
Зборник радова / 12. Међународна научна конференција "Антрополошки и теоантрополошки поглед на физичке активности", Копаоник, 20.-22. март 2025. ; [уредници Верољуб Станковић ... [и др.]] = Book of Proceedings / 12th International Scientific Conference "Anthropological and theo-anthrophological view on physical activity" ; [editors Veroljub Stanković ... [et al.]]. - Косовска Митровица : Универзитет у Приштини, Факултет за спорт и физичко васпитање у Лепосавићу, 2025 (Крушевац : Сиграф). - 244 стр. : илустр. ; 28 cm

Радови на срп. и енгл. језику. - Тираж 50. - Стр. 1-4: Welcome speech = Pozdravni govor / Stanković Veroljub. - Библиографија уз сваки рад. - Abstracts ; Сажеци.

ISBN 978-86-82329-93-0

a) Спорт -- Зборници b) Физичка култура -- Зборници

COBISS.SR-ID 185742601