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Research article

INFLUENCE OF BODY COMPOSITION ON BASIC MOTOR ABILITIES IN HANDBALL PLAYERS

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Abstract. *The aim of this study was to investigate the influence of body composition on motor abilities in handball players. The sample involved 16 male handball players aged 15-20. Body composition variables included body mass (BM), the body mass index (BMI), percentage of body fat (PBF) and percentage of muscle mass (PMM). For speed assessment, the 20m sprint test was used. The T-test, Slalom test and Zig-Zag test were used to estimate agility, while the squat jump (SJ), counter movement jump (CMJ) and counter movement jump with arm swing (CMJa) were used to assess the muscle strength of the lower limbs. Linear regression analysis was used to determine the influence of body composition variables on basic motor abilities. Negative, statistically significant correlations were observed between BMI, PBF, sprint speed and agility ($r = 0,52 – 0,66$, $R^2 = 0,27 - 0,44$, $p < 0,05$). Muscle mass contributed to better performance on speed and agility tests ($-0,55 < r < -0,67$, $R^2 = 0,31 - 0,45$, $p < 0,05$). There were no significant relationships between BM and motor abilities, as well as between the muscle strength and body composition variables. These findings indicate that obesity contributes to slower linear and multidirectional movement, while muscle mass makes handball players faster. More research is needed in order to determine the influence of body composition on muscle strength, and the influence of body mass on specific handball movements.*

Key words: *morphological characteristics, strength, speed, agility*

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1. INTRODUCTION

The game of handball, which has evolved from its first appearance at the Olympics in 1972 (Saavedra et al., 2018), became one of the most popular team sports on the planet (Sporiš, Vuleta, Vuleta Jr & Milanović, 2010). It represents a dynamic sport, which takes place through different tactical actions (Sporiš et al., 2010). Those tactical actions define handball as a complex ballgame, characterized by a high level of basic motor abilities such as strength, speed, agility and endurance (Mohamed et al., 2009). Furthermore, it is recognized by various defensive movements, and fast transition actions, which are carried out in order to score goals (Schwesig et al., 2016). For adequate positioning and the realization of tactics, players perform short, high intensity movements, both linear and with changes of direction (Karcher & Buchheit, 2014).

By observing and analyzing the above-mentioned competitive situations and movements, the anthropometric profile necessary for achieving elite level in handball has been defined (Katić, Čavala & Srhoj, 2007). However, the influence of body composition on motor abilities in handball players is not yet clearly established due to differences in the players' age, gender and competitive level, which make it difficult to generalize the results of previous research. Nikolaidis and Ingebrigsten (2013) studied the influence of body composition on motor abilities in male handball players of different age, where it was noted that the BMI has a negative influence on muscle strength and anaerobic abilities. The results of other studies support that claim, where higher values of the BMI were brought into connection with poor motor abilities in a sample of male handball players aged 12 to 18 (Molina-López et al., 2020; Visnapuu & Jürimäe, 2009). Similar results can be found when the effect of body fat on motor abilities was studied. Namely, Hammami (2018) found that a higher percentage of body fat contributes to slower changes of direction. The percentage of body fat has the same impact on muscle strength and aerobic endurance in young male and female players (Dellagrana et al., 2010). In a recent study, Molina-López (2020) also reported a negative influence of body fat on aerobic endurance.

Contrary to the consistency of the aforementioned results, the evidence varies when it comes to the effect of body mass on basic motor abilities in handball. Regardless of the numerous studies that confirm that the influence of body mass on motor abilities is statistically significant (Hammami et al., 2019; Marangoz & Var, 2018; Moncef, Said, Olfa & Dagbaji 2012; Moss, McWhannell, Michalsik & Twist, 2015; Saavedra et al., 2018) some studies reported contrary findings. Ciplak (2019) reported a non-significant relationship between body mass and muscle strength of the upper and lower limbs. In addition, non-significant relationships were noted in a study where the correlation between body mass, muscle strength and agility was investigated (Molina-López et al., 2020). The findings of the study, which examined the influence of body composition on the specific movements of handball players, also indicate that body mass does not significantly affect the velocity of the jump shot (Schwesig et al., 2016).

As Ziv and Lidor (2009) pointed out, experts involved in the training process, such as handball coaches, strength and conditioning coaches and physiotherapists, need to have insight into the physical and physiological aspects of the game in order to use practically applicable information when creating short-term and long-term training programs. Due to the diversity and variety of existing data, the generalization of the obtained results is not possible. Moreover, giving concrete guidelines for practical work becomes unachievable.

Therefore, the aim of this study was to determine the influence of body composition on basic motor abilities in adolescent male handball players.

2. METHODS

2.1. Participants

The sample consisted of 16 male handball players who voluntarily participated in this study. Players were aged from 15 to 20, with an average career length of 5.9 years. The mean values of the measured variables were: body height: 181.2 ± 7 cm; body mass: 83.5 ± 14 kg; body mass index: 25.5 ± 3.9 kg/m^2; percent of body fat: 17.8 ± 6.9%; percent of muscle mass: 40.6 ± 3.8%.

The benefits, risks and procedures involved in participation were explained to all players prior to testing. All players provided consent for participation in this study which was carried out in accordance with the Declaration of Helsinki. Permission was obtained from the handball club and parents/guardians as well, given that some participants were minors at the time when the study was conducted.

2.2. Measures

The examined variables in this research referred to the body composition and basic motor abilities of handball players. The sample of body composition variables and anthropometric characteristics were body height (BH), body mass (BM), the body mass index (BMI), percentage of body fat (PBF), and percentage of muscle mass (PMM). The motor abilities, tested in this study, included sprint speed, agility and muscle strength of the lower limbs.

2.3. Procedures

Body composition measurement

A cross-sectional study design was adopted where the players attended one testing session. Primarily, the players were instructed to maintain consistent dietary and sleeping patterns, to avoid alcohol consumption for 24 hours before testing and to consume adequate water prior to arrival. Measurements of body height were carried out with an anthropometer to the nearest 0.1 cm (anthropometer according to Martin). Body composition parameters were collected using an electronic scale (HBF-511B-E; Omron Healthcare) to the nearest 0.1 kg, while the participants were barefoot, wearing the clothes in which they practice (Đurašković, 2001).

Sprint testing

The 20m linear sprint has previously been used to measure linear speed in handball players (Ellis et al., 2000; Živković et al., 2019). The 20m linear sprint test involved players running with maximal effort in a straight line. Each player had one regular attempt, and for each trial, electronic timing gates (Witty, System, Microgate, Bolzano, Italy) were positioned on the start line, 5m from the start line, 10m from the start line and on the finish line. The photocell system was set at a height corresponding to the hip joint of the players, to ensure that only one segment of the body passes through the set gates (Yeadon, Kato & Kerwin, 1999). Players occupied a standing start position and were able to choose their preferred lead leg, which was positioned 50cm away from the starting line. Testing was conducted in an indoor stadium on a hardwood, non-slipping surface.

Agility testing

For the agility assessment, three tests were used: the T-test, Zig-Zag test and Slalom test (Mackenzie, 2005; Sporiš et al., 2010; Živković et al., 2019). Participants had one regular attempt, and for each trial, electronic timing gates (Witty, System, Microgate, Bolzano, Italy) were positioned on the start line and the finish line. The electronic timing gates were set according to the recommendations in previous research (Yeadon et al., 1999). Testing was conducted in an indoor stadium on a hardwood, non-slipping surface.

Muscle strength testing

Additionally, the muscle strength of the lower limbs was assessed with three different procedures. Each test is intended to assess the height of the vertical jump (Bosco, Luhtanen, & Komi, 1983). The tests used were: the squat jump (SJ), counter movement jump (CMJ), and counter movement jump with arm swing (CMJa). Participants had 3 regular attempts on each test, with a 30-second rest period between attempts, and 5-minute rest periods between the tests. The values of the highest jump were taken for statistical analysis. The measurement was conducted on the flat surface, using a system of photocells (Optojump, Microgate, Bolzano, Italy), which have shown exceptional validity and reliability when testing vertical jumps (Glatthorn et al., 2011).

2.4. Statistical analysis

All statistical analyses were performed in SPSS 20.0 (IBM Corporation). The results are presented as Mean ± SD. The normality of the data was confirmed by the Kolmogorov-Smirnov test. Simple linear regression was used to determine the relationship (r) and shared variance (R^2) between the body composition and basic motor abilities. All p-values less than 0.05 were considered significant for a 95% level of probability.

3. RESULTS

The basic descriptive statistics of the sample (n = 16) are presented in Table 1.

Table 1 The mean ± standard deviation values for a handball player's descriptive parameters and body composition parameters (n = 16).

Parameters	Mean ± SD
Age (years)	17.38 ± 1.26
Career length (years)	5.88 ± 1.86
Body height (cm)	181.16 ± 7.04
Body mass (kg)	83.53 ± 14.05
Body mass index (kg/m^2)	25.50 ± 3.87
Percent of body fat (%)	17.84 ± 6.92
Percent of muscle mass (%)	40.58 ± 3.85

For all outcome measures obtained, the mean value and standard deviation were calculated. The results are presented in Table 2.

Table 2 Outcome measures of male handball players (n = 16), presented as mean ± standard deviation.

Outcome measure	Mean ± SD
Sprint speed	
5m sprint (sec)	1.13 ± 0.09
10m sprint (sec)	1.87 ± 0.12
20m sprint (sec)	3.20 ± 0.17
Agility	
T-test (sec)	10.26 ± 0.75
Zig-Zag test (sec)	6.59 ± 0.42
Slalom test (sec)	8.06 ± 0.58
Muscle strength	
Squat jump (cm)	31.16 ± 3.95
Counter movement jump (cm)	33.99 ± 4.27
Counter movement jump with arm swing (cm)	41.31 ± 5.48

The correlations and shared variances between the body composition and motor abilities of handball players are presented in Table 3. The body mass index positively correlated with the time achieved on sprint and agility tests (r = 0.52 – 0.61, R^2 = 0.27 – 0.37, $p < 0.05$). Further, a significant correlation was established between the percent of body fat and scores obtained on sprint and agility tests (r = 0.52 – 0.66, R^2 = 0.27 – 0.44, $p < 0.05$). The percent of muscle mass contributed to lower values on sprint and agility tests, where the coefficient of determination ranged from 0.31 to 0.45 ($0.001 < p < 0.05$). No significant relationships were established between body mass and motor abilities. Moreover, a non-significant relationship was found between the body composition variables and muscle strength ($p > 0.05$).

Table 3 The relationships and the influence of the body composition on basic motor abilities in adolescent male handball players (n = 16).

		Speed			Agility			Muscle strength		
		Sprint 5m (s)	Sprint 10m (s)	Sprint 20m (s)	T test (s)	Zig-Zag test (s)	Slalom test (s)	SJ (cm)	CMJ (cm)	CMJa (cm)
BM	r	.443	.374	.436	.345	.304	.422	-.203	-.098	-.188
	R^2	.196	.139	.190	.119	.092	.178	.041	.009	.013
	p	.086	.153	.092	.191	.253	.104	.454	.718	.487
BMI	r	.591	.523	.611	.542	.547	.531	-.308	-.195	-.348
	R^2	.349	.273	.373	.293	.299	.281	.094	.038	.121
	p	**.016**	**.038**	**.012**	**.030**	**.028**	**.034**	.246	.468	.186
PBF	r	.627	.594	.660	.544	.519	.543	-.317	-.209	-.394
	R^2	.393	.352	.435	.295	.269	.294	.100	.043	.155
	p	**.009**	**.015**	**.005**	**.029**	**.039**	**.030**	.231	.437	.131
PMM	r	-.645	-.590	-.668	-.572	-.554	-.609	.420	.284	.464
	R^2	.416	.348	.446	.327	.306	.370	.176	.080	.215
	p	**.007**	**.016**	**.005**	**.021**	**.026**	**.012**	.106	.289	.070

BM – body mass; BMI – body mass index; PBF – percent of body fat; PMM – percent of muscle mass; SJ – squat jump; CMJ – counter movement jump; CMJa – counter movement jump with arm swing

4. DISCUSSION

This study aimed to assess the influence of the body composition on basic motor abilities in junior male handball players. The body mass index and the percent of body fat positively correlated with the time achieved on the speed and agility test, indicating that the influence of the mentioned variables is negative. The percent of muscle mass contributed to the better performance on the tests of linear and changes of direction speed. A non-significant relationship was found between body mass and motor abilities. Contrary to our expectations, body composition did not affect muscle strength.

Numerous studies have investigated the impact of body composition on physical performance in handball (Ciplak et al., 2019; Dellagrana et al., 2010; Hammami et al., 2018, Hammami et al., 2019; Kale & Akdoğan, 2020; Molina-López et al., 2020; Moss et al., 2015; Visnapuu & Jürimäe, 2009). The results of previous research indicate the negative impact of BMI and PBF on the movement velocity of handball players (Ciplak et al., 2019; Molina-López et al., 2020; Moss et al., 2015; Sporiš et al., 2010). Sporiš (2010) found a negative influence of PBF on sprint speed in professional players (r = -0.68, R^2 = 0.46, p < 0.01). Similar results can be found in the study of Ciplak (2019), where young female players with higher values of PBF were reported to move slower (R^2 = 0.28). In addition, more evidence can be found in the literature which confirms that body fat contributes to poorer results on the speed tests. In a recent study (Molina-López et al., 2020) the correlation between body fat and time scores on the sprint test was as high as 0.71. Further, it was reported that BMI negatively affected sprint speed (r = 0.41, R^2 = 0.17, p < 0.001) (Molina-López et al., 2020). The results of a study conducted on a sample of 120 female players of similar age support the mentioned data, with a positive relationship between the skin folds and the time score on the sprint test (Moss et al., 2015).

When it comes to the influence of body composition on the changes of direction of handball players, the results obtained by Hammami (2018, 2019) concur with those of this research. A positive correlation was found between PBF and the time achieved on the agility tests (r = 0.44, p = 0.04) (Hammami et al., 2018). Moreover, a negative relationship (r = -0.47, p < 0.001) between BM, BMI and agility was reported for a sample of male handball players aged 13 to 18 (Hammami et al., 2019). On the contrary, it was indicated that body mass had no significant influence on agility in senior handball players (Hammami et al., 2018). Nevertheless, sprint speed and muscle strength were not affected by body mass (Hammami et al., 2019). Notwithstanding the evidence that points to a conclusion that body mass has a significant impact on motor abilities (Hammami et al., 2019; Marangoz & Var, 2018; Moncef et al., 2012; Moss et al., 2015; Saavedra et al., 2018), opposing data can be found in the scientific literature. Namely, Ciplak (2019) assessed muscle strength with the counter movement jump and medicine ball throws, and a non-significant correlation was found between the obtained results and body mass (p > 0.05). In the aforementioned study, it was pointed out that the relationship between body mass and physical performance was non-significant (Molina-López et al., 2020). The findings of a study which investigated the influence of body composition on specific handball movements also indicate that jump shot velocity is not affected by body mass (Schwesig et al., 2016).

Contrary to expectations, body composition did not significantly affect the muscle strength of handball players. Kale and Akdoğan (2020) reported a non-significant relationship between lean body mass and the jump height. Further, jump height was not influenced by the body mass index and percentage of body fat in senior handball players (Moncef et al., 2012). The research conducted on a female sample, also showed that BMI has a non-significant impact on muscle strength (Ciplak et al., 2019; Saavedra et al., 2018). The discrepancy between the mentioned results leads to the conclusion that additional investigation is needed to determine the influence of body composition on basic motor abilities in handball. The findings of this study contain both expected outcomes and those opposed to our assumptions. Therefore, some limitations, which potentially influenced the results, should be emphasized. The present study was conducted only on male handball players aged from 15 to 20. Given the age range of the participants, it is likely that some players were in puberty, while others have already emerged from the second phase of accelerated growth. Furthermore, the impact of the position in the team should be taken into account, and therefore, position-specific examinations are needed in the future.

5. Conclusion

The findings in this study indicate that body composition variables affect motor abilities differently in a sample of junior male handball players. Body composition had no influence on motor abilities, while body mass was the only variable with a non-significant influence on sprint speed and agility. The body mass index and percentage of body fat had a negative influence on linear and multidirectional velocity. Notwithstanding that the muscle mass had a positive impact on the speed and agility, only a few studies examined the influence of the mentioned components on agility in handball players. Given that many activities in handball imply fast and sharp changes of direction, more research is needed in order to determine the influence of body composition on agility. Future research could examine the effect of muscle mass on the motor abilities of handball players after puberty.

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UTICAJ TELESNOG SASTAVA NA BAZIČNE MOTORIČKE SPOSOBNOSTI RUKOMETAŠA

Cilj ovog istraživanja bio je da se ispita uticaj telesnog sastava na motoričke sposobnosti mladih rukometaša. Uzorak ispitanika činilo je 16 rukometaša, uzrasta od 15 do 20 godina. Merene varijable telesnog sastava činile su telesna masa, indeks telesne mase, procenat telesnih masti i procenat mišićne mase. Merenje motoričkih sposobnosti sprovedeno je testovima za procenu brzine kretanja, agilnosti i mišićne snage. Statistička analiza obuhvatila je deskriptivnu statistiku, korelacionu analizu i regresionu analizu, kako bi se utvrdilo da li postoji uticaj određenih varijabli telesnog sastava na motoričke sposobnosti. Na osnovu dobijenih rezultata, utvrđeno je da indeks telesne mase i procenat telesnih masti negativno utiču na brzinu pravolinijskog kretanja i brzinu promene pravca kretanja ($r = 0{,}52 – 0{,}66$, $R^2 = 0{,}27 - 0{,}44$, $p < 0{,}05$). Procenat mišićne mase doprineo je boljim performansama rukometaša na testovima za procenu brzine i agilnosti ($-0{,}55 < r < -0{,}67$, $R^2 = 0{,}31 - 0{,}45$, $p < 0{,}05$). Između telesne mase i motoričkih sposobnosti nije utvrđena *značajna povezanost, kao što ni jedna komponenta telesnog sastava nije značajno uticala na mišićnu snagu rukometaša (p > 0,05). Ovim istraživanjem utvrđeno je da gojaznost doprinosi sporijem kretanju, za razliku od mišićne mase koja čini rukometaše bržim,* kako prilikom pravolinijskog, tako i *prilikom nepravolinijskog kretanja. Uticaj telesnog sastava na ispoljavanje mišićne snage je* potrebno dodatno *ispitati, kao i uticaj telesne mase na specifične motoričke* kretnje u rukometu.

Ključne reči: *telesna kompozicija, snaga, brzina, agilnost*