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ORIGINAL SCIENTIFIC PAPER

Differences in Anthropometric Characteristics and Motor Abilities Between Youth Female Volleyball Players and Non-Athletes, and Their Interrelationships in the Total Sample

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Abstract

The aim of this cross-sectional study was to examine potential differences in body characteristics and motor abilities between young girls enrolled in a volleyball school and those not participating in any organized sports activities. Additionally, the study sought to investigate the relationships between anthropometric and motor parameters. The anthropometric evaluation included three morphological variables: body height (BH), body mass (BM), and body mass index (BMI). For the assessment of motor abilities in girls, a battery of standardized field tests was used, including the following tasks: Plate Tapping Test, Flying 20 m test, Japan Test, 2 kg seated medicine ball throw, Standing Broad Jump, 30-second sit-up test, 30-second squat test, shoulder rotation with stick test, and Side Steps test. The results of the Mann–Whitney U test indicate that volleyball players achieved significantly better results in most of the examined variables ($p < 0.05$), particularly in speed, agility, explosive and repetitive strength, as well as coordination. The effect sizes, which were moderate to very large in most variables, suggest that the observed differences are not only significant but also practically meaningful, representing the outcome of a systematic and continuous volleyball training process. The correlation test revealed a strong relationship between body dimensions and strength-related tests, as well as pronounced interconnections among speed- and agility-related abilities. In contrast, flexibility appears to represent a relatively isolated motor component within the analyzed model. Based on the above findings, it can be concluded that volleyball, as a sports activity, represents an effective model of physical exercise for improving motor abilities and the overall physical development of girls.

Keywords: *morphological composition, motor performance, physical fitness, youth athletes, volleyball*

Introduction

Volleyball as a sport was developed in 1895 by William G. Morgan, director of physical education at Holyoke College in the state of Massachusetts, United States (Korjenić & Redžić, 2022).

Volleyball is an engaging, highly dynamic, and attractive sport in which the speed of ball movement during a match requires players to possess a high level of reaction speed and agility

in order to control the ball effectively. Motor abilities, including coordination, explosive strength, agility, and speed, are among the key factors with a strong influence on volleyball performance (Ilić, Stojanović & Mijalković, 2023).

The development and improvement of motor abilities in female volleyball players represent an important aspect that can be enhanced through systematic training (Bompa, 2000). It is im-

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portant to note that training models differ between sexes due to psychophysical differences (Katić, Grgantov & Jurko, 2006). The technical and tactical demands of volleyball, frequent changes of direction in the frontal and sagittal planes, and various types of jumps require adequate general and sport-specific physical preparation, as well as well-developed technical skills adapted to specific playing positions (Martinović et al., 2011).

Volleyball is considered an asymmetrical sport, as elements such as serving and spiking are predominantly performed with the dominant arm. Within the four defined stages of a volleyball career, the second phase (ages 10–14) emphasizes the acquisition of technical and tactical elements, with particular importance placed on bilateral muscular development during this developmental period (Katić, Grgantov & Jurko, 2006). Nešić (2005) highlights that volleyball schools at this stage, focused on mastering fundamental technical and tactical elements, play a crucial role in the development of elite female volleyball players.

Based on recent studies, it is evident that numerous researchers have sought to determine whether differences exist in anthropometric characteristics and motor abilities between athletes and non-athletes (Bubanj et al., 2013; Cristina-Elena & Liliana-Elisabeta, 2014; Ivanović & Ivanović, 2013; Jenko-Miholić, Čizmek, & Peršun, 2010; Radu, Popovici, & Puni, 2015). Previous findings have generally shown that athletes achieve better results than non-athletes in both anthropometric parameters (Bubanj et al., 2013; Radu et al., 2015) and motor abilities (Cristina-Elena & Liliana-Elisabeta, 2014; Ivanović & Ivanović, 2013; Jenko-Miholić, Čizmek, & Peršun, 2010).

However, most of these studies focused on boys rather than girls, and the samples predominantly consisted of older adolescents, meaning athletes with relatively long training experience. Only one study was found that compared differences between female athletes and non-athletes (Radu, Popovici, & Puni, 2015). That study included older adolescent girls and was limited exclusively to anthropometric parameters.

Accordingly, there is a clear need for research examining differences in both anthropometric characteristics and motor abilities, specifically between volleyball players and non-athletes. Therefore, the aim of this study was to determine the differences in anthropometric characteristics and motor abilities between adolescent volleyball players and their non-athletic peers. Additionally, the study sought to investigate the relationships between anthropometric and motor parameters.

Methods

Participants

The sample consisted of 43 healthy girls. Among them, 23 girls with a mean chronological age of 12.48±0.85 years were active members of the volleyball club “Banja Luka” and had 2.08±0.84

years of training experience. The remaining 20 girls were students of the primary school “Holandija” – Slatina, with a mean chronological age of 12.25±0.97 years, and were not involved in any sports activities.

Procedures

Testing was conducted between March 7 and March 15, 2024. Prior to the start of testing, the participants performed a 15-minute warm-up. All tests were carried out under the same conditions. The participants were familiarized with the testing protocol in advance. Measurements and testing were conducted by coaches and physical education teachers. The study was conducted in accordance with the World Medical Association Declaration of Helsinki (2011), and the parents of the participants provided informed consent for the implementation of the testing.

Measurements

Anthropometric characteristics

Anthropometric measurements were conducted in accordance with an internationally recognized biological assessment protocol (Eston & Reilly, 2013). The evaluation comprised three morphological indicators: body height (BH), body mass (BM), and body mass index (BMI). Stature was determined using a portable stadiometer (Seca Ltd., Bonn, Germany) with a precision of 0.1 cm, while body mass was obtained with a Tanita body composition analyzer (Tanita®, model BC-418MA, Tokyo, Japan). Body mass index was subsequently derived using the conventional equation: BMI = BM (kg) / BH² (m²). Given its strong association with adiposity levels, BMI is commonly applied as a practical marker of weight status in pediatric populations (Costill, Kenney, & Wilmore, 2008).

Motor abilities

Motor abilities were assessed using standardized field tests, with each test selected to evaluate a specific motor domain. Upper limb movement speed was evaluated using the Plate Tapping Test, sprint speed was assessed by the Flying 20 m test, and agility was measured with the Japan Test. Upper body explosive strength was determined by the 2 kg seated medicine ball throw, while lower body explosive strength was assessed using the Standing Broad Jump. Repetitive strength was evaluated through the 30-second sit-up test and the 30-second squat test. Flexibility was assessed by the shoulder rotation with stick test, and lower limb coordination was measured using the Side Steps test (Table 1). The given motor ability tests have been used in numerous studies (Gjinovci et al., 2025; Jovanović, Katanić, Trajković, Đorđević, & Stanković, 2025; Strukar, Harasin, & Gilić, 2025).

Table 1. Motor Ability Tests and Units

Motor Test	Motor Ability	Unit
Plate Tapping Test	Upper limb movement speed	seconds (s)
Flying 20 m test	Sprint speed	seconds (s)
Japan Test	Agility	seconds (s)
Medicine ball throw (2 kg)	Upper body explosive strength	meters (m)
Standing Broad Jump	Lower body explosive strength	centimeters (cm)
Sit-up test (30-second)	Repetitive strength (trunk)	repetitions (n)
Squat test (30-second)	Repetitive strength (lower limbs)	repetitions (n)
Shoulder rotation with stick	Flexibility	centimeters (cm)
Side Steps test	Lower limb coordination	repetitions (n)

Statistics

Descriptive statistics were calculated for all variables, and the normality of data distribution was examined prior to further analyses. Given the characteristics of the data, the Mann–Whitney U test was applied to determine differences between volleyball players and non-athletes. The effect size was calculated and presented using the coefficient *r*, in order to quantify the magnitude of the differences and to estimate the impact of volleyball training on the measured anthropometric and motor parameters.

For the analysis of relationships between motor abilities, Spearman’s rank correlation coefficient was used. The strength of the correlations was interpreted according to Cohen’s guidelines, with values of 0.10–0.29 considered small, 0.30–0.49

moderate, and ≥ 0.50 large.

All collected data were statistically processed using the software package Statistica 19.0 (StatSoft Inc., Tulsa, USA), along with Statistical Package for Social Sciences (SPSS), version 26.0 (SPSS Inc., Chicago, IL, USA). The level of statistical significance was set at $p < 0.05$.

Results

The results in Table 2 show that volleyball players achieved higher values than non-athletes in almost all measured parameters, including anthropometric measures, speed, agility, explosive and repetitive strength, and lower limb coordination. The only exceptions were the flexibility measures, where the differences were minimal.

Tabela 2. Descriptive Statistics

	Volleyball players			Non-athletes		
	N	Mean	SD	N	Mean	SD
Age (years)	23	12.48	0.85	20	12.25	0.97
Years of training	23	2.08	0.84	20	0.00	0.00
Body mass (kg)	23	52.99	9.00	20	42.90	10.23
Body height (cm)	23	161.19	7.18	20	152.43	8.76
BMI	23	20.34	3.11	20	18.30	3.15
Plate Tapping Test	23	10.20	1.46	20	11.44	2.02
Sprint speed (s)	23	3.98	0.30	20	4.50	0.36
Agility Japan (s)	23	8.69	0.74	20	10.17	0.73
Medicine ball throw (cm)	23	267.70	40.96	20	211.63	41.44
Standing broad jump (cm)	23	159.09	20.34	20	138.10	19.63
Sit-up test 30 sec	23	24.30	3.76	20	17.35	3.25
Squat test	23	30.09	3.53	20	25.95	2.61
Shoulder rotation with stick	23	74.17	15.74	20	78.11	15.07
Side Steps	23	10.87	0.81	20	12.64	1.30

Legend: N – number of samples, Mean – mean value, SD – standard deviation

Significant differences (Table 3) were found in favor of the volleyball players in the following variables: body weight ($p=0.001$; $r=0.486$) – moderate to large effect, body height ($p=0.003$; $r=0.457$) – moderate to large effect, and BMI ($p=0.028$; $r=0.334$) – moderate effect. Higher ranks among the volleyball players indicate that they are, on average, taller and heavier, which is consistent with the specific demands and selection criteria in volleyball.

The results show that volleyball players are significantly faster and more agile, with particularly pronounced differences in sprint speed and agility, which represent key abilities in volleyball: upper limb movement speed ($p=0.021$; $r=0.325$) – moderate effect, sprint speed ($p=0.000$; $r=0.646$) – large effect, and agility ($p=0.000$; $r=0.735$) – very large effect.

Similarly, significant differences in favor of the volleyball

players were recorded in all strength tests: upper body explosive strength ($p=0.000$; $r=0.585$) – large effect, lower body explosive strength ($p=0.002$; $r=0.466$) – moderate to large effect, repetitive trunk strength ($p=0.000$; $r=0.747$) – very large effect, and repetitive lower limb strength ($p=0.000$; $r=0.581$) – large effect.

Additionally, lower limb coordination showed a significant difference in favor of the volleyball players ($p=0.000$; $r=0.635$), with a large effect size, which is consistent with the complex movements and frequent changes of direction characteristic of volleyball.

In contrast to these findings, no significant difference was observed between the groups in flexibility ($p=0.526$; $r=0.097$), indicating that volleyball training did not have a decisive impact on this ability.

Table 3. Mann–Whitney U Test

	Group	N	Mean	U test	Z	Sig	r
Body mass (kg)	Volleyball players	23	27.70	99.000	-3.190	0.001	0.486
	Non-athletes	20	15.45				
Body height (cm)	Volleyball players	23	27.73	107.000	-2.995	0.003	0.457
	Non-athletes	20	15.85				

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Table 3. Mann–Whitney U Test

	Group	N	Mean	U test	Z	Sig	r
BMI	Volleyball players	23	25.91	140.000	-2.191	0.028	0.334
	Non-athletes	20	17.50				
Plate Tapping	Volleyball players	23	17.87	135.000	-2.131	0.021	0.325
	Non-athletes	20	26.75				
Sprint speed (s)	Volleyball players	23	14.43	56.000	-4.238	0.000	0.646
	Non-athletes	20	30.70				
Agility Japan (s)	Volleyball players	23	13.39	32.000	-4.822	0.000	0.735
	Non-athletes	20	31.90				
MBT(cm)	Volleyball players	23	28.85	72.500	-3.836	0.000	0.585
	Non-athletes	20	14.13				
SBJ (cm)	Volleyball players	23	27.46	104.500	-3.057	0.002	0.466
	Non-athletes	20	15.73				
Sit-up test	Volleyball players	23	30.72	29.500	-4.899	0.000	0.747
	Non-athletes	20	11.98				
Squat test	Volleyball players	23	28.76	74.500	-3.809	0.000	0.581
	Non-athletes	20	14.23				
Shoulder rotation	Volleyball players	23	20.87	204.000	-0.634	0.526	0.097
	Non-athletes	20	23.30				
Side Steps	Volleyball players	23	14.57	59.000	-4.164	0.000	0.635
	Non-athletes	20	30.55				

Legend: N – number of samples, Z – approximation value, Sig – level of significance, r – effect size, BW – Body Weight, BH – Body Height, BMI – Body Mass Index, Plate – Plate Tapping, Sprint – Sprint Test, Agility – Agility Test, MBT – Medicine Ball Throw, SBJ – Standing Broad Jump, Sit-up – Sit-up Test, Squat – Squat Test.

The correlational analysis (Table 4), conducted on the total sample, revealed clear and systematic relationships between anthropometric characteristics and motor abilities. Body weight (BW) was strongly and positively associated with body height (BH; $r=0.721$, $p<0.001$) and BMI ($r=0.835$, $p<0.001$), whereas body height was not significantly related to BMI ($r=0.271$, $p=0.079$)

With respect to motor abilities, greater body weight and height were associated with better performance in explosive strength tests,

particularly in the medicine ball throw (BW: $r=0.565$; BH: $r=0.621$; $p<0.001$) and, to a lesser extent, in the standing broad jump (BH: $r=0.348$, $p=0.022$). BMI showed a moderate positive correlation with the medicine ball throw ($r=0.342$, $p=0.025$). At the same time, body weight and height were negatively correlated with upper limb speed (plate tapping; BW: $r=-0.451$, $p=0.002$; BH: $r=-0.328$, $p=0.032$), indicating that participants with larger body dimensions achieved shorter completion times (i.e., better performance).

Table 4. Correlation Between Anthropometric and Motor Performance Variables

	BW	BH	BMI	Plate	Sprint	Agility	MBT	SBJ	Sit-up	Squat	SR
BH	0.721**										
	0.000										
BMI	0.835**	0.271									
	0.000	0.079									
Plate	-0.451**	-0.328*	0.359*								
	0.002	0.032	0.018								
Sprint	-0.211	-0.255	-0.122	0.205							
	0.174	0.099	0.436	0.186							
Agility	-0.294	-0.327*	-0.161	0.265	0.754**						
	0.056	0.032	0.301	0.086	0.000						
MBT	0.565**	0.621**	0.342*	-0.355*	-0.488**	-0.640**					
	0.000	0.000	0.025	0.019	.0001	0.000					
SBJ	0.251	0.348*	0.102	-0.115	-0.506**	-0.719**	0.606**				
	0.104	0.022	0.517	0.65	0.001	0.000	0.000				

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Table 4. Correlation Between Anthropometric and Motor Performance Variables

	BW	BH	BMI	Plate	Sprint	Agility	MBT	SBJ	Sit-up	Squat	SR
Sit-up	0.373*	0.230	0.301	-0.191	-0.550**	-0.745**	0.527**	0.579**			
	0.014	0.138	0.050	0.221	0.000	0.000	0.000	0.000			
Squat	0.169	0.204	0.049	-0.271	-0.563**	-0.696**	0.513**	0.487**	0.524**		
	0.278	0.191	0.753	0.079	0.000	0.000	0.000	0.001	0.000		
SR	-0.019	0.201	-0.160	0.062	-0.131	0.029	0.038	0.044	-0.167	-0.052	
	0.901	0.197	0.307	0.693	0.404	0.855	0.809	0.777	0.286	0.739	
SS	-0.318*	-0.353*	-0.181	0.230	0.614**	0.855**	-0.596**	-0.653**	-0.754**	-0.603**	0.155
	0.038	0.020	0.246	0.138	0.000	0.000	0.000	0.000	0.00	0.000	0.322

Legend: BW – Body Weight, BH – Body Height, BMI – Body Mass Index, Plate – Plate Tapping, Sprint – Sprint Test, Agility – Agility Test, MBT – Medicine Ball Throw, SBJ – Standing Broad Jump, Sit-up – Sit-up Test, Squat – Squat Test, rs – Spearman's Correlation Coefficient, p – Significance Level.

Speed and agility tests demonstrated strong interrelationships. The 20 m sprint (Flying) was highly correlated with agility assessed by the Japan test ($r=0.754$, $p<0.001$), as well as with lower limb coordination measured by the side steps test ($r=0.614$, $p<0.001$). The Japan test showed an exceptionally strong association with the side steps test ($r=0.855$, $p<0.001$), confirming their functional similarity in assessing agility and coordination.

Explosive strength (medicine ball throw and standing broad jump) was significantly associated with repetitive strength of the trunk and lower limbs (sit-up and squat tests; $r=0.487-0.579$, $p<0.001$), while simultaneously showing negative correlations with speed and agility tests (e.g., medicine ball and Japan test: $r=-0.640$, $p<0.001$; standing broad jump and Japan test: $r=-0.719$, $p<0.001$). Repetitive strength also demonstrated strong negative associations with sprint and agility performance (sit-up and Japan: $r=-0.745$; squat and Japan: $r=-0.696$; $p<0.001$).

Flexibility (stick rotation test) did not show significant correlations with most of the examined parameters, indicating its relative independence from other motor and anthropometric variables in this sample.

Overall, the findings suggest a strong relationship between body dimensions and strength-related tests, as well as pronounced interconnections among speed- and agility-related abilities, whereas flexibility appears to represent a relatively isolated motor component within the analyzed model.

Discussion

The aim of this study was to examine potential differences in body characteristics and motor abilities between young girls enrolled in a volleyball school and those not participating in any organized sports activities, as well as to investigate the relationships between anthropometric and motor parameters. The main findings showed that female youth volleyball players achieved significantly better performance in most motor variables, particularly in speed, agility, explosive and repetitive strength, and coordination, with effect sizes indicating practically meaningful differences. Additionally, strong correlations were found between body dimensions and strength-related tests, as well as clear interrelationships among speed- and agility-related abilities.

Based on the analysis of anthropometric characteristics, it was found that volleyball players demonstrated higher values in body height, body mass, and BMI, which is fully consistent with previous findings by Radu, Popovici, and Puni (2015), who also reported that female volleyball and handball players possess greater height and body mass than non-athletes. It is well established that success in volleyball largely depends on players' morphological characteristics, with body height and mass being key factors relative to the athletes' age (Marelić, Đurković, & Rešetar,

2008). The influence of anthropometric characteristics on motor abilities in volleyball players has also been demonstrated (Stamm, Veldre, Stamm, Thomson, Kaarma, Loko, & Koskel, 2003; Stamm, Stamm, & Koskel, 2006). In terms of competitiveness, these results may reflect a selection process favoring taller girls in volleyball clubs.

The results of the Mann-Whitney U test indicate that volleyball players achieve significantly better results in most motor variables, particularly in speed, agility, strength, and coordination, with moderate to very large effect sizes reflecting the impact of systematic training. These findings align with previous studies, which also reported that athletes outperform non-athletes in most motor tests (Cristina-Elena & Liliana-Elisabeta, 2014; Ivanović & Ivanović, 2013; Jenko-Miholić, Čizmek, & Peršun, 2010). While volleyball players were slightly more flexible, training did not produce a significant difference between volleyball players and non-athletes, suggesting that observed differences in other variables are primarily due to sports training rather than biological factors (Lazić, 2016).

The spike is a technical skill developed in training that initiates acceleration of the shoulder region (regio deltoidea) in volleyball players (Reeser, Fleisig, Bolt, & Ruan, 2010), which may explain the significantly greater upper limb speed in volleyball players compared to non-athletes. Strength is considered a fundamental motor quality in volleyball, initially developed through spontaneous and dynamic play in children and gradually directed toward structured training with external resistance (Sheppard, Nolan, & Newton, 2012). Strength has broad functional effects, contributing to endurance development, overall athletic performance, and injury prevention (Hughes, Ellefsen, & Baar, 2018). Training loads and repetitions vary depending on the targeted adaptations, promoting muscle hypertrophy and repeated force production, which explains the observed differences in repetitive strength between groups (Schoenfeld, Grgic, Van Every, & Plotkin, 2021). Upper and lower body strength are critical for optimizing athletic performance, as improved strength also enhances speed and agility during play (Martin, Gavra, & Martin-Hadmaş, 2024).

The development of serving skills in volleyball players is primarily aimed at optimizing service effectiveness, emphasizing not only execution speed but also increased muscle strength under isokinetic conditions, achieved through concentric muscle contractions (Telles, Cunha, Yoshimura, Pochini, Ejnisman, & Solieman, 2021). Simultaneously, enhanced upper limb strength is crucial for effective service reception, as it relates to the ability to generate maximal muscle contractions (Pawlik, Dziubek, Rogowski, Struzik, & Rokita, 2022). Training in service execution and reception, as key technical elements of volleyball, likely ex-

plains the significantly higher upper limb strength observed in volleyball players compared to non-athletes.

Significant differences in speed, agility, and lower limb coordination between groups can be attributed to sport-specific training, which predominantly influences locomotor patterns in the horizontal plane, characterized by rapid changes of direction (forward-backward, lateral left-right) (Nešić, Ilić, Majstorović, Grbić, & Osmankač, 2013). These specific horizontal agility models in volleyball likely contributed to the development of explosive strength in the lower limb extensors (hip, knee, and plantar flexors), resulting in significantly better standing broad jump performance in volleyball players compared to non-athletes (Farac, 2024).

Regarding the relationships between anthropometric characteristics and motor abilities, the correlation analysis highlights the significant influence of anthropometric characteristics on motor performance in young female volleyball players. Greater body weight and height were associated with superior performance in strength tests, particularly the medicine ball throw and, to a lesser extent, the standing broad jump. This suggests that larger body dimensions provide a mechanical advantage in tasks requiring force production. Interestingly, body size was negatively correlated with upper limb speed, indicating that participants with higher body mass and height completed the plate tapping task faster, which may reflect the integration of strength and coordination in upper limb movements. These findings are consistent with previous research emphasizing the role of body morphology in determining athletic performance, particularly in sports such as volleyball, where height and strength are critical for effective execution of technical elements (Stamm et al., 2003; Marelić et al., 2008).

The established relationships between motor abilities, particularly explosive strength, speed, and agility, are consistent with previous findings (Banda, Beitzel, Kammerer, Salazar, & Lockie, 2019; Lockie et al., 2014; Nejić et al., 2025). This suggests that these motor abilities share common underlying neuromuscular and coordinative mechanisms, especially those governing rapid changes of direction and lower-limb force production. Lockie et al. (2014) identified a strong link between jump test performance and sprint acceleration in athletes, while Banda et al. (2019) suggested that enhanced jump performance may contribute to im-

proved sprint capabilities. Additionally, Nimphius et al. (2010) emphasized that acceleration capacity underpins both linear and multidirectional movements, further highlighting the importance of developing explosive strength and agility in young athletes. In contrast, explosive and repetitive strength tests showed negative associations with speed and agility, indicating a trade-off between maximal force production and movement velocity. Flexibility appeared largely independent of other motor and anthropometric variables, confirming its role as a distinct motor component that is less influenced by body size or strength capacities. Overall, these relationships emphasize the complex interplay between anthropometric characteristics and motor abilities.

Limitations and Future Directions

Some of the main limitations of this study relate to the small sample size, particularly the small sub-samples, which limit the generalizability of the findings. Therefore, future research should include larger samples to enable broader generalization of the results. Additionally, although valid measurement instruments previously used in other studies were applied, future studies should incorporate more advanced measurement equipment to allow for a more detailed assessment of body composition and motor performance in girls.

Conclusion

The findings of this study indicate that young female volleyball players demonstrate significantly better performance in most motor variables compared to their non-athletic peers, particularly in speed, agility, explosive and repetitive strength, and coordination. The moderate to very large effect sizes confirm that these differences are not only statistically significant but also practically meaningful, reflecting the impact of systematic and continuous volleyball training. Furthermore, strong associations were identified between body dimensions and strength-related abilities, as well as among speed- and agility-related variables, while flexibility appeared to be a relatively independent motor component. Overall, the results suggest that volleyball represents an effective model of physical activity for enhancing motor abilities and supporting the overall physical development of girls.

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Conflict of interest

The authors declare no conflicts of interest.

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ORIGINAL SCIENTIFIC PAPER

Coach-Athlete Intimacy, Parental Support, Emotional Regulation on Anxiety in Indonesian Boxing Student-Athletes with Gender as a Moderator

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Abstract

The purpose to analyze coach-athlete intimacy, parental support, emotional regulation towards competition anxiety in boxing student athletes with gender as a moderating variable. This type of research is quantitative descriptive, while the number of subjects was 103 athletes (34 female boxers and 69 male boxers) and aged 14 – 18 years. The research utilized a questionnaire as a research instrument and the indicators of this variable were coach-athlete intimacy (closeness, commitment, complementarity), parental support (emotional, instrumental, informative, reward), emotional regulation (cognitive reappraisal and expressive suppression), anxiety (Cognitive, Somatic, Confidence). Data analysis of this study used Smart Partial Least Squares (PLS). The results of study were coach-athlete intimacy ($T = 3.133$; $p = 0.027$), parental support ($T = 3.177$; $p = 0.024$), and emotional regulation ($T = 3.118$; $p = 0.008$) had an effect on anxiety. Meanwhile, gender moderated the anxiety of boxing student athletes based on coach-athlete intimacy ($T = 2.167$; $p = 0.041$), parental support ($T = 2.125$; $p = 0.003$), and emotional regulation ($T = 2.128$; $p = 0.037$). This study also found that gender acted as a moderating variable, strengthening or influencing the relationship between three main variables and competition anxiety. Future research is expected to utilize a mixed-methods design to explore the qualitative aspects of athletes' interpersonal relationships and emotions in greater depth, as well as to expand the population and encompass various sports.

Keywords: *sport psychology, athlete psychology, student athletes, combat sport*

Introduction

Anxiety is a complex emotional response, characterized by feelings of worry, nervousness, and tension (Cahyo et al., 2025). This is accompanied by physical symptoms such as increased heart rate, sweating, and muscle tension (Zhang, 2023). In boxing, where athletes face opponents head-on and face the risk of physical injury, anxiety levels tend to be high. The intense competitive nature, the pressure to achieve peak performance, and the physical threat posed by opponents make boxing a highly psychologically challenging arena. Anxiety before and during a competition, in particular, can significantly impact an athlete's performance (Mojtahedi et al., 2023).

Anxiety in boxers becomes more complex when they become student-athletes. As student-athletes, they face not only the competitive pressure and physical demands of boxing, but also the academic burden and expectations of academic achievement (Saniah et al., 2024). Time management, expectations from coaches, parents, teachers, and peers all play a role in shaping their experiences of anxiety (Andrade et al., 2021). Furthermore, during adolescence, student-athletes also face various psychosocial changes that can influence how they experience and manage anxiety (Yusup et al., 2024).

Based on previous research on anxiety in boxing, factors include the pressure of competition and the physical threats inher-

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ent in the sport, as well as psychological factors such as self-confidence, motivation, and prior experience (Alejo et al., 2020 & Prabowo et al., 2024). An athlete's social environment, including the dynamics of their relationship with their coach, parental support, and interactions with teammates and opponents, are also important factors (Olmedilla et al., 2018). Furthermore, an athlete's coping strategies, their ability to regulate their emotions, and their perception of the pressure they face all interact to determine the intensity and impact of anxiety on their performance and well-being (Weber et al., 2018).

Intimacy between coach and athlete is an important dimension of the broader coach-athlete relationship. Intimacy refers to the level of emotional depth, trust, openness, and shared understanding between coach and athlete (Mandan et al., 2024). A positive intimate relationship, characterized by mutual trust, respect, and effective communication, can act as an antidote to anxiety (Oktavianingrum & Maryam, 2023). Athletes who feel close and comfortable with their coach are more likely to express concerns, seek support, and feel more secure in the training and competition environment (Negoro & Sungkowo, 2023).

It is important to distinguish between "Coach-Athlete Intimacy" and the broader concept of "Coach-Athlete Relationship." The Coach-Athlete Relationship encompasses various aspects of interaction between the coach and athlete, including leadership, communication, collaboration, and instrumental support from the coach (Nicholls, 2021). Meanwhile, intimacy is a specific component of this relationship that focuses on the affective or emotional dimension. Intimacy involves sharing personal experiences, demonstrating empathy, and building a deep emotional bond (Indarto et al., 2025). In other words, not all well-functioning coach-athlete relationships have a high level of intimacy; intimacy indicates the depth and quality of the emotional connection that goes beyond simply professional interactions (Latief et al., 2024).

Parental support has a significant impact on student athletes' experiences of anxiety (Rouquette et al., 2021). Parents who provide appropriate emotional, informational, and instrumental support can help athletes feel more confident and reduce their stress. This support can include attending games, offering encouragement, helping organize practice and academic schedules, or simply being a good listener (Imtihansyah et al., 2024). However, excessive parental pressure to perform, excessive criticism, or apathy can exacerbate athletes' anxiety, leaving them feeling unsupported, inadequate, or depressed (Nikander et al., 2022).

Emotion regulation refers to the process by which individuals influence the nature of emotions, when they experience them, and how they express them (Robazza et al., 2023). In the context of boxing, athletes' ability to effectively regulate their emotions, particularly when faced with stress and pressure, is crucial for managing anxiety. Athletes with adaptive emotion regulation strategies, such as cognitive restructuring, relaxation, or task-focused focus, tend to reduce anxiety levels and maintain optimal performance (Yamaguchi et al., 2023). Conversely, athletes who struggle with emotion regulation, often resorting to maladaptive strategies such as emotional suppression or rumination, may experience increased anxiety, leading to decreased performance (Karmakar & Ghosh, 2023).

Based on the above description, it has been identified that anxiety is a crucial issue for boxing students, and factors such as coach-athlete intimacy, parental support, and emotion regulation have the potential to influence this level of anxiety. However, a comprehensive understanding of how these three factors interact, and how this interaction is moderated by gender, remains limited, particularly in the Indonesian context (Correia & Rosado, 2019). This research is important because it will provide in-depth insights into the psychological mechanisms underlying anxiety in this specific group of athletes. The inclusion of gender as

a moderator is particularly relevant because there are potentially significant differences between male and female athletes in terms of emotional responses, coping strategies, anxiety expression, and how they interact with their social environment (coach and parent). Understanding these differences is crucial for developing more targeted and effective interventions.

The purpose of this study was to analyze the influence of coach-athlete intimacy, parental support, and emotion regulation on anxiety in Indonesian college boxers, and to investigate the role of gender as a moderator in this relationship. This novel study combines these three psychosocial predictors into a single model to explain anxiety in the Indonesian amateur college boxer population, a context that remains underexplored. Furthermore, emphasizing the role of gender as a moderator will provide a unique contribution to the literature, allowing for the identification of gender differences in vulnerability and resilience to anxiety, which may inform more gender-specific and gender-sensitive training and psychological support programs.

Research methods

Research Design and Procedures

The research method used in this study is a quantitative descriptive method. This study has four research stages: the first stage is problem analysis based on field observations. The purpose of the first stage is to collect and identify problems based on facts in the field. The second stage is document analysis based on a scientific literature review. The purpose of the second stage is to analyze factors scientifically, determine hypotheses, and develop data collection instruments. The third stage is data collection. The fourth stage is data analysis and reporting research results through scientific publications.

Population and Sample

The population and sample of this study were all boxers from Yogyakarta Province, Indonesia. The sample inclusion criteria were: 1) boxers from Yogyakarta Province, 2) boxers still in school, 3) still actively exercising, and 4) having participated in competitions at the district, city, or national level. The sample exclusion criteria were: 1) boxer was an athlete at a college, 2) boxers were beginners or had never participated in competitions. Thus, the sample of this study that met the criteria were 103 athletes (34 female athletes and 69 male athletes), aged 14-18 years, with 2-4 years of training experience, and 1-2 years of experience as athletes.

Research Instruments

The research instrument was a questionnaire with a Likert scale of 1-5, where 1 'strongly disagree', 2 'disagree', 3 'fair', 4 'agree', 5 'strongly agree'. Meanwhile, this research questionnaire was adopted from previous research and modified to suit the needs of the current research problem.

The indicators in the coach-athlete intimacy variable are closeness, commitment, and complementarity (Mandan et al., 2024 & Latief et al., 2024). In indicators of parental support variable, there are emotional, instrumental, informative, reward (Burke et al., 2023 & Imtihansyah et al., 2024). Indicators in emotional regulation variable are cognitive reappraisal and expressive suppression (Aune et al., 2025). In anxiety variable, the Competitive State Anxiety Inventory-2 Revised (CSAI-2R) was adapted Cox et al., (2003). Indicators in anxiety variable are Cognitive, Somatic, Self-Confidence (Saniah et al., 2024, Sridana et al., 2024, & Cahyo et al., 2025).

Data analysis

Data analysis used the Structural Equation Model (SEM) approach assisted by the smart PLS (Partial Least Squares)

application, which refers to the theory by Hair et al., (2019). The stages of data analysis in this study are, the first stage is the measurement model stage. This stage is carried out to test the validity and reliability of each indicator. The validity test in this study uses convergent validity by correlating item scores (component scores) with construct scores which then produce loading factor values. The instrument is declared valid if it has a loading factor value >0.6. After conducting the validity test, a reliability test is then conducted to determine the reliability of the instrument. Measurement of the level of reliability in this study uses the alpha coefficient or Cronbach's alpha and composite reliability, an item is declared reliable if it has a coefficient value >0.6.

The second stage is the structural model testing stage, this stage is the hypothesis testing stage that aims to determine whether there is an association between variables or correlation between

constructs measured using Smart PLS. The structural or inner model is measured by looking at the r-square which shows the percentage level of influence between variables in the model. Then continued with the estimation of the path coefficients obtained by the bootstrapping procedure with a value considered significant if the t-statistics are greater than 1.96, with a p-value score <0.05, while to see the direction of the association, the Beta coefficient value is used.

Result

Outer Model

The outer model is the first analysis in this study using PLS Algorithm after selecting the section in 'calculate'. The external model is divided into validity and reliability tests to determine whether each indicator shows valid or invalid values. The following is an image based on the PLS Algorithm menu.

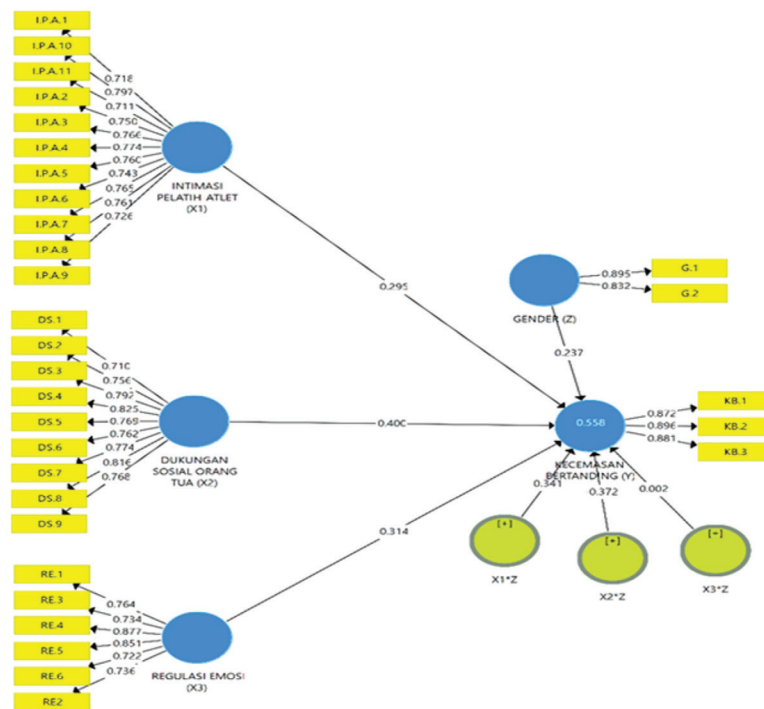


FIGURE 1. Results of PLS Algorithm

Note: INTIMASI PELATIH ATLET (X1) - Coach-Athlete Intimacy; Variable, DUKUNGAN SOSIAL ORANG TUA (X2) - Parental Support; Variable, REGULASI EMOSI (X3) - Emotional Regulation Variable; GENDER (Z) – Gender is a moderator variable, KECEMASAN; BERTANDING – Anxiety Variable.

Table 1. Results of convergent validity

Variabel	Indicator Code	AVE	Outer Loading	Information
Coach-Athlete Intimacy (X1)	I.P.A.1	0,566	0,718	Valid
	I.P.A.2		0,750	Valid
	I.P.A.3		0,766	Valid
	I.P.A.4		0,774	Valid
	I.P.A.5		0,760	Valid
	I.P.A.6		0,743	Valid
	I.P.A.7		0,765	Valid
	I.P.A.8		0,761	Valid
	I.P.A.9		0,726	Valid
	I.P.A.10		0,797	Valid
	I.P.A.11		0,711	Valid

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Table 1. Results of convergent validity

Variabel	Indicator Code	AVE	Outer Loading	Information
Parental Support (X2)	DS.1	0,602	0,710	Valid
	DS.2		0,756	Valid
	DS.3		0,792	Valid
	DS.4		0,825	Valid
	DS.5		0,769	Valid
	DS.6		0,762	Valid
	DS.7		0,774	Valid
	DS.8		0,816	Valid
	DS.9		0,768	Valid
Emotion Regulation (X3)	RE.1	0,613	0,764	Valid
	RE.2		0,736	Valid
	RE.3		0,877	Valid
	RE.4		0,851	Valid
	RE.5		0,722	Valid
	RE.6		0,734	Valid
Competition anxiety (Y)	KB.1	0,780	0,390	Valid
	KB.2		0,359	Valid
	KB.3		0,383	Valid
Gender (Z)	G.1	0,747	0,895	Valid
	G.2		0,832	Valid

Based on Figure 1, the first analysis in outer model is validity test for each item indicator. The validity test serves to measure the validity of the questionnaire. After successfully conducting the analysis using the PLS Algorithm in Figure 1, it shows that the indicator value for each construct shows more than 0.7. In this study, validity testing was conducted using convergent validity and AVE (Average Variance Extracted). The AVE value in Smart PLS is used to assess how much of the indicator variance can be explained by the measured latent construct. The instrument is declared valid if AVE value is >0.5 and outer loading value is >0.7.

Based on the results of Table 1, outer loading value for each

indicator item in the coach-athlete intimacy, parental support, emotional regulation, competitive anxiety, and gender variables showed more than 0.7, and AVE (Average Variance Extracted) value showed more than 0.5. Then, the second analysis in the outer model was the reliability test.

In this study, the researchers used two types of reliability tests: Cronbach Alpha test and Composite Reliability test. Cronbach Alpha measures the lowest reliability value (lowerbound). Data is considered good if it has a Cronbach Alpha value >0.6. Composite reliability measures the actual reliability value of a variable. Data is considered highly reliable if it has a Composite Reliability score >0.7.

Table 2. Results of reliability test

Variabel	Cronbach's Alpha	Composite Reliability
Coach-Athlete Intimacy (X1)	0,923	0,935
Parent's social support (X2)	0,917	0,931
Emotion regulation (X3)	0,874	0,904
Competition anxiety (Y)	0,859	0,914
Gender (Z)	0,764	0,855
X1*Z	1,000	1,000
X2*Z	1,000	1,000
X3*Z	1,000	1,000

Based on the calculations in Table 2, it was found that all instrument items were reliable, with all variables having a Cronbach Alpha score >0.6 and Composite Reliability >0.7. Therefore, the research data can be continued to the inner model stage.

Inner Model

This inner model analysis is intended to test path coefficients for each construct. So, this analysis uses Bootstrapping menu. Bootstrapping menu can also be found in the 'calculate' section. This test analyzes to effect of independent variable on dependent

Table 3. Results of relationship between independent variable and dependent variable

	Original Sample (O)	T Statistics (O/STDEV)	P Values
Coach-Athlete Intimacy (X1) -> Competition anxiety (Y)	0,295	3,133	0,027
Parental Support (X2) -> Competition anxiety (Y)	0,400	3,177	0,024
Emotion Regulation (X3) -> Competition anxiety (Y)	0,314	3,118	0,008
X1*Z -> Competition anxiety (Y)	0,341	2,167	0,041
X2*Z -> Competition anxiety (Y)	0,372	2,125	0,003
X3*Z -> Competition anxiety (Y)	0,302	2,128	0,037

variable based on gender as a moderator. The following are the results of Table 3, in the hypothesis test.

Based on the results of table 3, Coach-Athlete Intimacy on Competition Anxiety obtained a T statistic of 3.133 > 1.960 and p value of 0.027 ($p < 0.05$) resulting in a significant influence where coach-athlete intimacy influences an athlete's competition anxiety. Parental support on competition anxiety obtained a T statistic score of 3.177 > 1.960 and p value of 0.024 ($p < 0.05$) resulting in a significant influence where parental social support influences an athlete's competition anxiety. Emotional Regulation on competition anxiety obtained a T statistic score of 3.118 > 1.960 and p value of 0.008 ($p < 0.05$) resulting in a significant influence where emotional regulation influences an athlete's competition anxiety.

Coach-athlete intimacy towards competition anxiety with gender as a moderator showed a statistical T score of 2.167 > 1.960 and p value of 0.041 ($p < 0.05$). Parental support towards competition anxiety with gender as a moderator showed a statistical T score of 2.125 > 1.960 and p value of 0.003 ($p < 0.05$). Emotional regulation towards competition anxiety with gender as a moderator showed a statistical T score of 2.128 > 1.960 and a value of 0.037 ($p < 0.05$).

Discussion

The findings of this study indicate that the higher the coach-athlete intimacy, the greater the influence on competitive anxiety in amateur boxing students. This theoretical explanation can be viewed from the perspective of interpersonal relationships in the context of sports achievement. When coaches and athletes are close, committed, and complement each other, the coach is able to provide emotional support, understanding, open communication, and adaptive feedback (Mandan et al., 2024 & Latief et al., 2024). Previous research has found that the coach-athlete relationship is significantly correlated with the experience of competitive anxiety (Kassim et al., 2022); (Indarto et al., 2025). Amateur boxing students may experience a state where good intimacy with their coaches helps reduce anxiety because they feel supported, cared for, and secure in the face of competition. Therefore, the findings of this study are consistent with previous findings that the coach-athlete relationship is a protective factor against anxiety.

The results of moderation showed that gender moderated the effect of coach-athlete intimacy on competition anxiety ($T = 2.167$; $p = 0.041$). This means that the effect of intimacy on competition anxiety is different for male athletes compared to female athletes. This can be explained by looking at the socio-cultural context and gender characteristics in coach-athlete interactions. Female athletes may be more sensitive to the emotional and relational aspects of the coach-athlete relationship and utilize closeness to reduce anxiety, while male athletes may be more focused on technical or competitive aspects, so emotional closeness may have a slightly different effect (Powers et al., 2020 & Saarinen et al., 2023). Although previous research specific to gender moderation of the coach-athlete relationship on anxiety is limited, a new de-

velopmental model of the coach-athlete relationship suggests that gender may moderate multiple psychological pathways (Wei et al., 2025). Thus, these findings suggest that in the context of boxing student-athlete and coach-athlete relationships, it is important to consider gender differences as a moderating factor. This suggests that coaches and training programs may need to be tailored sensitively to gender for this coach-athlete relationship intimacy to be truly effective in reducing anxiety.

The results of the study also showed that parental support significantly influenced competition anxiety. The theoretical explanation is that student-athletes are at an age and developmental stage where family support is crucial (Imtihansyah et al., 2024). Adolescent involved in boxing pressures from training, school, and competition (Prabowo et al., 2024). If parents provide social support (emotional, instrumental, informational) then athletes feel they have a source of security and self-confidence that can mitigate competition anxiety (Mandan et al., 2024). A recent meta-analysis of the literature found that general social support generally had a negative impact on anxiety and stress in athletes (Luo et al., 2025). While the article did not specifically address parental support, it did reinforce the importance of family as a source of support in reducing anxiety. Thus, the research findings consistently demonstrate that the greater the parental support, the lower the athlete's perceived competitive anxiety.

Gender moderation of the effect of parental support on competitive anxiety was also shown significant ($T = 2.125$; $p = 0.003$). This means that the effect of parental support on competitive anxiety differs between male and female athletes. Based on previous scientific evidence, this can be explained by the fact that female athletes may rely more on parental emotional support when dealing with competitive pressure, while male athletes may respond differently to such support through support in technical or performance aspects rather than emotional ones (Rumahpasal et al., 2020 & Lev et al., 2020). Research on parental education styles and gender in athletes shows that there are differences in parental education styles based on the gender of the child (González-García et al., 2023). These findings suggest that in the context of Indonesian boxing student-athletes, parental involvement and its effects on competition anxiety should be tailored based on the athlete's gender. For example, parent training for female athletes could emphasize emotions and emotional empowerment, while for male athletes it might focus more on practical support and resource mobilization.

The emotional regulation variable significantly influenced competitive anxiety ($T = 3.118$; $p = 0.008$). Contextually, athletes who possess good emotional regulation skills, such as cognitive reappraisal (reinterpreting situations), efforts to control negative emotional expression (suppression), or attention regulation, will be better able to cope with pre-competition pressure and reduce the emergence of competitive anxiety (Agustina & Widyastuti, 2023 & Bird et al., 2023). Then, a study found that emotion regulation was a significant predictor of competition anxiety, with athletes who used adaptive regulation strategies experiencing lower

anxiety (Amaro & Brandão, 2023). So this finding is in line with the literature, that increasing emotional regulation can reduce competition anxiety in boxing student athletes.

Furthermore, gender also moderated the relationship between emotion regulation and competitive anxiety ($T = 2.128$; $p = 0.037$). Therefore, the influence of emotion regulation on competitive anxiety differs between male and female athletes. The literature shows that male and female athletes have differences in emotion regulation scores, with males tending to be better at regulation according to the study (Oktavia & Jannah, 2022). These findings suggest that female athletes with high levels of emotional regulation experience greater benefits in reducing competitive anxiety than male athletes, or conversely, that male athletes require different regulation strategies for optimal effectiveness. Therefore, emotional regulation interventions to reduce competitive anxiety need to consider gender as a moderating factor. Several previous studies have suggested that emotional regulation programs for female athletes can emphasize emotional aspects and reflection (Rens et al., 2021). Meanwhile, for male athletes, physical control and mental readiness components can be included (Salehian et al., 2021).

This study has several limitations that need to be considered, including the use of a quantitative descriptive method that only describes the relationships between variables without delving into the psychological and social aspects in depth. The population size was limited to amateur boxing students in the Special Region of Yogyakarta (Province DIY), making the results unable to be generalized to athletes from other regions or different sports. Furthermore, the use of the Smart PLS-assisted Structural Equation Modeling (SEM) approach focused on linear relationships between latent variables and did not test alternative, possibly more complex, models. The data was also self-reported, potentially leading to bias in respondents' subjective perceptions of their relationships with coaches, parental support, and emotional regulation. This study also did not consider other external variables such as competition experience, additional psychological conditions, or self-confidence levels that may influence competition anxiety.

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Conflict of Interest

The researchers have no conflicts of interests.

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Therefore, future research is expected to use a mixed-method design to be able to explore the qualitative aspects of interpersonal relationships and emotions of athletes in more depth, expand the population to various provinces and sports to increase the generalizability of the results, and test mediation and non-linear models to be able to understand more comprehensively how social and psychological factors interact to influence the competition anxiety of student athletes in Indonesia.

Conclusion

This study concluded that coach-athlete intimacy, parental support, and emotional regulation significantly influenced competition anxiety in amateur boxing students in Indonesia. These findings indicate that emotional closeness between coaches and athletes can create a sense of security, trust, and psychological support that play a significant role in reducing pre-competition anxiety levels. Social support from parents, whether emotional, motivational, or instrumental, has also been shown to have a positive influence in helping athletes cope with competitive pressure. Furthermore, good emotional regulation skills enable athletes to manage stress and emotional reactions adaptively, thereby suppressing the emergence of competitive anxiety.

This study also found that gender acts as a moderating variable that strengthens or influences the relationship between the third main variable and competition anxiety. This means that the influence of coach-athlete intimacy, parental support, and emotional regulation on competition anxiety differs between male and female athletes. This difference emphasizes the importance of a gender-sensitive approach in the psychological training of boxing student-athletes. Thus, this study confirms that positive interpersonal relationships, adequate family support, and good emotional regulation skills are important psychological foundations for reducing competition anxiety, and that sports training strategies should consider gender differences for more effective results in the context of developing boxing student-athletes in Indonesia.

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ORIGINAL SCIENTIFIC PAPER

Somatotype Variations Among Young Male and Female Handball Players Across Different Playing Positions

Aljaž Kren¹¹Faculty of sport, Department of Institute of Sport, University of Ljubljana, Gortanova ulica 22, 1000 Ljubljana**Abstract**

This study examined whether young male and female handball players differ in morphological characteristics and somatotype profiles across playing positions. The sample included 124 Slovenian handball players: 68 males (16.85 ± 1.72 years) and 56 females (15.36 ± 1.20 years), grouped as backs, wings, pivots, or goalkeepers. Anthropometric measurements were conducted in accordance with ISAK protocols, and somatotypes were determined using the Heath–Carter method. Positional differences were analysed using one-way analysis of variance (ANOVA) or the Kruskal–Wallis test, as appropriate. Significant positional differences were observed in both genders. Male pivots were the heaviest (96.44 ± 11.20 kg) and most robust players, exhibiting significantly greater skeletal diameters and limb girths compared with wings, who were the lightest and leanest. Among female players, backs were significantly taller (174.33 ± 5.20 cm) than wings, while goalkeepers demonstrated the highest endomorphic component (5.04 ± 0.95) and the largest thigh girths. A significant effect of playing position on endomorphy was identified in both male ($p = 0.006$) and female players ($p = 0.032$). Overall, the results indicate clear position-related morphological tendencies, with notable differences between male and female players.

Keywords: handball, antropometry, somatotypes, athletic performance

Introduction

According to historical accounts, early versions of handball were developed at the end of the 19th century, when educators such as Holger Nilsson attempted to create an indoor team game suitable for school settings and both sexes (Kamolovich, 2024). To reach an elite level in handball, it is essential not only to possess strong technical skills and tactical intelligence, but also to exhibit optimal morphological characteristics and key performance attributes, including exceptional muscular power, speed, high-intensity running endurance, and ball-throwing velocity (Martínez-Rodríguez et al., 2020; Schwesig et al., 2016).

The study of physique, body shape, and composition in athletes across different sports, and their association with athletic performance, has long been a subject of considerable scientific investigation. Somatotyping represents one of the most widely

applied methods for the assessment of body composition. Owing to its specificity, somatotype analysis has been extensively employed in research on exercise physiology, sports science, and human biology. This approach is particularly valuable in the identification of morphological characteristics that may facilitate talent detection and the early selection of young athletes for specific sporting disciplines (Carter & Heath, 1990). Consistent research in team handball provides strong evidence that an athlete's physical, physiological, and anthropometric profile is not merely incidental but is fundamentally linked to their designated playing position (Alneama et al., 2023; Haugen, Tønnessen, & Seiler, 2016).

Recent comprehensive reviews establish a general framework for somatotypes in team sports. A scoping review by Martínez-Mirales, García-García & Sánchez-López (2025), encompassing

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3,757 elite athletes, reported that while male athletes predominantly exhibit an endomorphic–mesomorph profile, female athletes are more frequently characterized by a mesomorph–endomorph build. This aligns with empirical data specific to handball, which show that players are generally robust athletes with a high body mass index attributable to a significant muscular component (Ruscello et al., 2021). This general profile, however, is significantly nuanced by position-specific morphological characteristics that are crucial for competitive efficiency (Leuciuc et al., 2022).

For instance, pivots are consistently identified as the most physically imposing players, characterized by high muscle mass and robustness (Bon, Sibila & Pori, 2015), the greatest height, weight, and lean mass variables (Gligoroska et al., 2024), and an endomorph–mesomorph somatotype (Leuciuc et al., 2022). In stark contrast, wings differ the most from other players (Bon, Sibila & Pori, 2015), being significantly shorter, lighter, and the leanest on the court (Gligoroska et al., 2024). Goalkeepers are typically tall with high body mass and the greatest body fat component (Bon, Sibila & Pori, 2015), fitting an ecto-endomorph profile (Leuciuc et al., 2022). Meanwhile, backcourt players are described as mesomorphic, with high levels of soft lean mass and skeletal muscle mass (Gligoroska et al., 2024; Leuciuc et al., 2022). These position-specific locomotor and technical demands reinforce the necessity of specialized morphological profiles; for instance, the higher running volume and fast-break frequency of wings align with their leaner, more ectomorphic build, whereas the high-contact nature of the pivot position necessitates the robust, mesomorphic characteristics previously described (García-Sánchez et al., 2023).

Mohoric, Abazovic & Paravlic (2022) investigated the morphological and performance characteristics of elite handball players across different playing positions and age categories. Their findings revealed variations in body composition and aerobic fitness between positions and age groups. However, the authors emphasized that scouts and coaches should place particular importance on body height and power-related variables. These results hold significant relevance for talent identification programs. The clear distinctions in morphological and performance profiles among positions and age groups offer valuable guidance for coaches in developing position-specific training programs and improving the overall effectiveness of their training approaches.

Despite the extensive literature describing anthropometric and somatotype characteristics of elite adult handball players, considerably less attention has been directed toward adolescent populations, particularly at the national level. In Slovenia, where handball has a long-standing tradition and a well-established youth development system, position-specific morphological data for young players remain limited. The absence of such evidence complicates early talent identification processes and the development of position-oriented training strategies during critical stages of athletic development.

The purpose of this study is to examine and compare the morphological characteristics and somatotypes of male and female handball players in relation to their specific playing positions. By analyzing the physical profiles of both genders, this research seeks to clarify how anthropometric traits align with the modern technical and locomotor demands of the game.

Methods

Participants

The sample of participants consisted of 124 young Slovenian handball players. The sample was divided into 68 male players (mean age: 16.85±1.72) and 56 female players (mean age: 15.36±1.20). Based on their playing position, the male

group (n=68) included: Back player (n=34), Goalkeeper (n=12), Pivot (n=12), Wing (n=10). The female group (n=56) included: Back player (n=29), Wing (n=15), Goalkeeper (n=7), and Pivot (n=5). The experimental procedures did not require separate ethics committee approval, as the data were obtained from standard athlete monitoring practices. The study was conducted in accordance with the ethical principles outlined in the revised Declaration of Helsinki. All participants, or their legal guardians, were fully informed about the purpose and procedures of the anthropometric assessments and provided written informed consent voluntarily.

Procedures

Constitution, i.e., the somatotype, was determined by the Heath-Carter method, which requires a set of anthropometric measurements and included the following 23 variables recorded in the database: body height (cm), body mass (kg), nine skinfolds (mm) (triceps, biceps, forearm, chest, back (subscapular), abdomen, supriliac, thigh and calf), six girths (arm - relaxed and flexed, forearm, thigh, mid-thigh and calf) and six breadths (cm) (shoulder (biacromial), pelvis (biiliac), elbow (bicipicondylar humerus), wrist, knee (bicipicondylar femur), and ankle. All skinfold measurements were taken on the right side of the body using a Gima skinfold caliper. All of the measurements were taken by the same accredited investigator in optimal conditions, with the participants wearing minimal clothing, and according to the methods proposed by the International Society for the Advancement of Kinanthropometry (ISAK). Body height was measured to the nearest 0.1 cm using a stadiometer (GPM, Model 101, Zurich, Switzerland), while body mass was assessed to the nearest 0.05 kg using a multifrequency bioelectrical impedance analyzer (InBody 720, Biospace). BMI was determined according to the standard formula (Kg/m²). Each measure was taken in duplicate. If the difference between the two measurements was greater than 5%, a third measurement was taken, and the median value was used. According to the theory, human physiques can be sorted into three fundamental types: endomorph, mesomorph, and ectomorph. Endomorphs typically have a soft, round appearance due to greater fat storage. In contrast, mesomorphs are defined by their well-developed muscles and athletic build. Ectomorphs, meanwhile, are recognized for their long, lean, and somewhat fragile-looking frames (Carter & Heath, 1990). The somatotype components were calculated according to the methodology of Heath-Carter (Carter & Heath, 1990), using the appropriate computer software for somatotype analysis.

Statistical analysis

The statistical analyses were conducted with the SPSS statistical software (version 29, IBM, USA). All of the data were presented as mean ± SD and 95% of confidence intervals. The normality of data distribution was confirmed by using the Kolmogorov–Smirnov test. or comparisons between groups, a two-way ANOVA was employed to examine the main effects and interactions of the independent variables. In cases where the data did not meet the assumptions for parametric testing, the Kruskal–Wallis test was used as a non-parametric alternative. The statistical significance at the present study was set to value $p < 0.05$.

Results

The research results are the following:

Table 1 presents the descriptive statistics for the selected anthropometric variables, including the mean and standard deviation. Additionally, the results of the Kolmogorov–Smirnov test are provided to indicate the normality of the data distribution.

Table 1. Descriptive statistics of all parameters

Variable	\bar{x} (male)	s (male)	pK-S	\bar{x} (female)	s (female)	pK-S
Body Height (cm)	188.19	7.49	0.410	172.37	5.95	0.609
Body Mass (kg)	84.85	11.85	0.072	64.25	8.95	0.015
BMI (kg/m ²)	23.91	2.66	0.586	21.52	2.55	0.015
Arm Girth Relaxed (cm)	31.51	2.49	0.833	26.9	2.25	0.736
Arm Girth Flexed (cm)	34.92	2.64	0.520	28.91	2.33	0.740
Forearm Girth (cm)	28.99	1.78	0.304	24.59	1.47	0.994
Thigh Girth (cm)	61.77	4.90	0.110	58.75	4.84	0.167
Mid-Thigh Girth (cm)	57.11	4.25	0.804	52.28	4.46	0.134
Calf Girth (cm)	40.39	2.77	0.574	37.16	2.51	0.043
Shoulder Breadth (cm)	42.42	1.97	0.065	37.45	1.57	0.156
Pelvis Breadth (cm)	29.10	1.60	0.028	27.33	1.52	0.497
Elbow Diameter (cm)	7.42	0.45	0.119	6.30	0.33	0.085
Wrist Diameter (cm)	6.06	0.33	0.021	5.20	0.32	0.002
Knee Diameter (cm)	10.17	0.38	0.669	8.98	0.43	0.531
Ankle Diameter (cm)	8.14	0.61	<0.001	6.92	0.36	0.032
Skinfold Back (mm)	11.75	4.46	<0.001	10.99	4.80	<0.001
Skinfold Triceps (mm)	13.62	5.95	<0.001	18.24	6.49	0.785
Skinfold Biceps (mm)	7.45	4.50	<0.001	10.44	5.47	<0.001
Skinfold Forearm (mm)	8.76	3.55	<0.001	9.89	3.49	0.001
Skinfold Abdomen (mm)	17.15	8.70	<0.001	16.57	8.86	0.007
Skinfold Chest (mm)	8.17	3.18	<0.001	9.04	5.56	<0.001
Skinfold Suprailiac (mm)	11.05	6.52	<0.001	12.90	7.38	<0.001
Skinfold Thigh (mm)	15.74	7.18	0.002	17.52	11.22	<0.001
Skinfold Calf (mm)	10.66	5.96	<0.001	13.74	7.64	0.001
Body Fat % (Avg. Ind.)	14.52	5.41	<0.001	24.24	6.12	0.782
Body Fat % (Matiegka)	17.70	5.73	<0.001	25.52	6.31	0.443
Body Fat % (J&P)	11.42	5.16	<0.001	22.94	6.19	0.476
Muscle Mass (Matiegka, kg)	43.49	6.02	0.857	28.99	3.80	0.013
Bone Mass (Matiegka, kg)	14.26	1.56	0.151	9.75	1.08	0.002
Endomorph Component	3.57	1.12	<0.001	4.05	1.14	0.156
Mesomorph Component	4.32	1.14	0.942	3.14	1.03	0.025
Ectomorph Component	2.86	1.22	0.570	3.07	1.26	0.200

Notes: \bar{x} – average values, s – standard deviations, pK-S – significance of the Kolmogorov-Smirnov test, p: statistical significance

Table 2 presents the anthropometric characteristics and positional differences among male handball players. Statistically significant differences were observed in Body Height ($p = 0.016$), Body Mass ($p < 0.001$), and BMI ($p = 0.020$). Pivots were significantly taller than Wings ($p = 0.031$) and maintained a substantially higher Body Mass compared to both Wings and Back players ($p < 0.001$). Correspondingly, the BMI of Pivots was significantly higher than that of Wings ($p = 0.018$) and Back players ($p = 0.041$). Arm Girth (Relaxed) ($p = 0.017$), Forearm Girth ($p = 0.048$), and Thigh Girth ($p = 0.007$) were significantly greater in Pivots compared to Wings ($p = 0.012$, $p = 0.040$, and $p = 0.008$, respectively). Furthermore, Pivots displayed a significantly wider Pelvis Breadth ($p = 0.001$) than Wings ($p = 0.002$) and Back players ($p = 0.006$). Elbow Diameter ($p = 0.003$), Wrist Diameter ($p = 0.031$), and Knee Diameter ($p < 0.001$) all reached statistical significance. Pivots possessed larger skeletal diameters than all other positions, specifically showing significant differences against Goalkeepers, Wings, and Back players in Elbow diameter ($p = 0.005$,

0.009, and 0.033, respectively) and against Wings and Back players in Knee diameter ($p = 0.002$ and $p < 0.001$). While several skinfold sites showed non-significant results, Biceps skinfold ($p = 0.016$) and Suprailiac skinfold ($p = 0.031$) showed significant positional effects. Post-hoc analysis for the Biceps skinfold revealed that Pivots had significantly higher values than Goalkeepers ($p = 0.015$).

Table 3 presents the anthropometric characteristics and positional differences among female handball players. Statistically significant differences were observed in Body Height ($p = 0.013$) and Body Mass ($p = 0.015$). Post-hoc analysis indicated that Back players were significantly taller than Wings ($p = 0.008$). Similarly, Wings exhibited significantly lower Body Mass compared to Back players ($p = 0.025$). Significant positional disparities were identified in lower-body circumferences. Thigh Girth ($p = 0.044$) and Mid-Thigh Girth ($p = 0.027$) showed significant variations, with Goalkeepers possessing significantly larger dimensions than Wings ($p = 0.032$ and $p = 0.017$, respectively).

Table 2. Positional differences in anthropometric characteristics among male handball players

Variable	Goalkeeper	Wing	Back	Pivot	p
Body Height (cm)	190.50	184.21	186.62	192.83	0.016
Body Mass (kg)	86.62	77.02	82.19	96.44	<0.001
BMI (kg/m ²)	23.88	22.64	23.61	25.89	0.020
Arm Girth Relaxed (cm)	31.15	30.14	31.43	33.32	0.017
Arm Girth Flexed (cm)	34.40	33.80	34.87	36.56	0.068
Forearm Girth (cm)	28.67	28.13	28.93	30.13	0.048
Thigh Girth (cm)	62.92	58.82	61.01	65.28	0.007
Mid-Thigh Girth (cm)	57.28	54.86	56.66	60.15	0.020
Calf Girth (cm)	40.80	38.95	40.00	42.27	0.022
Shoulder Breadth (cm)	42.64	42.31	42.09	43.29	0.323
Pelvis Breadth (cm)	29.59	28.20	28.75	30.32	0.001*
Elbow Diameter (cm)	7.20	7.21	7.41	7.81	0.003
Wrist Diameter (cm)	6.03	5.86	6.04	6.28	0.031*
Knee Diameter (cm)	10.21	9.98	10.08	10.54	<0.001
Ankle Diameter (cm)	8.08	8.14	8.06	8.35	0.104*
Skinfold Back (mm)	11.08	9.78	10.99	16.18	0.061*
Skinfold Triceps (mm)	13.52	10.70	13.46	17.23	0.076*
Skinfold Biceps (mm)	5.57	6.36	7.23	11.02	0.016*
Skinfold Forearm (mm)	7.15	7.48	9.30	9.95	0.075*
Skinfold Abdomen (mm)	15.62	14.94	16.24	23.65	0.119*
Skinfold Chest (mm)	8.58	7.22	8.04	9.02	0.250*
Skinfold Suprailiac (mm)	9.53	8.72	9.90	17.88	0.031*
Skinfold Thigh (mm)	16.17	13.02	15.33	19.47	0.162*
Skinfold Calf (mm)	9.40	10.08	10.27	13.98	0.220*

Note. *: Kruskal–Wallis test, p: statistical significance

Table 3. Positional differences in anthropometric characteristics among female handball players

Variable	Goalkeeper	Wing	Back	Pivot	p
Body Height (cm)	170.65	168.27	174.33	173.10	0.013
Body Mass (kg)	67.41	58.38	65.52	66.78	0.015*
BMI (kg/m ²)	23.22	20.27	21.54	22.20	0.054*
Arm Girth Relaxed (cm)	28.04	25.93	27.13	27.42	0.165
Arm Girth Flexed (cm)	29.72	27.75	29.12	29.52	0.166
Forearm Girth (cm)	24.71	23.66	24.88	24.96	0.066
Thigh Girth (cm)	62.20	56.08	58.82	59.70	0.044
Mid-Thigh Girth (cm)	56.00	50.05	52.15	53.36	0.027
Calf Girth (cm)	38.24	35.90	37.21	38.30	0.231*
Shoulder Breadth (cm)	37.88	37.34	37.39	37.28	0.879
Pelvis Breadth (cm)	27.80	26.97	27.38	27.18	0.676
Elbow Diameter (cm)	6.30	6.16	6.35	6.30	0.376
Wrist Diameter (cm)	5.07	5.13	5.24	5.28	0.525*
Knee Diameter (cm)	9.01	8.83	8.99	9.16	0.477
Ankle Diameter (cm)	6.92	6.78	6.95	7.14	0.368*
Skinfold Back (mm)	13.57	9.06	11.35	10.44	0.125*
Skinfold Triceps (mm)	17.80	17.80	18.08	18.56	0.996
Skinfold Biceps (mm)	10.80	9.50	10.10	13.92	0.909*

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Table 3. Positional differences in anthropometric characteristics among female handball players

Variable	Goalkeeper	Wing	Back	Pivot	p
Skinfold Forearm (mm)	10.14	9.00	9.86	11.20	0.987*
Skinfold Abdomen (mm)	17.80	14.60	17.42	14.76	0.724*
Skinfold Chest (mm)	13.41	10.21	8.15	9.56	0.261*
Skinfold Suprailiac (mm)	18.58	12.46	11.88	13.08	0.150*
Skinfold Thigh (mm)	23.90	14.54	17.20	17.56	0.668*
Skinfold Calf (mm)	16.27	13.24	12.75	15.80	0.431*

Note. *: Kruskal–Wallis test, p: statistical significance, p: statistical significance

Table 4 presents the comparison of somatotype components (endomorph, mesomorph, and ectomorph) between young male and female handball players across different playing positions (goalkeeper, pivot, wing, and back players). A significant effect of playing position on endomorphy was observed in both males ($p = 0.006$) and females ($p = 0.032$). In the male cohort, pivots exhibited the highest endomorphic values, while wings showed the lowest.

Among females, goalkeepers were characterized by the highest relative adiposity. While the initial Two-way ANOVA indicated a highly significant interaction ($p < 0.001$), the subsequent post-hoc analysis yielded a value of $p = 0.095$. This result is interpreted as marginally significant, suggesting a strong trend toward gender-based positional differences that does not meet the strict 0.05 threshold, likely due to the inherent variability within the female subgroups.

Table 4. Comparison of somatotype components by gender and playing position among handball players

Somatotype component	Gender	Goalkeeper	Pivot	Wing	Back players	p (within group)	p (between group)
Endomorph Component	Male	3.69±1.02	4.58±1.49*	2.82±0.83*	3.41±0.84	0.006*	<0.001**
	Female	5.04±0.95	4.04±1.55	3.50±0.81	4.05±1.15	0.032	
Mesomorph Component	Male	3.87±1.31	4.82±0.88	4.14±0.96	4.35±1.17	0.218	0.318**
	Female	3.62±1.28	3.46±1.82	3.00±0.64	3.03±0.96	0.468	
Ectomorph Component	Male	3.04±1.52	2.25±1.17	3.15±0.85	2.93±1.19	0.278	0.285**
	Female	2.14±1.13	2.86±1.90	3.42±0.86	3.17±1.27	0.156	

Note. X: average values, s: standard deviations, *: Kruskal–Wallis test, **: Two-way ANOVA, p: statistical significance

Discussion

This study focused on young Slovenian handball players. Specifically, we examined how morphological characteristics and somatotype profiles differ between playing positions and between male and female handball players. The results largely confirm the established paradigm of position-specific morphological specialization in team handball, while also revealing nuanced, sex-dependent patterns in somatotype distribution that contribute to a more refined anthropometric model for the sport (Gabrys et al., 2020; Leuciuc et al., 2022). The most significant finding is the robust anthropometric profile of pivots (Body Height: 192.83 cm; Body Mass: 96.44 kg; BMI: 25.89 kg/m²). They were significantly taller than wings (184.21 cm; $p = 0.031$) and maintained a substantially higher body mass compared to both wings (77.02 kg) and back players (82.19 kg; $p < 0.001$). Correspondingly, their BMI was significantly greater than that of both wings (22.64 kg/m²; $p = 0.018$) and back players (23.61 kg/m²; $p = 0.041$). This aligns perfectly with the established literature, where pivots are consistently identified as the most robust players, requiring greater mass and strength to withstand physical confrontations in the 6-meter area and secure positioning (Mohorič, Abazović & Paravlic, 2022; Šibila & Pori, 2009). The significantly larger limb girths (Arm Girth Relaxed: 33.32 cm; Forearm Girth: 30.13 cm; Thigh Girth: 65.28 cm) and skeletal breadths (Pelvis Breadth: 30.32 cm; Elbow Diameter: 7.81 cm; Knee Diameter: 10.54 cm) observed in pivots further delineate this profile. These measurements are indicative of greater muscular development and skeletal robustness, characteristics synonymous with the mesomorphic-endomorphic somatotype commonly reported for this position in both senior and junior players [Bon-

Pori & Šibila, 2015; Vuleta et al., 2020). Wings were the lightest (77.02 kg), with the lowest BMI (22.64 kg/m²) among field players and the smallest skeletal diameters (Wrist: 5.86 cm; Knee: 9.98 cm), consistent with a large body of research identifying wings as the smallest and most linear players (Nikolaidis et al., 2015; Šibila & Pori, 2009; Zapartidis et al., 2011). This morphology is biomechanically advantageous for the positional demands of high-speed linear running, rapid changes of direction, and aerial jumps from the wing position, where a lower body mass enhances acceleration and agility. Their significantly smaller skeletal diameters and limb girths further emphasize a leaner, less robust build optimized for speed and endurance rather than static power. Back players (Body Height: 186.62 cm; Body Mass: 82.19 kg) and goalkeepers (Body Height: 190.50 cm; Body Mass: 86.62 kg) exhibited intermediate and less differentiated anthropometric profiles in this adolescent sample. While backs were not significantly different from pivots in height, they were substantially lighter and had a lower BMI, resulting in a more ectomorphic profile suited for the dual demands of long-range shooting and defensive mobility. The lack of extreme anthropometric values in backs may reflect the versatile physical requirements of the position, which necessitates a balance of power, agility, and endurance (Matthys et al., 2013). Some studies on younger adolescents have found minimal or less consistent morphological differentiation (Ingebrigtsen, Jeffreys & Rodahl, 2013), often attributed to ongoing growth and selection processes. The pronounced differences found here, in players with a mean age of 16.85 years, suggest that the specialisation process is advanced. This aligns with longitudinal data from Slovenian male players, which indicates that significant morphological differentiation is evident

by the U17-U19 age categories (Mohorič, Abazović & Paravlic, 2022). The anthropometric differentiation among female players was less pronounced than in males, particularly in circumferential and skeletal measures, aligning with studies suggesting morphological specialization may be subtler or develop later in females (Vuleta et al., 2020). However, key positional trends emerged. Backs were the tallest (174.33 cm), followed by pivots and goalkeepers, with wings being the shortest (168.27 cm). Wings were also the lightest (58.38 kg) with the lowest BMI (20.27 kg/m²), mirroring the male trend of a lighter build for perimeter players. The results confirm the expected sexual dimorphism, with males being taller, heavier, more muscular, and leaner than females. Specifically, males exhibited substantially greater muscle mass (43.49 kg vs. 28.99 kg) and a lower percentage of body fat (14.5% vs. 24.2%), reflecting a higher proportion of fat-free mass and sport-specific physiological adaptations. The somatotype classification of the entire male sample (3.57–4.32–2.86) indicates a balanced mesomorph, whereas the female sample (4.05–3.14–3.07) is characterized as a mesomorphic endomorph. These somatotype profiles are consistent with those reported for youth elite players from other European populations (Mohorič, Abazović & Paravlic, 2022; Moss et al., 2015).

In our male cohort, pivots displayed the highest endomorphic values (4.58±1.49), consistent with descriptions of elite male pivots as endo-mesomorphic (Leuciuc, Gherghel & Bota, 2022). Conversely, in our female cohort, goalkeepers demonstrated the highest endomorphy (5.04±0.95), a statistically significant positional effect ($p = 0.032$). This pattern indicates that the linkage between positional demands and adiposity may follow different selective or adaptive pathways in male and female athletes. This finding enriches the general observation from Martínez-Mireles, García-García, and Sánchez-López (2025) that female team-sport athletes tend toward a mesomorph-endomorph build. It suggests that within this general female tendency, the distribution of endomorphy is position-specific in a way that differs from males. The presence of significant positional differences in this age group suggests that sport-specific morphological selection or adaptation is already advanced by mid-to-late adolescence. This supports the utility of anthropometric profiling in youth talent identification, as advocated by researchers who highlight body height and power-related variables as key predictors (Mohamed et al., 2009; Mohorič, Abazović & Paravlic, 2022).

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Limitations of the study

This study has limitations. The cross-sectional design of the study provides only a single time-point assessment, thereby limiting causal inference regarding the development of position-specific morphological characteristics. The small number of female pivots ($n=5$) and goalkeepers ($n=7$) reduces statistical power and constrains the generalizability of findings for these positional subgroups. Furthermore, participants were in mid-to-late adolescence, a developmental stage marked by considerable interindividual variability in biological maturation. Differences in maturation timing and tempo may have influenced anthropometric measures and somatotype components independently of playing position, potentially confounding the observed results.

Recommendations for future research

Future research should adopt longitudinal designs to track athletes from puberty to senior level, clarifying the development of these morphological profiles. Furthermore, integrating detailed anthropometry with objective measures of position-specific performance (e.g., throwing velocity, defensive actions, aerobic power) in youth cohorts is essential to bridge the gap between descriptive morphology and performance prediction. Expanding this paradigm to include biomechanical and physiological metrics would ultimately support the creation of more holistic, position-specific athlete profiles.

Conclusion

In summary, this study on young Slovenian handball players strongly affirms the existence of distinct, position-specific morphological profiles, confirming patterns established in the international literature on elite adult athletes. Its principal novel insight is the identification of a sex-based dichotomy in the distribution of endomorphy, challenging the assumption of uniform positional somatotypes across sexes. These results validate the use of anthropometric assessment as a tool in youth talent identification and positional orientation. Moreover, they provide a refined, sex-differentiated evidence base to guide the development of individualized strength and conditioning regimens, ultimately aiming to optimize the physical preparedness of young handball players for the specific demands of their chosen position.

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REVIEW PAPER

Aquatic Interventions in Autism: A Dual-Lens Review of Clinical Efficacy and Community Implementation

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Abstract

Accidental drowning is a leading cause of death among children with Autism Spectrum Disorder (ASD), making aquatic interventions a public health priority. Although clinical benefits are well documented, the literature remains fragmented, often separating child-centered physiological and behavioral outcomes from the socioecological barriers faced by caregivers and instructors. To address this gap, this narrative review synthesizes 21 peer-reviewed empirical studies published between 2017 and 2025. Using a dual-lens framework, the review examines both clinical efficacy and community-based implementation. Quantitative evidence shows that structured aquatic programs improve water competence, gross motor skills, and executive functioning. Preliminary findings suggest that these gains may be linked to physiological mechanisms, including increased vagal tone and modulation of inflammatory cytokines [IL-6 and IL-10], which are associated with better sleep regulation and fewer stereotypic behaviors. In contrast, qualitative evidence reveals a serious implementation gap. Although families value aquatic participation as a meaningful activity that reduces parental stress, equitable access remains limited by sensory-challenging pool environments, high costs, and a shortage of autism-informed instructors. Bridging this efficacy-implementation divide requires scalable policy reforms, including task-sharing models in which therapists support mainstream instructors. Larger randomized controlled trials are also needed to strengthen the evidence base and help establish aquatic therapy as an equitably accessible standard of care.

Keywords: *Autism spectrum disorder, aquatic therapy, water safety, swimming interventions, caregiver perspectives*

Introduction

Autism Spectrum Disorder (ASD) is a neurodevelopmental condition marked by persistent difficulties in social communication, restricted patterns of behavior, and frequent gross motor impairments (American Psychiatric Association, 2013; Puspongoro et al., 2016). Within this population, water safety is a major public health concern. Accidental drowning remains a leading cause of death among children with ASD, a risk commonly linked to attraction to water, limited danger awareness, and wandering or elopement behaviors (Carter & Koch, 2023; Cosart et al., 2025; Guan & Li, 2017; Kemp, Woodson, & Baldino, 2023; Rice et al., 2016). As a result, aquatic interventions should be viewed not only as recre-

ational activities but also as potentially life-saving measures.

Although drowning prevention is often the main reason children with ASD are enrolled in swimming programs, recent research points to broader therapeutic benefits. The literature has moved beyond basic skill acquisition to emphasize the hydrostatic, thermodynamic, and sensory properties of water as forms of somatosensory input that may reduce nervous system hyperarousal (Bell, 2021; Güeita-Rodríguez et al., 2021). Empirical studies indicate that structured aquatic therapy can improve gross motor skills, dynamic balance, and executive functioning (Faraji et al., 2023; Marzouki et al., 2022). Emerging research also examines the neurophysiological and biological mechanisms underlying these outcomes. Aquatic interventions appear to

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increase vagal tone, which is associated with improved social behaviors such as eye contact, and to modulate inflammatory cytokines by lowering IL-6 and increasing IL-10 (AdibSaber et al., 2024; Bell, 2021). These changes may help explain reported reductions in restrictive and stereotypic behaviors, as well as improvements in sleep regulation (AdibSaber & Ansari, 2024; Lawson & Little, 2017). However, these mechanistic findings remain preliminary, as many studies rely on small samples and short intervention periods, underscoring the need for larger randomized controlled trials with objective clinical measures (Alecú & Onea, 2025; Kemp et al., 2024).

Beyond child outcomes, qualitative research highlights the wider effects of aquatic interventions on family life. Caregivers often seek swimming lessons because of intense fear that their child may drown (Carter & Koch, 2023; Cosart et al., 2025). Yet successful participation often develops into a meaningful and inclusive family activity. Studies report broader psychosocial benefits, including improved sibling interaction, reduced parental stress, and a stronger sense of community belonging (Alecú & Onea, 2025; Johnson et al., 2021). This shift from safety necessity to valued family occupation underscores the broader contribution of aquatic participation to family quality of life (Carter & Koch, 2023).

Despite strong evidence of clinical and psychosocial benefits, major implementation barriers remain in community settings. Children with ASD are often excluded from mainstream swimming programs because public pools can be sensory-challenging and because autism-informed instructors remain scarce (Cosart et al., 2025; Kraft, 2019). Mainstream instructors frequently report feeling unprepared to address ASD-related behavioral and pedagogical needs, leaving families to depend on costly private lessons or forgo access altogether (Carter & Koch, 2023). This gap reflects a clear form of occupational injustice.

A further limitation is that the literature remains fragmented. Some studies focus narrowly on physiological and behavioral

outcomes in controlled clinical settings (AdibSaber et al., 2024; Marzouki et al., 2022), while others examine the lived experiences of caregivers and instructors in community contexts (Carter & Koch, 2023; Cosart et al., 2025). Few reviews integrate both perspectives. This narrative review addresses that gap by synthesizing the dual impacts of aquatic interventions for children with ASD. Using a dual-lens framework, it examines both the clinical and neurobiological outcomes for children and the implementation experiences of caregivers and instructors. In doing so, it aims to clarify how aquatic programs can be optimized and made more equitably accessible, not only to protect children with ASD but also to support their families.

Methods

The aim of this narrative literature review is to critically synthesize the multidimensional effects of aquatic interventions for children with ASD, with attention to both child-centered clinical outcomes and the real-world implementation experiences of caregivers and instructors. To address this dual-lens objective, a comprehensive search was conducted in PubMed, Scopus, and Google Scholar for peer-reviewed empirical studies published between 2017 and 2025. The search strategy combined Medical Subject Headings (MeSH) and targeted free-text terms linked with Boolean operators (AND, OR, and truncation). The core search string was as follows: ("Autism Spectrum Disorder" OR "ASD" OR "autism") AND ("aquatic therapy" OR "swimming" OR "hydrotherapy" OR "water safety" OR "aquatic intervention*") AND ("caregiver*" OR "parent*" OR "motor skills" OR "social interaction" OR "efficacy" OR "implementation").

Initial screening, full-text eligibility assessment, and final article selection were conducted in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines (Moher et al., 2009). The full study selection process is presented in the PRISMA flow diagram in Figure 1.

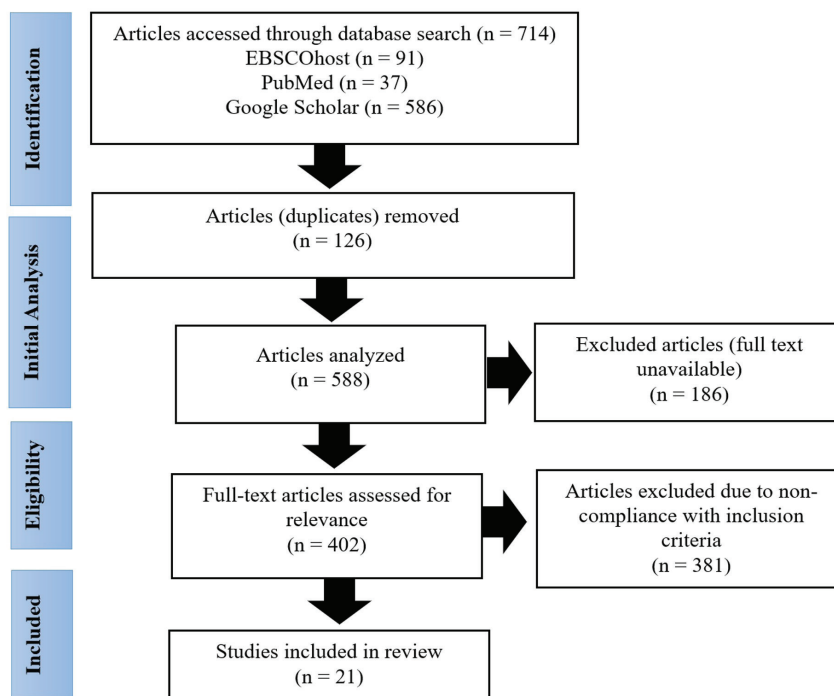


FIGURE 1. PRISMA flow chart of the article selection process

Inclusion Criteria

To ensure a rigorous synthesis, study eligibility was guided by a modified Population, Intervention, Comparison, Outcomes, and Study Design (PICOS) framework. Peer-reviewed empirical stud-

ies, including randomized controlled trials, quasi-experimental, observational, single-subject, mixed-methods, and qualitative designs, were included if they evaluated structured aquatic programs. The target population was children and adolescents aged 18 years

Table 1. Summary of included studies grouped by thematic clusters

Study (Author, Year)	Study Design	Participants (N, Age)	Intervention	Key Findings
PART A: Child-Centric Efficacy and Skill Acquisition				
Quraishi & Jarrar (2018)	Quasi-experimental	N=56; 5–8 years	6 months; aquatic therapy, 3 days/week	Significant improvements were observed in both sensory modulation (Short Sensory Profile) and activities of daily living (WeeFIM).
Battaglia et al. (2019)	Case report/ Multi-method	N=3; 10–15 years	12 weeks; Multi-systemic Aquatic Therapy (CI-MAT)	Participants significantly improved gross motor proficiency (locomotor and object control skills). The highest social gains included eye contact and complying with turns.
Hubená (2021)	Observational	N=5 boys; 5–10 years	10 months; preparatory swimming lessons	Using the Štochl scale, all probands showed an overall improvement in basic aquatic skills, with the most significant gains in head dunking and starfish positions.
Shayakhmetova et al. (2021)	Quasi-experimental	N=5 boys; 9–10 years	6 months; swimming using visually associative boards	All children successfully mastered basic survival tasks, including immersion, exhalation in water, and sliding on the chest.
Vodakova et al. (2022)	Single-subject design	N=7; 7–12 years	7 weeks; Halliwick method	Participants improved aquatic skills (mental adjustment, breathing control) measured by the WOTA1, and gross motor function measured by the GMFM.
Marzouki et al. (2022)	Randomized controlled trial (RCT)	N=22; 6–7 years	8 weeks; Technical vs. Game-based aquatic training	Both experimental groups showed significant improvements in gross motor skills and reduced stereotypy compared to controls, with no significant differences between the two modalities.
Faraji et al. (2023)	Quasi-experimental	N=40; 7–10 years	8 weeks; Response-Oriented Aquatic (ROA) exercise	ROA exercise significantly improved gross motor skills (static/dynamic balance, throwing) and executive function (cognitive flexibility and working memory).
Sugiharto et al. (2023)	Research & Development (R&D)	N=70; 6–12 years	N/A (Developed a freestyle learning model)	The newly developed freestyle swimming learning model proved both feasible and highly effective in improving swimming skills for children with autism in special schools.
Kemp et al. (2024)	Randomized controlled trial (RCT)	N=37; 5–9 years	10 weeks; AquOTic intervention	Children receiving AquOTic demonstrated significant, large-effect-size improvements in water competency (measured by WOTA 1 & 2) and foundational swim skills.
PART B: Underlying Mechanisms of Action (Physiological & Sleep)				
Lawson & Little (2017)	Pre-post feasibility study	N=10 boys; 5–12 years	8 weeks; Sensory Enhanced Aquatics	Children with increased sensory sensitivity and decreased autism severity showed significantly decreased sleep disturbance following the intervention.
Bell (2021)	Quasi-experimental	N=64 (32 ASD, 32 TD); ~9–10 years	Single ~20-minute aquatic session	The aquatic intervention significantly increased vagal tone in participants with ASD. This increase positively correlated with social skills, including eye contact and laughing.
AdibSaber et al. (2024)	Randomized controlled trial (RCT)	N=40 boys; 6–14 years	10 weeks; Aquatic exercise + Vitamin D3	Only the combination of aquatic exercise and Vitamin D3 supplementation significantly reduced pro-inflammatory IL-6 and increased anti-inflammatory IL-10 serum levels.
AdibSaber & Ansari (2024)	Quasi-experimental	N=30 boys; 8–14 years	10 weeks; Aquatic vs. Kata techniques	Both modalities improved stereotypic behaviors. The aquatic exercise group achieved superior scores in reducing sleep anxiety and parasomnias compared to the Kata group.

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Table 1. Summary of included studies grouped by thematic clusters

Study (Author, Year)	Study Design	Participants (N, Age)	Intervention	Key Findings
PART C: Real-World Implementation & Lived Experiences				
Kraft (2019)	Qualitative/ Phenomenological	N=2 (1 therapist, 1 instructor)	N/A (Explored instructor experiences)	Swimming fostered socialization, but instructors faced challenges with communication and sensory distractions, highlighting a need for physical assistance and relationship-building.
Johnson et al. (2021)	Mixed methods (Pilot/Feasibility)	N=10 dyads; 5.5–11 years	3 weeks (12 sessions); private swim program	Parents reported improved child sleep and decreased stress. Qualitative themes revealed major challenges regarding sibling integration and parental fear of drowning.
Güeita-Rodríguez et al. (2021)	Mixed methods	N=6; 6–12 years	7 months; Water Specific Therapy (Halliwick)	While quantitative metrics showed physical improvements, embedded qualitative data revealed parents placed highest value on unexpected gains in emotional reciprocity and non-verbal communication.
Carter & Koch (2023)	Qualitative/ Phenomenological	N=5 parents, 6 swimming teachers	N/A (Explored lived experiences)	Parents initially sought lessons for survival but found them to be a meaningful occupation. Teachers found lessons rewarding but faced a critical lack of knowledge and autism-specific training.
Kemp, Woodson, & Baldino (2023)	Mixed methods (Pilot/Feasibility)	N=8; 3–7 years	10 weeks; group-based aquatic OT	81% of individualized goals were met. Parents highly valued the occupational therapy (OT) approach, noting improved safety, tailored sensory adaptations, and decreased family stress.
Bekhet et al. (2023)	Qualitative evaluation	N=10 caregivers	12 sessions; Swimming Training Program	Caregivers found the program acceptable and highly valued instructor creativity. However, parents expressed a desire for instructors to utilize more firmness when managing behavioral issues.
Alecu & Onea (2025)	Mixed methods	N=36; 8–16 years	8 weeks; therapeutic swimming (post-ABA)	Using the PPQ-Autism-Swim, parents reported highly significant improvements in child well-being, learning, and self-confidence. Qualitative data reinforced benefits like calmer behavior and improved sleep.
Johnson et al. (2025)	Qualitative (Focus groups/ Interviews)	N=21 parents	N/A (Explored lived experiences)	Identified severe systemic barriers including autism traits increasing water safety risks, sensory overload in pools, financial constraints, and a critical lack of prepared instructors.

or younger with a medically confirmed diagnosis of ASD. To address real-world implementation, studies involving primary caregivers, parents, or aquatic instructors of these children were also included. Interventions included therapeutic swimming, aquatic occupational or physical therapy, and adapted recreational lessons using structured approaches such as the Halliwick concept, AquOTic, or sensory-enhanced aquatics. Studies were eligible regardless of control group type, including active controls, waitlist controls, and single-group pre-post designs. To capture both clinical efficacy and community implementation, studies had to report either quantitative child-centered outcomes, such as gross motor skills, water safety, sleep, vagal tone, and inflammatory cytokines (IL-6 and IL-10), or qualitative adult-centered outcomes related to feasibility, parental stress, and systemic or environmental barriers.

Exclusion Criteria

Studies were excluded if they focused only on adults with ASD (older than 18 years), as the literature primarily addresses child-

hood and adolescence. Studies involving other primary neurodevelopmental or physical disabilities were also excluded unless they reported separate data for an ASD subgroup. The review further excluded unstructured aquatic recreation, animal-assisted aquatic therapies, and land-based interventions without a direct aquatic comparison. Epidemiological studies on drowning rates without a preventive aquatic intervention, and studies limited to the biochemical properties of pool environments, were also excluded. To maintain methodological rigor, non-peer-reviewed sources, gray literature, opinion pieces, and conference abstracts without complete datasets were not included.

Results

Table 1 summarizes the 21 empirical studies included in this narrative review. To reflect the manuscript’s dual-lens focus, the studies are organized into three thematic clusters: (A) child-centered efficacy and skill acquisition, (B) underlying mechanisms of action (physiological and sleep), and (C) real-world implementa-

tion and lived experiences. For each study, the table reports the authors and year, study design, participant characteristics, intervention parameters, and primary findings, providing a clear comparative overview of the current literature.

Discussion

This narrative literature review synthesizes the dual impacts of aquatic interventions for children with ASD, examining both direct clinical outcomes for children and the implementation experiences of caregivers and instructors. By linking clinical efficacy with community-based implementation, the review offers a holistic understanding of how aquatic programs can be optimized to support children with autism and their broader family ecosystem.

Child-centered efficacy and clinical outcomes

The literature consistently shows that structured aquatic environments support physical, cognitive, and psychosocial development in children with ASD. Water safety is especially critical, as drowning is a leading cause of accidental death among children with autism, largely due to wandering and attraction to water without a clear sense of danger (Cosart et al., 2025; Kemp et al., 2023). Interventions based on the Halliwick concept and occupational therapy programs such as AquOTic effectively build foundational water competence, survival skills, and breath control, thereby reducing drowning risk (Güeita-Rodríguez et al., 2021; Kemp et al., 2024; Vodakova et al., 2022).

Beyond safety, the physical properties of water, including hydrostatic pressure, resistance, and buoyancy, make it an effective setting for addressing common motor deficits in ASD, particularly poor balance and coordination (Qurraishi & Jarrar, 2018; Sugiharto et al., 2023). Evidence suggests that aquatic therapies, whether technical, game-based, or response-oriented, improve gross motor skills such as object control, dynamic balance, and locomotion (Battaglia et al., 2019; Faraji et al., 2023; Marzouki et al., 2022). These physical benefits also appear to extend to executive functioning, with response-oriented aquatic exercises improving cognitive flexibility and working memory (Faraji et al., 2023).

Aquatic settings also promote psychosocial development. Children in swimming interventions show gains in joint attention, peer acceptance, and emotional reciprocity, along with reductions in hyperactivity, aggression, and stereotypic behaviors (AdibSaber & Ansari, 2024; Alecu & Onea, 2025; Marzouki et al., 2022). Regular aquatic therapy is also associated with longer sleep duration and lower levels of sleep anxiety and parasomnias, particularly among children with high sensory avoidance profiles (AdibSaber & Ansari, 2024; Johnson et al., 2021; Lawson & Little, 2017).

Underlying mechanisms of action

The literature identifies several biological, neurological, and sensory mechanisms that may explain the broad benefits of aquatic therapy. From a sensory perspective, hydrostatic pressure provides continuous proprioceptive and tactile input, often described as a “massive hug,” which may reduce hyperarousal and regulate sensory processing difficulties (Alecu & Onea, 2025; Qurraishi & Jarrar, 2018).

Neurologically, Polyvagal Theory offers one explanation for improved social engagement. Swimming practices such as breath control and submersion may induce meditative states and increase vagal tone, a physiological change associated with better eye contact, laughter, and cooperative play (Bell, 2021). Biologically, aquatic exercise may also reduce systemic inflammation. Aerobic swimming depletes muscle glycogen stores, which may lower the pro-inflammatory cytokine interleukin-6 (IL-6). When combined with vitamin D3 supplementation, aquatic exercise ap-

pears to further decrease IL-6 and increase the anti-inflammatory cytokine IL-10, with corresponding improvements in social interaction deficits (AdibSaber et al., 2024). Finally, the neurotrophic hypothesis suggests that the metabolic demands of aquatic exercise increase cerebral blood flow and stimulate brain-derived neurotrophic factor (BDNF), thereby supporting neuroplasticity and executive functioning (Faraji et al., 2023).

Real-world implementation and lived experiences

Although clinical outcomes are largely positive, translating aquatic interventions into community programs reveals substantial systemic and logistical barriers. Qualitative syntheses show that many parents initially seek swimming lessons out of an intense fear of drowning but later come to view swimming as a meaningful and inclusive family activity that reduces stress and fosters a sense of achievement (Carter & Koch, 2023; Cosart et al., 2025; Kemp et al., 2023).

These experiences also expose major implementation challenges. Parents and mainstream instructors alike report frustration over the lack of autism-specific training. Instructors often feel unprepared and rely on trial and error because they lack formal preparation for ASD-related behavioral and sensory needs (Carter & Koch, 2023; Kraft, 2019). Public pools can also create serious sensory barriers, as echoing acoustics and splashing may trigger sensory overload and meltdowns (Cosart et al., 2025). Parents face additional logistical strain in managing neurotypical siblings during specialized one-to-one lessons, often without access to concurrent childcare (Bekhet et al., 2023; Johnson et al., 2021). Financial, geographic, and systemic inequities, including high costs and long waitlists, further limit access for marginalized communities, making inclusive water safety an urgent issue of occupational justice (Carter & Koch, 2023; Cosart et al., 2025).

Methodological quality and gaps in the literature

Research on aquatic interventions is marked by a tension between individualized clinical observation and the demand for stronger statistical rigor. Much of the foundational literature relies on small convenience samples, single-subject designs, or quasi-experimental pre-post studies without active control groups (Lawson & Little, 2017; Vodakova et al., 2022). Although more recent work reflects a needed shift toward large-scale mixed-methods studies and randomized controlled trials (RCTs) (Alecu & Onea, 2025; Kemp et al., 2024; Marzouki et al., 2022), the independent effects of aquatic therapy often remain difficult to isolate because of confounding factors such as concurrent Applied Behavior Analysis (ABA) or natural maturation (Alecu & Onea, 2025).

Measurement validity also remains contested. Standardized tools such as WOTA and GMFM are important for objective assessment, but they may produce ceiling effects in higher-functioning children or fail to capture small gains in beginners, which has led to the use of modified measures such as the Štochl assessment (Hubená, 2021; Kemp et al., 2024; Vodakova et al., 2022). At the same time, many studies depend on custom parent-report questionnaires to assess broader psychosocial outcomes such as sleep and behavior. Although these measures improve ecological validity, they also introduce expectancy bias and halo effects (Alecu & Onea, 2025).

The literature also shows clear demographic selection bias. Studies often require participants to follow verbal instructions or to have received prior behavioral therapy, which systematically excludes minimally verbal children and those with profound cognitive impairments. Representation is also limited for females, fathers, and non-English-speaking minority families (Alecu & Onea, 2025; Cosart et al., 2025; Kemp et al., 2024).

Implications for practice and policy

To address these gaps and advance occupational justice, the literature offers several practical recommendations for practitioners and policymakers. A key strategy is task-sharing. Rather than fully medicalizing service delivery, healthcare professionals, including occupational therapists, can support community programs by training mainstream instructors or supervising university therapy students as one-to-one “swim buddies,” creating a more scalable and cost-effective model (Carter & Koch, 2023; Kemp et al., 2023). Practice should also adopt a whole-family approach by providing sibling childcare or allowing parents to join sessions in the water, which may reduce child anxiety and strengthen parent confidence (Bekhet et al., 2023; Johnson et al., 2021).

Pedagogical adaptations in the pool are equally important. Instructors should use autism-specific strategies such as predictable routines, visual schedules, and sensory-adapted equipment, including visually engaging swim boards shaped like rockets or animals, to reduce tactile aversion and support participation (Kraft, 2019; Shayakhmetova et al., 2021). At the policy level, the inequities identified by caregivers call for stronger structural support. Recommended reforms include insurance coverage for adapted swimming lessons, integration of water safety goals into Individualized Education Programs (IEPs), and proactive distribution of drowning-prevention resources in pediatric clinics to better protect this vulnerable population (Cosart et al., 2025).

Conclusion

This dual-lens narrative review indicates that aquatic interventions for children with ASD may offer benefits that extend beyond the prevention of accidental drowning. Across the literature, structured aquatic therapy is associated with improvements in gross motor skills, executive functioning, and social-emotional regulation, suggesting its potential value as a multidimensional therapeutic modality. These outcomes may be partly explained by neurophysiological and biological mechanisms, as the sensory

characteristics of water have been linked to reduced hyperarousal, enhanced vagal regulation, and modulation of inflammatory markers such as IL-6 and IL-10, which may, in turn, support sleep quality and social engagement.

At the same time, the review highlights a persistent gap between therapeutic promise and community-based accessibility. Caregivers and instructors consistently identify structural barriers, including the limited availability of autism-informed instructors, sensory demands within public aquatic environments, and financial constraints, all of which restrict equitable participation. Addressing these barriers will require coordinated action at both practice and policy levels. Scalable, family-centered task-sharing approaches, in which healthcare professionals equip mainstream swimming instructors with autism-relevant knowledge and strategies, may represent a feasible pathway for broader implementation. Framed in this way, equitable access to aquatic interventions is not solely a service delivery issue but also a question of occupational justice with important implications for the safety and well-being of children with ASD and their families.

Directions for Future Research

Future research should strengthen the evidence base by moving beyond small-scale exploratory studies toward adequately powered randomized controlled trials that incorporate standardized outcome measures and longitudinal follow-up. Greater consistency in intervention design is also needed to clarify dose-response relationships and identify the conditions under which aquatic therapy is most effective. In addition, further investigation is warranted into the potential synergistic effects of combining aquatic interventions with other behavioral, developmental, or neurobiological supports. Finally, implementation research should be prioritized to examine the scalability, feasibility, and equity of community-based delivery models, with particular attention to demographic and socioeconomic disparities that may shape access across diverse populations.

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Conflict of Interest

The authors report no conflicts of interest related to this study.

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ORIGINAL SCIENTIFIC PAPER

Impact of fitness related content on social media on body image and physical activity among university students

Ladislav Kručanica¹¹Pavol Jozef Šafárik University in Košice, Institute of Physical Education and Sport Slovakia**Abstract**

Introduction. In recent years, considerable attention has been devoted to the influence of social media (SM) on the mental and physical health of various age groups. Despite a growing body of research, the specific effects of fitness-related content on social media remain unclear. **Problem and Aim.** The study aimed to investigate the gender differences and relationship between social media, body image and the intensity of physical activity in university students. **Methods.** A questionnaire survey (Social media use questionnaire, Body appreciation scale – 2, The International Physical Activity Questionnaire) was used to conduct this research. The sample comprised 314 university students from Slovakia (115 males, 198 females). **Results.** 1. Male students who follow more fitness-related accounts on SM have a more positive body image. 2. Female students who follow more fitness-related accounts on SM have a higher level of PA. 3. Female students who claim that SM motivates them to exercise have a higher level of PA. **Conclusion.** Our study aspired to bring insight into university students' body image and exercise behaviour in relation to the use of SM and, in particular, fitness-related content. Despite statistically significant findings, the correlation between the variables was found to be weak, thus we assume that there are also other factors affecting these relationships which should be investigated in the future research.

Keywords: *fitspiration, body perception, physical activity level, social media*

Introduction

Social media (SM) influences numerous aspects of our lives, with significant social, economic, and political impacts on both society and individuals. In past years, much attention has been given to SM's influence on the mental and physical health of different age groups. Often, the content is so influential that young people, in particular, are inspired to begin a new fitness lifestyle, while others may fall into a deep depression because of the unattainable beauty standards promoted on platforms like Instagram, TikTok, and similar sites.

Many academics have researched the influence of SM on body image since its rise to worldwide popularity over the past two decades. Sharp (2022) highlights gender differences and found that females have a more negative body image, are more likely to experience depression when exposed to fitness-related content and compare their bodies to those they view on social media more frequently

than males. Nonetheless, the survey also revealed males who struggle with body image and feel pressured by social media to maintain a particular appearance. Viewing idealised images on social media had a negative impact on females' body image, regardless of the presence disclaimer comments (Fardouly & Holland, 2018). Saiphoo and Vahedi (2019) conducted a meta-analysis to clarify the relationship between social media use and body image. They analysed the results of sixty-three independent samples (N = 36,552) and found a small, positive, and significant relationship between social media use and body image disturbance. Notably Smith et al. (2024) recorded interesting results after testing the effects of a one-week break from social media (SM) on body image and self-esteem in young women. The findings show the short-term benefits of taking a break from SM for one week on self-esteem and body image especially noticeable in females with higher baseline levels of thin-ideal internalization. This

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is in line with the results of Saiphoo and Vahedi (2019), who on the contrary found that increased social media use was associated with higher body image dissatisfaction. Norton's (2017) survey showed that content on social media is influencing people's lifestyles and how they compare themselves to their peers.

In recent years, a concept of fitspiration has been introduced which seems to inspire people to achieve their fitness and body goals, but apparently, it also sets those goals itself (Norton, 2017). Engaging in physical activity (PA) for fitness, health or other purposes based on viewing fitness-related content on social media is undoubtedly positive stimulation. Despite the growing body of research, the ways in which fitspiration might affect individuals remain unclear (Vandenbosch et al., 2022). In a study investigating the impact of athletic and muscular fitness-idealized images on exercise behaviour, participants were not motivated to exercise at higher intensities by fitness-idealized images, indicating that this kind of motivation for fitness may not actually spur exercise behaviour (Robinson et al., 2017). Another study looked at the characteristics of fitspiration on Instagram targeted at men. Males were frequently depicted participating in activities that accentuated their physical appearance but had little bearing on fitness or health (i.e., passive modelling). In line with research examining female-focused fitspiration, male-focused fitspiration reinforces a glamorized appearance while paying little attention to fitness and health (Angrish et al., 2024). In addition, the frequency of viewing fitspiration content in men is not directly linked to their reasons for exercise. Viewing more fitspiration content is associated with greater muscular-ideal internalization and a higher tendency for body comparison. Fitspiration seems to be linked to body image rather than health in females (Fatt et al., 2019). A systematic review by Nuss et al. (2023) focused on the content of social media fitspiration and its effect on physical activity-related behaviour and suggested that fitspiration may affect physical activity behaviour through modelling; however, the included studies showed little evidence that fitspiration has a positive relationship with physical activity. The influence of fitspiration may be restricted in its impact due to perceived unattainability of the idealized body types featured in the posts (Nuss et al., 2023).

Problem and aim

The study aimed to investigate the gender differences and relationship between social media, body image and the intensity of physical activity in university students.

Methods

Based on the aim of our study, we hypothesized:

1. Students who follow more fitness-related accounts on SM have a more positive body image.
2. Students who follow more fitness-related accounts on SM have a higher level of PA.
3. Students who often use SM to compare their bodies with their peers have a more positive body image.
4. Students who claim that SM motivates them to exercise have a higher level of PA.

Sample

Our sample comprised 314 university students from Slovakia (115 males, 198 females) who agreed to participate in the survey. Each participant voluntarily provided informed consent before participating. The students were randomly selected and were involved in the survey based on the requirement of being a university student and having an account on a social media platform with the possibility to share pictures or videos. Student who failed to answer all the questions in the questionnaire were excluded. The Ethics Committee of the Pavol Jozef Šafárik University in Košice (7/2025) approved this study in advance.

Procedures

A questionnaire survey was used to conduct this research. Three questionnaires were merged into a single Google Form to create the final version. Each participant was sent a link to complete the questionnaire. Data collection began in June 2025 and concluded in September 2025. Anticipating some attrition, we initially distributed 400 questionnaires to students, from which we selected 314 properly completed forms. The final questionnaire comprised the following:

Social media use questionnaire

The first non-standardised questionnaire was our own construct. However we were inspired by Norton's questionnaire (2017) who conducted his research on a very similar topic. The first set of questions focused on social media consumption. The remaining questions aimed to measure the level of agreement using a 5-point Lickert scale (from strongly agree to strongly disagree) with a variety of statements. However, to test our hypotheses for this paper, we used only three items: the number of fitness-related accounts followed, "Social media motivates me to exercise," and "I tend to compare my body with others on social media."

Body appreciation scale – 2

The standardised 10-item Body Appreciation Scale-2 (BAS-2) gauges a person's acceptance, positive perceptions, and regard for their own body. This scale is an adaptation of the original 13-item Body Acceptance Scale (BAS) developed in 2005. The overall score is determined by calculating the mean of the ten items, with higher ratings indicating greater body appreciation (Tylka & Wood-Barcalow, 2015).

The International Physical Activity Questionnaire (IPAQ)

The standardised International Physical Activity Questionnaire is a well-researched and extensively used tool that can be used to obtain comparable estimates of physical activity obtaining similar estimates of physical activity across people and nations. If a respondent achieves a HIGH score in the IPAQ for physical activity, their level of physical activity corresponds to at least one hour of moderately intense activity every day. If a respondent scores a MODERATE in the IPAQ, they are probably engaging in physical activity most days that is at least equal to 30 minutes of moderate-intensity exercise. If respondents receive an IPAQ score of LOW, it indicates that they do not satisfy the requirements for either MODERATE or HIGH physical activity.

Statistical analysis

All statistical analyses were conducted using SPSS v.210 separately for males and females. Given the ordinal data type and non-normal distribution of the cardinal variables (tested by the Kolmogorov-Smirnov test), we decided to use nonparametric statistical measures, namely the Spearman correlation. The hypotheses were confirmed/rejected based on the p-value. Statistical significance was set at $\alpha = 0.05$. Effect size was determined according to the value of the correlation coefficient (r) according to:

- $r < 0,10$ – Negligible
- $0,10 \leq r < 0,30$ – Weak association
- $0,30 \leq r < 0,50$ – Medium
- $0,50 \leq r < 0,80$ – Strong
- $0,80 \leq r \leq 1,00$ – Very strong

Results

Regarding the first hypothesis, the statistical analysis showed that the relationship between the number of followed SM accounts with fitness-related content and positive body image was

statistically significant only in males. Based on the positive direction of the correlation, we can state that those males who follow more fitness-related accounts have a more positive body image. However, the effect size of this relationship was weak $r_s = 0,220$.

In females, we did not record a statistically significant relationship between the number of fitness-related accounts followed and positive body image. These findings supported our hypothesis in males. The results are shown in Table 1.

Table 1. Relationship between the number of the followed SM accounts with fitness related content and the positive body image

Variables	Spearman correlation		Sample	
			Males (N = 115)	Females (N = 198)
	r_s	p(1)	rS	p(1)
Number of the followed SM accounts with fitness related content	0,220	0,009*	-0,009	0,452
Positive body image				

Key: r_s - Spearman correlation coefficient, p(1) – statistical significance, *significant at 0.05

Regarding the relationship between the number of followed accounts featuring fitness-related content and the level of physical activity among students, the results of the analysis showed that it is statistically significant only in the group of females. Considering the positive direction of the relationship, it can be concluded that the more accounts with fitness-related content or content about a healthy lifestyle females watch, the higher their level of physical activity. From the view of effect size, the described relationship can be considered weak $r_s = 0.262$. In males, the relationship between the number of followed accounts with fitness-related content and the level of physical activity was not recorded. These findings thus supported our research hypothesis, but only in the group of females. The results are summarized in Table 2.

We tested the hypothesis that students who agree or strongly agree that they use SM to compare their bodies with others have a more positive body image. The data analysis showed that this association is statistically significant only in females. However, the negative direction of correlation suggests that the more females agree that they often compare their bodies on SM with others, the lower their body satisfaction. The finding did not confirm our hypothesis in males or females. Although the statistical significance relation between the variables was recorded in females, the correlation appeared to be in the opposite direction as we hypothesized. However, we found a statistical significance between the tendency to compare appearance on SM and negative body image in females. The results are summarized in Table 3.

Table 2. Relationship between the number of the followed SM accounts with fitness related content and the level of PA

Variables	Spearman correlation		Sample	
			Males (N = 115)	Females (N = 198)
	r_s	p(1)	rS	p(1)
Number of the followed SM accounts with fitness related content	0,138	0,071	0,262	<0,001*
Level of physical activity				

Key: r_s - Spearman correlation coefficient, p(1) – statistical significance, *significant at 0.05

Table 3. Relationship between the tendency to compare body on SM and the body image

Variables	Spearman correlation		Sample	
			Males (N = 115)	Females (N = 198)
	r_s	p(1)	rS	p(1)
Comparing body with others on SM	-0,064	0,249	-0,314	<0,001*
Positive body image				
Comparing body with others on SM	-0,114	0,113	0,241	<0,001*
Negative body image				

Key: r_s - Spearman correlation coefficient, p(1) – statistical significance, *significant at 0.05

Finally, we hypothesized that students who claim (agree or strongly agree) that fitness related content on SM motivates them to exercise perform a physical activity more frequently. The asso-

ciation was confirmed only in females. Given the positive direction of the correlation, we state that the more females that agree that SM motivates them to exercise, the more frequent their phys-

Table 4. Relationship between the motivation to perform PA based on SM fitness content and the level of physical activity

Variables	Spearman correlation		Sample	
			Males (N = 115)	Females (N = 198)
	r_s	p(1)	rS	p(1)
Motivation to perform PA based on fitness-related content on SM	-0,072	0,224	0,246	<0,001*
Level of physical activity				

Key: r_s - Spearman correlation coefficient, p(1) – statistical significance, *significant at 0.05

ical activity. The effect size suggests that this relationship is weak $r_s = 0.246$. A statistical relationship was not recorded in males. The finding confirmed our hypothesis; however, it was only in females. The results are summarized in Table 4.

Discussion

Our first hypothesis assumed that students who follow more fitness-related accounts on SM have a more positive body image. This was confirmed only in males. Even though we cannot determine if there is a relationship between the number of SM accounts females follow and their body perception, there is a body of research suggesting that females are prone to be more vulnerable regarding their body image (Fioravanti et al., 2021; Rodgers & Nowicki, 2024; Papageorgiou et al., 2022). We also hypothesized that the students who agree or strongly agree that they use SM to compare their bodies with others have a more positive body image. We did not confirm this hypothesis in either males or females. However, our findings showed that the more females agree that they compare their bodies on SM with others, the lower their body satisfaction. This corresponds with previous studies (Sherlock & Wagstaff, 2019; Salomon & Brown, 2019) which found a relationship between fitness-related content posted on SM and body perception. Body image appears to be a major concern among adolescent women (Papageorgiou et al., 2022). Comparisons of appearances seem to exacerbate teenage females' anxieties about their looks and influence adolescent girls' efforts to change their appearance and seek validation on social media. These concerns may easily carry over to young women as well since we found a positive association between our students comparing appearance on SM and body image. However, Pedalino and Camerini (2022) argue that being an adolescent female compared to a young woman was associated with worse body appreciation. Despite the lack of evidence that SM can influence negative body image in males Sharp (2022) identified males who struggle with body image and experience social media pressure to maintain a particular appearance. Nevertheless, in terms of gender differences, the above studies support the fact that SM negatively influences mainly females' body image.

Furthermore, we investigated how social media use influences university students' physical activity. We found that the more fitness-related accounts females follow, the higher their physical activity; however, we did not record this in males. Moreover, we did not record a relationship between the tendency to compare one's body with peers on SM and a higher level of physical activity in both groups. This is not in line with the results of Kim (2022) who found that engaging in upward social comparison through fitness postings inspires fitness app users to feel confident about PA and motivated to engage in PA. In turn, they participate more in PA. Our results showed that females with a higher tendency to compare their appearance on SM tend to have lower body satisfaction. Simultaneously, the females with a higher tendency to compare their appearance are not engaged

in a higher level of physical activity. This finding implies that for the females in our sample, there might be a whole set of barriers that prevent them from performing PA even though they are not satisfied with their appearance. We can assume that these barriers have deeper psychological, sociological, and physiological characteristics and this ought to be further investigated in future research.

Fitness related content on SM is a highly profitable business which attracts many influencers with a questionable fitness background. The research on how SM affects physical activity of individuals mostly indicate a negative relationship. However, we found that females, unlike males, who claim that fitness-related content on SM media motivates them to exercise, have indeed a higher level of physical activity. Our results thus do not correspond with Nuss et al. (2024), who carried out a systematic review to look at how fitspirational content affected behaviours linked to physical activity and suggest that there is insufficient evidence that fitspiration influences physical activity. Fitspiration may be restricted in its influence because of the perceived unattainability of the idealized body types featured in the posts. Because the idealized body types represented in the posts are viewed as unachievable, the influence of fitspiration may be restricted. In addition, Bowles et al. (2021) suggest that fitspiration is not related to exercise and is related to poorer body image perceptions among college students. Furthermore, Cataldo et al. (2021) even point at numerous factors related to psychopathological risks that have been associated with the exposure to fitspiration contents, such as exercise addiction, body dissatisfaction; appearance-related anxiety and depressive symptoms, self-esteem; excessive control of eating habits; use of enhancing drugs; and quality of life.

Conclusion

Our study aspired to bring insight into university students' body image and exercise behaviour in relation to the use of SM and, in particular, fitness-related content. We found: (1) Male students who follow more fitness-related accounts on SM have a more positive body image; (2) Female students who follow more fitness-related accounts on SM have a higher level of PA; (3) Female students who claim that SM motivates them to exercise have a higher level of PA. Since the correlation between the variables was found to be weak we have to conclude that there also other factors affecting these relationships.

Currently, SM and online space play a vital role in self-educating and influencing young people in particular. Thus, besides conducting further research on different behavioural patterns of the young on SM, we should also focus on searching for online tools and strategies to motivate to perform physical activity and stimulate positive body image. One of the solutions may be developing SM channels by universities and their departments of sports, which would bring attractive yet evidence-based fitness and healthy lifestyle content or at least recommend suitable fitness channels to their students.

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The editors of JASPE consider plagiarism to be a serious breach of academic ethics. Any author who practices plagiarism (in part or totality) will be suspended for six years from submitting new submissions to JASPE. If such a manuscript is approved and published, public exposure of the article with a printed mark (“plagiarized” or “retracted”) on each page of the published file, as well as suspension for future publication for at least six years, or a period determined by the editorial board. Third party plagiarized authors or institutions will be notified, informing them about the faulty authors. Plagiarism will result in immediate rejection of the manuscript.

JASPE only publishes studies that have been approved by an institutional ethics committee (when a study involves humans or animals). Fail to provide such information prevent its publication. To ensure these requirements, it is essential that submission documentation is complete. If you have not completed this step yet, go to JASPE website and fill out the two required documents: Declaration of Potential Conflict of Interest and Authorship Statement. Whether or not your study uses humans or animals, these documents must be completed and signed by all authors and attached as supplementary files in the originally submitted manuscript.

1.6. After Acceptance

After the manuscript has been accepted, authors will receive a PDF version of the manuscripts for authorization, as it should look in printed version of JASPE. Authors should carefully check for omissions. Reporting errors after this point will not be possible and the Editorial Board will not be eligible for them.

Should there be any errors, authors should report them to the Office e-mail address jaspe@ucg.ac.me. If there are not any errors authors should also write a short e-mail stating that they agree with the received version.

1.7. Code of Conduct Ethics Committee of Publications



JASPE is hosting the Code of Conduct Ethics Committee of Publications of the **COPE** (the Committee on Publication Ethics), which provides a forum for publishers and Editors of scientific journals to discuss issues relating to the integrity of the work submitted to or published in their journals.

2. MANUSCRIPT STRUCTURE

2.1. Title Page

The first page of the manuscripts should be the title page, containing: title, type of publication, running head, authors, affiliations, corresponding author, and manuscript information. *See example:*

Analysis of Dietary Intake and Body Composition of Female Athletes over a Competitive Season

Original Scientific Paper

Diet and Body Composition of Female Athletes

Svetlana Nepocatyč¹, Gytis Balilionis¹, Eric K. O'Neal²

¹Elon University, Department of Exercise Science¹, Elon, NC 27215

²University of North Alabama, Department of Health, Physical Education and Recreation, Florence, AL 35632

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2525 CB

Elon, NC 27244

United States

E-mail: snepocatyč@elon.edu

Word count: 2,946

Word count: 4259

Abstract word count: 211

Number of Tables: 3

2.1.1. Title

Title should be short and informative and the recommended length is no more than 20 words. The title should be in Title Case, written in uppercase and lowercase letters (initial uppercase for all words except articles, conjunctions, short prepositions no longer than four letters etc.) so that first letters of the words in the title are capitalized. Exceptions are words like: “and”, “or”, “between” etc. The word following a colon (:) or a hyphen (-) in the title is always capitalized.

2.1.2. Type of publication

Authors should suggest the type of their submission.

2.1.3. Running head

Short running title should not exceed 50 characters including spaces.

2.1.4. Authors

The form of an author's name is first name, middle initial(s), and last name. In one line list all authors with full names separated by a comma (and space). Avoid any abbreviations of academic or professional titles. If authors belong to different institutions, following a family name of the author there should be a number in superscript designating affiliation.

2.1.5. Affiliations

Affiliation consists of the name of an institution, department, city, country/territory (in this order) to which the author(s) belong and to which the presented / submitted work should be attributed. List all affiliations (each in a separate line) in the order corresponding to the list of authors. Affiliations must be written in English, so carefully check the official English translation of the names of institutions and departments.

Only if there is more than one affiliation, should a number be given to each affiliation in order of appearance. This number should be written in superscript at the beginning of the line, separated from corresponding affiliation with a space. This number should also be put after corresponding name of the author, in superscript with no space in between.

If an author belongs to more than one institution, all corresponding superscript digits, separated with a comma with no space in between, should be present behind the family name of this author.

In case all authors belong to the same institution affiliation numbering is not needed.

Whenever possible expand your authors' affiliations with departments, or some other, specific and lower levels of organization.

2.1.6. Corresponding author

Corresponding author's name with full postal address in English and e-mail address should appear, after the affiliations. It is preferred that submitted address is institutional and not private. Corresponding author's name should include only initials of the first and middle names separated by a full stop (and a space) and the last name. Postal address should be written in the following line in sentence case. Parts of the address should be separated by a comma instead of a line break. E-mail (if possible) should be placed in the line following the postal address. Author should clearly state whether or not the e-mail should be published.

2.1.7. Manuscript information

All authors are required to provide word count (excluding title page, abstract, tables/figures, figure legends, Acknowledgements, Conflict of Interest, and References), the Abstract word count, the number of Tables, and the number of Figures.

2.2. Abstract

The second page of the manuscripts should be the abstract and key words. It should be placed on second page of the manuscripts after the standard title written in upper and lower case letters, bold.

Since abstract is independent part of your paper, all abbreviations used in the abstract should also be explained in it. If an abbreviation is used, the term should always be first written in full with the abbreviation in parentheses immediately after it. Abstract should not have any special headings (e.g., Aim, Results...).

Authors should provide up to six key words that capture the main topics of the article. Terms from the Medical Subject Headings (MeSH) list of Index Medicus are recommended to be used.

Key words should be placed on the second page of the manuscript right below the abstract, written in italic. Separate each key word by a comma (and a space). Do not put a full stop after the last key word. *See example:*

Abstract

Results of the analysis of

Key words: *spatial memory, blind, transfer of learning, feedback*

2.3. Main Chapters

Starting from the third page of the manuscripts, it should be the main chapters. Depending on the type of publication main manuscript chapters may vary. The general outline is: Introduction, Methods, Results, Discussion, Acknowledgements (optional), Conflict of Interest (optional), and Title, Author's Affiliations, Abstract and Key words must be in English (for both each chosen language of full paper). However, this scheme may not be suitable for reviews or publications from some areas and authors should then adjust their chapters accordingly but use the general outline as much as possible.

2.3.1. Headings

Main chapter headings: written in bold and in Title Case. *See example:*

✓ **Methods**

Sub-headings: written in italic and in normal sentence case. Do not put a full stop or any other sign at the end of the title. Do not create more than one level of sub-heading. *See example:*

✓ *Table position of the research football team*

2.3.2 Ethics

When reporting experiments on human subjects, there must be a declaration of Ethics compliance. Inclusion of a statement such as follow in Methods section will be understood by the Editor as authors' affirmation of compliance: "This study was approved in advance by [name of committee and/or its institutional sponsor]. Each participant voluntarily provided written informed consent before participating." Authors that fail to submit an Ethics statement will be asked to resubmit the manuscripts, which may delay publication.

2.3.3 Statistics reporting

JASPE encourages authors to report precise p-values. When possible, quantify findings and present them with appropriate indicators of measurement error or uncertainty (such as confidence intervals). Use normal text (i.e., non-capitalized, non-italic) for statistical term "p".

2.3.4. 'Acknowledgements' and 'Conflict of Interest' (optional)

All contributors who do not meet the criteria for authorship should be listed in the 'Acknowledgements' section. If applicable, in 'Conflict of Interest' section, authors must clearly disclose any grants, financial or material supports, or any sort of technical assistances from an institution, organization, group or an individual that might be perceived as leading to a conflict of interest.

2.4. References

References should be placed on a new page after the standard title written in upper and lower case letters, bold.

All information needed for each type of must be present as specified in guidelines. Authors are solely responsible for accuracy of each reference. Use authoritative source for information such as Web of Science, Medline, or PubMed to check the validity of citations.

2.4.1. References style

JASPE adheres to the American Psychological Association 6th Edition reference style. Check "American Psychological Association. (2009). Concise rules of APA style. American Psychological Association." to ensure the manuscripts conform to this reference style. Authors using EndNote® to organize the references must convert the citations and bibliography to plain text before submission.

2.4.2. Examples for Reference citations

One work by one author

- ✓ In one study (Reilly, 1997), soccer players
- ✓ In the study by Reilly (1997), soccer players
- ✓ In 1997, Reilly's study of soccer players

Works by two authors

- ✓ Duffield and Marino (2007) studied
- ✓ In one study (Duffield & Marino, 2007), soccer players
- ✓ In 2007, Duffield and Marino's study of soccer players

Works by three to five authors: cite all the author names the first time the reference occurs and then subsequently include only the first author followed by et al.

- ✓ First citation: Bangsbo, Iaia, and Krstrup (2008) stated that
- ✓ Subsequent citation: Bangsbo et al. (2008) stated that

Works by six or more authors: cite only the name of the first author followed by et al. and the year

- ✓ Krstrup et al. (2003) studied
- ✓ In one study (Krstrup et al., 2003), soccer players

Two or more works in the same parenthetical citation: Citation of two or more works in the same parentheses should be listed in the order they appear in the reference list (i.e., alphabetically, then chronologically)

- ✓ Several studies (Bangsbo et al., 2008; Duffield & Marino, 2007; Reilly, 1997) suggest that

2.4.3. Examples for Reference list

Journal article (print):

Nepocatyč, S., Balilionis, G., & O'Neal, E. K. (2017). Analysis of dietary intake and body composition of female athletes over a competitive season. *Montenegrin Journal of Sports Science and Medicine*, 6(2), 57-65. doi: 10.26773/mjssm.2017.09.008

Duffield, R., & Marino, F. E. (2007). Effects of pre-cooling procedures on intermittent-sprint exercise performance in warm conditions. *European Journal of Applied Physiology*, 100(6), 727-735. doi: 10.1007/s00421-007-0468-x

Krstrup, P., Mohr, M., Amstrup, T., Rysgaard, T., Johansen, J., Steensberg, A., Bangsbo, J. (2003). The yo-yo intermittent recovery test: physiological response, reliability, and validity. *Medicine and Science in Sports and Exercise*, 35(4), 697-705. doi: 10.1249/01.MSS.0000058441.94520.32

Journal article (online; electronic version of print source):

Williams, R. (2016). Krishna's Neglected Responsibilities: Religious devotion and social critique in eighteenth-century North India [Electronic version]. *Modern Asian Studies*, 50(5), 1403-1440. doi:10.1017/S0026749X14000444

Journal article (online; electronic only):

Chantavanich, S. (2003, October). Recent research on human trafficking. *Kyoto Review of Southeast Asia*, 4. Retrieved November 15, 2005, from <http://kyotoreview.cseas.kyoto-u.ac.jp/issue/issue3/index.html>

Conference paper:

Pasadilla, G. O., & Milo, M. (2005, June 27). *Effect of liberalization on banking competition*. Paper presented at the conference on Policies to Strengthen Productivity in the Philippines, Manila, Philippines. Retrieved August 23, 2006, from <http://siteresources.worldbank.org/INTPHILIPPINES/Resources/Pasadilla.pdf>

Encyclopedia entry (print, with author):

Pittau, J. (1983). Meiji constitution. In *Kodansha encyclopedia of Japan* (Vol. 2, pp. 1-3). Tokyo: Kodansha.

Encyclopedia entry (online, no author):

Ethnology. (2005, July). In *The Columbia encyclopedia* (6th ed.). New York: Columbia University Press. Retrieved November 21, 2005, from <http://www.bartleby.com/65/et/ethnolog.html>

Thesis and dissertation:

Pyun, D. Y. (2006). *The proposed model of attitude toward advertising through sport*. Unpublished Doctoral Dissertation. Tallahassee, FL: The Florida State University.

Book:

Borg, G. (1998). *Borg's perceived exertion and pain scales*: Human kinetics.

Chapter of a book:

Kellmann, M. (2012). Chapter 31-Overtraining and recovery: Chapter taken from Routledge Handbook of Applied Sport Psychology ISBN: 978-0-203-85104-3 *Routledge Online Studies on the Olympic and Paralympic Games* (Vol. 1, pp. 292-302).

Reference to an internet source:

Agency. (2007). Water for Health: Hydration Best Practice Toolkit for Hospitals and Healthcare. Retrieved 10/29, 2013, from www.rcn.org.uk/newsevents/hydration

2.5. Tables

All tables should be included in the main manuscript file, each on a separate page right after the Reference section.

Tables should be presented as standard MS Word tables.

Number (Arabic) tables consecutively in the order of their first citation in the text.

Tables and table headings should be completely intelligible without reference to the text. Give each column a short or abbreviated heading. Authors should place explanatory matter in footnotes, not in the heading. All abbreviations appearing in a table and not considered standard must be explained in a footnote of that table. Avoid any shading or coloring in your tables and be sure that each table is cited in the text.

If you use data from another published or unpublished source, it is the authors' responsibility to obtain permission and acknowledge them fully.

2.5.1. Table heading

Table heading should be written above the table, in Title Case, and without a full stop at the end of the heading. Do not use suffix letters (e.g., Table 1a, 1b, 1c); instead, combine the related tables. *See* example:

✓ **Table 1.** Repeated Sprint Time Following Ingestion of Carbohydrate-Electrolyte Beverage

2.5.2. Table sub-heading

All text appearing in tables should be written beginning only with first letter of the first word in all capitals, i.e., all words for variable names, column headings etc. in tables should start with the first letter in all capitals. Avoid any formatting (e.g., bold, italic, underline) in tables.

2.5.3. Table footnotes

Table footnotes should be written below the table.

General notes explain, qualify or provide information about the table as a whole. Put explanations of abbreviations, symbols, etc. here. General notes are designated by the word *Note* (italicized) followed by a period.

✓ *Note.* CI: confidence interval; Con: control group; CE: carbohydrate-electrolyte group.

Specific notes explain, qualify or provide information about a particular column, row, or individual entry. To indicate specific notes, use superscript lowercase letters (e.g. ^{a,b,c}), and order the superscripts from left to right, top to bottom. Each table's first footnote must be the superscript ^a.

✓ ^aOne participant was diagnosed with heat illness and n = 19.^bn = 20.

Probability notes provide the reader with the results of the tests for statistical significance. Probability notes must be indicated with consecutive use of the following symbols: * † ‡ § ¶ || etc.

✓ *P<0.05, †p<0.01.

2.5.4. Table citation

In the text, tables should be cited as full words. *See* example:

- ✓ Table 1 (first letter in all capitals and no full stop)
- ✓ ...as shown in Tables 1 and 3. (citing more tables at once)
- ✓ ...result has shown (Tables 1-3) that... (citing more tables at once)
- ✓ ...in our results (Tables 1, 2 and 5)... (citing more tables at once)

2.6. Figures

On the last separate page of the main manuscript file, authors should place the legends of all the figures submitted separately.

All graphic materials should be of sufficient quality for print with a minimum resolution of 600 dpi. JASPE prefers TIFF, EPS and PNG formats.

If a figure has been published previously, acknowledge the original source and submit a written permission from the copyright holder to reproduce the material. Permission is required irrespective of authorship or publisher except for documents in the public domain. If photographs of people are used, either the subjects must not be identifiable or their pictures must be accompanied by written permission to use the photograph whenever possible permission for publication should be obtained.

Figures and figure legends should be completely intelligible without reference to the text.

The price of printing in color is 50 EUR per page as printed in an issue of JASPE.

2.6.1. Figure legends

Figures should not contain footnotes. All information, including explanations of abbreviations must be present in figure legends. Figure legends should be written below the figure, in sentence case. *See* example:

- ✓ **Figure 1.** Changes in accuracy of instep football kick measured before and after fatigued. SR – resting state, SF – state of fatigue, * $p > 0.01$, † $p > 0.05$.

2.6.2. Figure citation

All graphic materials should be referred to as Figures in the text. Figures are cited in the text as full words. *See* example:

- ✓ Figure 1
 - × figure 1
 - × Figure 1.
 - ✓ ...exhibit greater variance than the year before (Figure 2). Therefore...
 - ✓ ...as shown in Figures 1 and 3. (citing more figures at once)
 - ✓ ...result has shown (Figures 1-3) that... (citing more figures at once)
 - ✓ ...in our results (Figures 1, 2 and 5)... (citing more figures at once)

2.6.3. Sub-figures

If there is a figure divided in several sub-figures, each sub-figure should be marked with a small letter, starting with a, b, c etc. The letter should be marked for each subfigure in a logical and consistent way. *See* example:

- ✓ Figure 1a
- ✓ ...in Figures 1a and b we can...
- ✓ ...data represent (Figures 1a-d)...

2.7. Scientific Terminology

All units of measures should conform to the International System of Units (SI).

Measurements of length, height, weight, and volume should be reported in metric units (meter, kilogram, or liter) or their decimal multiples.

Decimal places in English language are separated with a full stop and not with a comma. Thousands are separated with a comma.

Percentage	Degrees	All other units of measure	Ratios	Decimal numbers
✓ 10%	✓ 10°	✓ 10 kg	✓ 12:2	✓ 0.056
× 10 %	× 10 °	× 10kg	× 12 : 2	× .056

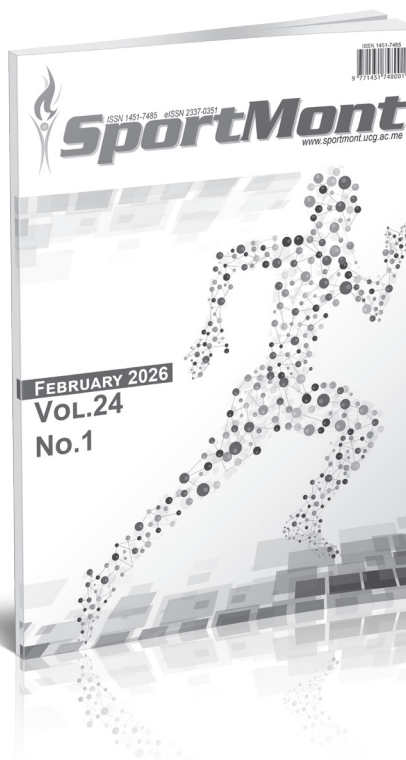
Signs should be placed immediately preceding the relevant number.

✓ 45±3.4	✓ p<0.01	✓ males >30 years of age
× 45 ± 3.4	× p < 0.01	× males > 30 years of age

2.8. Latin Names

Latin names of species, families etc. should be written in italics (even in titles). If you mention Latin names in your abstract they should be written in non-italic since the rest of the text in abstract is in italic. The first time the name of a species appears in the text both genus and species must be present; later on in the text it is possible to use genus abbreviations. See example:

✓ First time appearing: *musculus biceps brachii*
Abbreviated: *m. biceps brachii*



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MONTENEGRIN SPORTS ACADEMY

Founded in 2003 in Podgorica (Montenegro), the Montenegrin Sports Academy (MSA) is a sports scientific society dedicated to the collection, generation and dissemination of scientific knowledge at the Montenegrin level and beyond.

The Montenegrin Sports Academy (MSA) is the leading association of sports scientists at the Montenegrin level, which maintains extensive co-operation with the corresponding associations from abroad. The purpose of the MSA is the promotion of science and research, with special attention to sports science across Montenegro and beyond. Its topics include motivation, attitudes, values and responses, adaptation, performance and health aspects of people engaged in physical activity and the relation of physical activity and lifestyle to health, prevention and aging. These topics are investigated on an interdisciplinary basis and they bring together scientists from all areas of sports science, such as adapted physical activity, biochemistry, biomechanics, chronic disease and exercise, coaching and performance, doping, education, engineering

and technology, environmental physiology, ethics, exercise and health, exercise, lifestyle and fitness, gender in sports, growth and development, human performance and aging, management and sports law, molecular biology and genetics, motor control and learning, muscle mechanics and neuromuscular control, muscle metabolism and hemodynamics, nutrition and exercise, overtraining, physiology, physiotherapy, rehabilitation, sports history, sports medicine, sports pedagogy, sports philosophy, sports psychology, sports sociology, training and testing.

The MSA is a non-profit organization. It supports Montenegrin institutions, such as the Ministry of Education and Sports, the Ministry of Science and the Montenegrin Olympic Committee, by offering scientific advice and assistance for carrying out coordinated national and European research projects defined by these bodies. In addition, the MSA serves as the most important Montenegrin and regional network of sports scientists from all relevant subdisciplines.

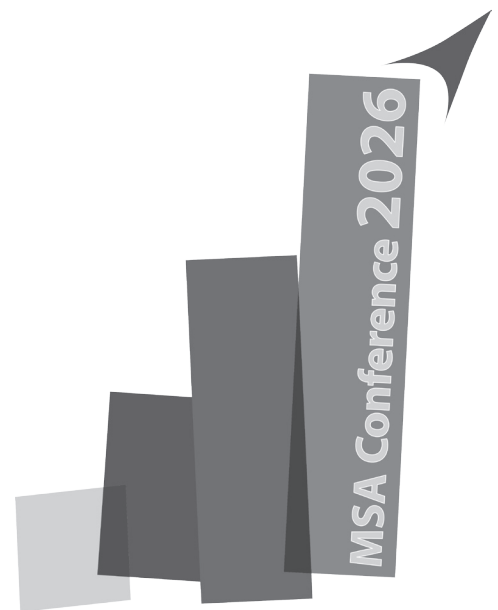
The main scientific event organized by the Montenegrin Sports Academy (MSA) is the annual conference held in the first week of April.

Annual conferences have been organized since the inauguration of the MSA in 2003. Today the MSA conference ranks among the leading sports scientific congresses in the Western Balkans. The conference comprises a range of invited lecturers, oral and poster presentations from multi- and mono-disciplinary areas, as well as various types of workshops. The MSA conference is attended by national, regional and international sports scientists with academic careers. The MSA conference now welcomes up to 200 participants from all over the world.

It is our great pleasure to announce the upcoming 25th International Conference of Montenegrin Sports Academy "Sports Science, Medicine & Health - Innovations, Achievements, Synergy and Challenges A Bridge to the Future of Excellence in Sports" to be held in Podgorica, Montenegro, from 24 to 26 September, 2026. It is planned to be once again organized by the Montenegrin Sports Academy, in cooperation with the Faculty of Sport and Physical Education, University of Montenegro and other international partner institutions (specified in the partner section).

The conference is focused on very current topics from all areas of sports science and sports medicine including physiology and sports medicine, social sciences and humanities, biomechanics and neuromuscular (see Abstract Submission page for more information).

We do believe that the topics offered to our conference participants will serve as a useful forum for the presentation of the latest research, as well as both for the theoretical and applied insight into the field of sports science and sports medicine disciplines.





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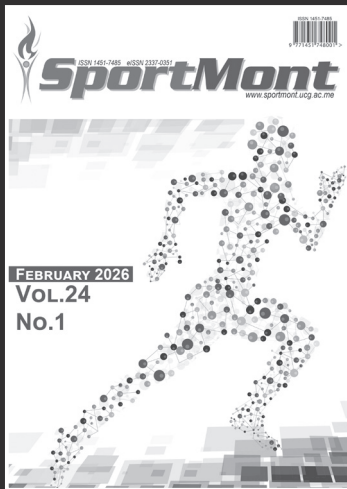
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