International Journal of Science Culture and Sport
December 2017 : 5(4)
ISSN : 2148-1148
Doi : 10.14486/IntJSCS681

Field *: Coaching*
Type *: Research Article*
Received: *25.09.2017* **-** ***Corrected:*** *19.10.2017* **-** ***Accepted:*** *26.10.2017*

Investigating the Anthropometric Variables and Bio-Motoric Properties in Male and Female Swimmers

Bircan DOKUMACI[1], Cihan AYGÜN[1], Demet DEMIR DOĞAN[2], Hayriye ÇAKIR ATABEK[1]
[1]Department of Coach Training in Sports, Faculty of Sports Science, Anadolu University, TURKEY
[2]Department of Physical Education and Sports, Faculty of Sports Science, Anadolu University, TURKEY
Email: bircanakdogan@gmail.com

Abstract

The purpose of this study was to investigate the anthropometric features, and some bio-motoric properties in young male and female swimmers. Furthermore, this study aimed to investigate the relationship between anthropometric and bio-motoric variables considering the gender differences. Eighteen male and seventeen female amateur swimmers (mean age = 13.4 ± 2.9 and 12.7 ± 2.2 years respectively) volunteered to participate in this study. All swimmers were member of the same team who had trained at least for 3 days in a week. The anthropometric features were evaluated by height, weight, skinfold thicknesses (triceps, biceps, pectoral chest, midaxillary, abdominal, subscapular, midthigh, suprailium, supraspinale, and calf skinfold thicknesses), breadth, and girth measurements, and body fat. The bio-motoric variables were limited with flexibility, squat jump (SJ), counter movement jump (CMJ), and handgrip strength. The results showed that there was no significant differences between groups for age, height, weight, skinfold thicknesses and ∑8 skinfolds ($p>0.05$). However, there was a significant difference between groups for body fat ($p<0.01$), humerus and femur breadth values ($p<0.01$), and for waist girth values ($p<0.05$). There was significant differences between male and female swimmers for investigated bio-motoric properties. The results showed that the SJ and CMJ values were significantly related with height, weight, breadth, and girth measurements ($p<0.01$) in male swimmers. On the other hand, no such relationship was found in female swimmers. In conclusion, present study indicated that there were significant differences between genders, with favor results for male swimmers. The determination of anthropometric properties may help the trainers to predict and follow the swimmers' performance.

Keywords: Swimming, amateur athletes, gender, anthropometry, strength

Introduction

Swimming is all the purposeful movements that an individual makes in order to cover a certain distance in the water (Çelebi, 2008). As athletes compete in a fluid environment, they have to push a liquid substance instead of a solid to push their bodies forward (Maglischo, 2003). Water is not a natural environment for humans. For this reason, in order to pass through the water, it is essential to learn to be comfortable and to support natural floating ability. Additionally, it is essential to bring the body to its maximum swimming position with minimum effort, faster than the face (Guzman, 2007).

Fast swimming is built on efficiency and effect. Efficiency means faster swimming with less effort, and consuming less energy. On the other side, effect means a force produced to move the body from one side of the pool to another side; in other words, the force that was being used effectively. Both concepts are based on the ability to create the force The technique of the style, force, power, and flexibility of the swimmer, a hydrodynamic body position in the water, form level, body type and shape of the swimmer are the factors that affect these skills (Salo and Riewald, 2008). On the other hand, but similar to the other sports, aerobic and anaerobic endurance, strength, speed, rhythm, coordination, and technical skills play important roles for high performance. Addition to these mentioned determinants; anthropometry is another factor that influence the swimming performance. Certain parameters, such as size of the hands, long arms, large feet, and a wide shoulder diameter are features that must exist in the swimmers (Cicchella et al., 2009; Ayan and Kavi, 2016).

By determining these qualities with certain measures and directing them to swim at the appropriate age, the coach will prevent time loss by developing appropriate training and they will produce successful elite swimmers (Ayan and Kavi, 2016). Hence, the purpose of this study was to investigate the anthropometric features, and some bio-motoric properties such as isometric handgrip strength, explosive leg strength, and flexibility in young swimmers. Furthermore, this study aimed to investigate the relationship between anthropometric and bio-motoric variables considering the gender differences.

Materials and Methods

Participants

Eighteen male and seventeen female amateur swimmers (mean age = 13.4 ± 2.9 and 12.7 ± 2.2 years respectively) volunteered to participate in this study. All swimmers were member of the same team who had trained at least for 3 days in a week. None of the swimmers had medical history, leg or arm injury, cardiovascular and pulmonary diseases. At the beginning of the study all participants and their parents were informed about possible risks and benefits of the study and written consents were obtained. The study was approved by the local ethical committee and was conducted in accordance with the Helsinki Declaration for experiments involving humans.

Anthropometric data collection

Participants' heights were measured with a stadiometer (Seca, 767) to the nearest 0.1 cm and their weights were measured with an electronic scale (Seca, 767) to the nearest 0.1kg.

Skinfold thicknesses (triceps, biceps, pectoral chest, midaxillary, abdominal, subscapular, midthigh, suprailium, supraspinale, and calf skinfold thicknesses) were measured using a skinfold caliper (Holtain, ltd, England) to the nearest 0.2 mm. The average of the three values was used for data analysis. Sum of eight skinfold thicknesses (∑8 skinfolds; triceps, biceps, suprailium, supraspinale, abdominal, subscapular, thigh, and calf skinfolds) was calculated. Body density (BD) of males was predicted using the equation of Jackson and Pollock (1978), additionally, BD of females was predicted using the equation of Jackson and Pollock (1980) (Formula 1 and Formula 2, respectively), whereas the body fat (BF) was estimated using the equation of Siri (Siri, 1956) (Formula 3) (Eston and Reilly, 2009).

$$\text{BD of males} = 1.112 - 0.00043499(\Sigma 7) + 0.00000055(\Sigma 7)^2 - 0.00028826(X2) \qquad \text{Formula 1}$$

$$\text{BD of females} = 1.097 - 0.00046971(\Sigma 7) + 0.00000056(\Sigma 7)^2 - 0.00012828(X2) \qquad \text{Formula 2}$$

Σ7 = Sum of 7 skinfolds as specified (mm) [pectoral chest + midaxillary + abdominal + suprailium + subscapular + triceps + midthight]

X2 = age (years)

$$\text{BF \%} = ((4.95/\text{body density})-4.5) \times 100 \qquad \text{Formula 3}$$

Additionally to the mentioned anthropometric measurements, breadth of the distal extremity of the humerus and femur was measured based on standardized procedures (Eston and Reilly, 2009) Furthermore, girth of the hip, waist, and arm (biceps relaxed, and biceps flexed (tensed)) were measured based on standardized procedures (Eston and Reilly, 2009). All anthropometric measurements were taken by one professional who was assisted by a recorder, additionally all measurements were obtained from the left side of the body.

Flexibility

The sit-and-reach test was applied according to the explained method before (Fagnani et al., 2006).This test involves sitting on the floor with legs out straight ahead. Feet (shoes off) are placed flat against the box. Both knees are held flat against the floor by the researcher. The swimmer lean forward slowly as far as possible toward a graduated ruler held on the box from -25 to +25, holding the greatest stretch for 2 sec. The researcher had to be sure that there were no jerky movements on the part of the subject and that her/his fingertips remain at the level and the legs flat. The score was recorded as the distance before (negative) or beyond (positive) the toes. The test was repeated twice, and the best score was recorded. This test measures only the flexibility of the lower back and extensibility of hamstring muscles.

Squat jump and Counter movement jump tests

All participants started with a standardized warm-up of 5-7 minute of cycling at 55-60 rpm against no load (894 Ea, Peak Bike by Monark AB, Sweden) and 5-7 minute of stretching. Following the warm-up, subjects rested for 5-min. After a familiarization session (learning the proper techniques of the jump condition) each participant performed three maximal voluntary vertical jumps at each of two testing conditions – Squat Jump (SJ) and Counter Movement Jump (CMJ); and the best value of the three trials was used for further analysis. The SJ was performed from a starting position with the subjects' knees flexed to 90^0, hands fixed on the hips and with no allowance for preparatory counter-movement. The CMJ was performed from an upright standing position, with the hands fixed on the hips and with a counter movement preparatory phase ended at a position corresponded to the starting position in SJ. Sufficient recovery time was given among trials (more than 2 minutes). The jump heights were measured using a dedicated force platform (Fusion Sport, Old, Australia). For the SJ and CMJ, three parameters were estimated: (1) the maximum jumping height (SJh and CMJh), (2) the difference between CMJh and SJh as explosive strength and (3) the power output

(SJpower and CMJpower) value which was determined using the following formula (Rogers, 1990).

SJpower and CMJpower (kg.m/s) = $\sqrt{4.9}$ x body weight (kg) x $\sqrt{\text{jump height (m)}}$ Formula 4

Handgrip strength

Each participant was given a brief demonstration and verbal instructions for the hand-grip test using the Takei T.K.K.5101 digital hand-grip dynamometer (Takei Scientific Instruments Co. Ltd, Tokyo, Japan). If necessary, the grip opening was adjusted according to the subject's hand size. The test was conducted for both the dominant and non-dominant hand, in standing, with shoulder adducted and neutrally rotated, the wrist, and the elbow in full extension. The dynamometer was held freely without support, not touching the subject's trunk (Koley et al., 2011). Three trials were allowed with sufficient recovery period and the highest score was recorded in kilograms (kg) as peak grip strength. The body mass was used to determine relative strength expressed in kg/kg (weight).

Statistical analyses

Descriptive statistics were compute for each group and all values were presented as mean ± standard deviation (SD). The normality of distribution of the data was assessed with Kolmogorow-Simirnov test; as final the median values of age and ten skinfold thicknesses were compared between groups using the "Man Whitney U" test. Additionally, the mean values of height, weight, breadth, and girth measurements, ∑8 skinfold thicknesses, BF, jump heights, anaerobic power, flexibility, and handgrip strength were compared between groups using the "independent student t-test". The correlations between anthropometric variables (age, height, body mass, sum of 8 skinfold and body fat percentage) and bio-motoric properties (jump heights, handgrip strength, flexibility, and anaerobic power) was evaluated using the Pearson Product Moment Correlation analysis. All analyses were executed using the SPSS for windows version 18.0 and statistical significance was set at $p < 0.05$.

Results

The values of physical properties and anthropometric variables of swimmers who participated in the current study are presented in Table 1. The results indicated that there was no significant differences between groups for age, height, weight, measured ten skinfold thicknesses and ∑8 skinfolds ($p>0.05$). There was a significant difference between groups for body fat values ($p<0.01$), with significant higher body fat value in female swimmers. Furthermore, there was a significant difference between groups for breadth values of humerus and femur ($p<0.01$), additionally, there was a significant difference for girth value of waist ($p<0.05$).

The mean values of investigated bio-motoric properties (jump heights, the difference between CMJh and SJh, anaerobic power, handgrip strength) are presented in Table 2. There was a significant difference between groups for SJh and CMJh values ($p<0.05$ and $p<0.01$), furthermore there was a significant difference between groups for anaerobic power values calculated by SJ and CMJ values ($p<0.05$). It has been observed that the values of jump height and anaerobic power were higher in male swimmers. Similar to these findings there were significant differences between groups based on handgrip strength values (absolute and relative strength values) with higher values in male swimmers ($p<0.05$), except right handgrip strength normalized to the body weight ($p>0.05$).

Table 1. The physical properties and anthropometric variables of swimmers.

Variables	Males (n=18)	Females (n=17)
Age (years)	13.44 ± 2.97	12.75 ± 2.26
Height (cm)	161.71 ± 13.54	157.10 ± 9.25
Weight (kg)	54.97 ± 15.68	48.00 ± 9.77
Body fat (%)	11.36 ± 4.43	19.01 ± 4.78 **
Skinfold thicknesses		
Triceps (mm)	12.22 ± 3.12	13.05 ± 4.28
Biceps (mm)	6.45 ± 2.50	8.10 ± 4.47
Subscapular (mm)	10.22 ± 3.63	11.12 ± 4.17
Pectoral chest (mm)	9.52 ± 3.89	10.22 ± 3.93
Midaxillary (mm)	11.49 ± 6.00	11.48 ± 4.37
Suprailium (mm)	11.23 ± 5.30	11.58 ± 5.21
Supraspinale (mm)	7.35 ± 3.35	7.98 ± 1.77
Abdominal (mm)	20.25 ± 8.01	21.34 ± 6.19
Midthight (mm)	17.91 ± 5.47	20.28 ± 6.83
Proximal Calf (mm)	12.32 ± 3.98	13.33 ± 5.32
∑8 skinfolds (mm)	97.98 ± 30.92	104.86 ± 32.97
Breadth and girth measurements		
Humerus (cm)	6.52 ± 0.64	5.83 ± 0.37 **
Femur (cm)	9.51 ± 0.66	8.76 ± 0.47 **
Waist (cm)	75.03 ± 8.19	69.18 ± 5.15 *
Hip (cm)	85.05 ± 8.55	85.45 ± 8.34
Biceps relaxed (cm)	25.99 ± 4.30	23.53 ± 2.88
Biceps flexed (cm)	26.66 ± 5.05	24.75 ± 2.83

* $p<0.05$; ** $p<0.01$; ∑8 skinfolds = triceps + biceps + suprailium + supraspinale + abdominal + subscapular + thigh + calf

Table 2. The bio-motoric properties' values of swimmers

Variables	Males (n=18)	Females (n=17)
SJh (cm)	28.15 ± 5.23	24.33 ± 2.93 *
CMJh (cm)	30.47 ± 5.85	25.84 ± 3.23 **
The difference between CMJh and SJh	2.31 ± 1.29	1.60 ± 1.92
SJ-Anaerobic power	65.52 ± 24.16	52.29 ± 10.95 *
CMJ-Anaerobic power	68.15 ± 25.21	53.92 ± 11.66 *
Flexibility (cm)	28.18 ± 5.48	32.91 ± 8.01*
Handgrip strength – right (kg)	28.77 ± 13.22	21.51 ± 6.25 *
Normalized handgrip strength – right	0.50 ± 0.11	0.44 ± 0.07
Handgrip strength – left (kg)	27.68 ± 13.03	19.70 ± 5.35 *
Normalized handgrip strength – left	0.48 ± 0.12	0.41 ± 0.07 *

* $p<0.05$; ** $p<0.01$; SJh = squat jump height; CMJh = counter movement jump height

Table 3 and 4 present the correlation coefficients among measured variables in male and female swimmers. The results showed that the SJh and CMJh values were significantly related with some anthropometric variables such as height and weight, also significantly related with breadth and girth measurements ($p<0.01$) in male swimmers. On the other hand, it has been observed that the SJh and CMJh values were not significantly related with anthropometric variables (height, weight, breadth, and girth measurements) in female swimmers ($p>0.05$). There was no significant relationship between jump height values (SJh and CMJh), ∑8 skinfolds, and BF values in both groups ($p>0.05$), except the significant relationship between SJh and ∑8 skinfolds in female swimmers ($p<0.05$).

As seen in Table 3, there was a significant relationship between handgrip strength – both absolute and relative strength - values and other investigated variables in male swimmers ($p>0.05$ and $p<0.01$). On the other hand, only the absolute handgrip strength values were significantly related with other investigated variables (except jump height values) in female swimmers ($p<0.05$), and the relative handgrip strength values were not related with them ($p<0.05$; Table 4).

Table 3. Correlation between anthropometric variables and bio-motoric variables in male swimmers

	Height	Weight	Hum	Fem	Waist	Hip	Biceps Rel.	Biceps Con.	SJh	CMJh	SJ An.P	CMJ An. P	HG-R	N-HG-R	HG-L	N-HG-L	∑8 Skinfolds	BF
Age	0.962**	0.882**	0.783**	0.614**	0.708**	0.805**	0.806**	0.554*	0.884**	0.845**	0.923**	0.919**	0.950**	0.783**	0.944**	0.766**	NS	NS
Height		0.923**	0.865**	0.680**	0.725**	0.852**	0.839**	0.662**	0.823**	0.781**	0.935**	0.929**	0.923**	0.693**	0.916**	0.680**	NS	NS
Weight			0.928**	0.808**	0.874**	0.924**	0.967**	0.682**	0.772**	0.749**	0.985**	0.983**	0.915**	0.558*	0.898**	0.534*	NS	NS
Hum				0.860**	0.727**	0.809**	0.925**	0.664**	0.664**	0.643**	0.902**	0.898**	0.848**	0.527*	0.847**	0.522*	NS	NS
Fem					0.685**	0.820**	0.834**	0.501*	0.561*	0.564*	0.770**	0.776**	0.733**	NS	0.732**	NS	NS	NS
Waist						0.886**	0.858**	0.503*	0.610**	0.591**	0.842**	0.842**	0.722**	NS	0.688**	NS	0.479*	0.638**
Hip							0.871**	0.541*	0.665**	0.650**	0.889**	0.891**	0.840**	0.517*	0.823**	0.482*	NS	0.522*
Biceps Rel.								0.675**	0.704**	0.673**	0.944**	0.940**	0.860**	0.469*	0.851**	NS	NS	NS
Biceps Con.									NS	NS	0.629**	0.619**	0.480*	NS	0.471*	NS	NS	NS
SJh										0.979**	0.868**	0.869**	0.909**	0.806**	0.900**	0.787**	NS	NS
CMJh											0.845**	0.856**	0.884**	0.789**	0.882**	0.780**	NS	NS
SJ An.P												0.998**	0.955**	0.646**	0.939**	0.622**	NS	NS
CMJ An.P													0.954**	0.646**	0.940**	0.625**	NS	NS
HG-R														0.836**	0.993**	0.812**	NS	NS
N-HG-R															0.841**	0.976**	NS	NS
HG-L																0.841**	NS	NS
N-HG-L																	NS	NS
∑8 Skinfolds																		0.970**

* $p<0.05$; ** $p<0.01$; Hum = Humerus; Fem = Femur; Biceps Rel. = Biceps relaxed; Biceps Con. = Biceps contraction; SJh = Squat jump height; CMJh = Counter movement jump height; HG-R = Handgrip right; N-HG-R = Normalized handgrip right; HG-L = Handgrip left; N-HG-L = Normalized handgrip left; ∑8 skinfolds = sum of eight skinfold thicknesses; BF = Body fat.

Table 4. Correlation between anthropometric variables and bio-motoric variables in female swimmers.

	Height	Weight	Hum	Fem	Waist	Hip	Biceps Rel.	Biceps Con.	SJh	CMJh	SJ An.P	CMJ An. P	HG-R	N-HG-R	HG-L	N-HG-L	∑8 Skinfolds	BF
Age	0.592*	0.626**	0.684**	0.536*	NS	0.668**	0.483*	0.495*	NS	NS	0.619**	0.627**	0.528*	NS	NS	NS	NS	NS
Height		0.859**	0.579*	0.734**	0.736**	0.755**	0.586*	0.635**	NS	NS	0.914**	0.895**	0.626**	NS	0.550*	NS	NS	NS
Weight			0.712**	0.852**	0.933**	0.952**	0.889**	0.912**	NS	NS	0.951**	0.946**	0.795**	NS	0.727**	NS	0.610**	0.642**
Hum				0.848**	0.509*	0.672**	0.708**	0.727**	NS	NS	0.675**	0.671**	0.832**	0.528*	0.717**	NS	NS	NS
Fem					0.760**	0.749**	0.782**	0.799**	NS	NS	0.828**	0.830**	0.809**	NS	0.749**	NS	NS	0.510*
Waist						0.870**	0.863**	0.884**	NS	NS	0.876**	0.879**	0.614**	NS	0.567*	NS	0.710**	0.762**
Hip							0.910**	0.905**	NS	NS	0.852**	0.846**	0.722**	NS	0.668**	NS	0.656**	0.650**
Biceps Rel.								0.988**	NS	NS	0.760**	0.753**	0.742**	NS	0.727**	NS	0.749**	0.740**
Biceps Con.									NS	NS	0.818**	0.809**	0.777**	NS	0.746**	NS	0.716**	0.727**
SJh										0.813**	NS	NS	NS	NS	NS	NS	-0.550*	NS
CMJh											NS	NS	NS	NS	NS	NS	NS	NS
SJ An.P												0.990**	0.768**	NS	0.706**	NS	NS	NS
CMJ An.P													0.770**	NS	0.703**	NS	NS	0.484*
HG-R														0.711**	0.935**	NS	NS	NS
N-HG-R															0.690**	0.833**	NS	NS
HG-L																0.658**	NS	NS
N-HG-L																	NS	NS
∑8 Skinfolds																		0.975**

* $p<0.05$; ** $p<0.01$; Hum = Humerus; Fem = Femur; Biceps Rel. = Biceps relaxed; Biceps Con. = Biceps contraction; SJh = Squat jump height; CMJh = Counter movement jump height; HG-R = Handgrip right; N-HG-R = Normalized handgrip right; HG-L = Handgrip left; N-HG-L = Normalized handgrip left; ∑8 skinfolds = sum of eight skinfold thicknesses; BF = Body fat.

Discussion and Conclusion

The first objective of this study was to compare anthropometric measurements (skinfold thicknesses, height, weight, BF, breadth, and girth) and bio-motoric properties (jump heights, anaerobic power, flexibility and handgrip strength) of male and female swimmers. The second objective of this study was to examine the correlation of bio-motoric properties (jump heights, handgrip strength, flexibility, and anaerobic power) with anthropometrics variables (age, height, body mass, sum of 8 skinfold and body fat percentage). Finally, the findings of the current study were tried to be evaluated with the related literature.

In swimming, physical characteristics, such as body size, structure and composition contribute to a good performance in the water (Mameletzi et al., 2003). General hypotheses were that swimmers with a higher percentage of body fat would have a better performance than swimmers with lower percentage (Knechtle et al., 2010). On the other hand, Zampagni et al. (2008) reported that there was an inverse significant relationship between body weight, height, and freestyle swimming time obtained in 50-,100-,200-,400-,and 800-m. In addition, compared to other sports that are characterized by great power production, such as gymnastics, ballet, skating running, and cycling BF levels of swimmers are significantly higher (Mameletzi et al., 2003). Among swimmers fat provides buoyancy by reducing the energy required to stay on the surface of the water. However, extreme excesses of fat mass will alter the body's contour, mass, and increase the water resistance (Mameletzi et al., 2003). For this reason, it can be said that anthropometric variables are important for swimming performance. The results of this study showed that there was a significant difference between the groups for BF values ($p < 0.01$), with significant higher body fat level in female swimmers. There was also a statistically significant difference between the groups for breadth values of humerus and femur ($p < 0.01$), and there was also a significant difference for girth value of waist ($p < 0.05$). Knechtle et al. (2010) reported significant differences between anthropometric variables (body height, body mass, length of arm and length of leg percent body fat (%)) between male and female athletes. McLean et al. (1998) indicated that females were found to have significantly higher body fat quantity than males. In addition, males' height and weight values were significantly higher than females. These results are consistent with the results of the current study.

Handgrip is a physiological variant influenced by a number of factors such as age, sex and body size (Koley et al., 2011). Handgrip strength was significantly higher in the elite swimmers than in controls for 50- and 100-m Freestyle events, thereby, suggesting that a better ability to perform short races is an important parameter to determine (Geladas et al., 2005). The current study demonstrated that there were significant differences between groups based on handgrip strength values (absolute and relative strength values) with higher values in male swimmers ($p<0.05$), except right handgrip strength normalized to the body weight ($p>0.05$). On the other hand, only the absolute handgrip strength values were significantly related with other investigated variables (except jump height values) in female swimmers ($p<0.05$), and the relative handgrip strength values were not related with them ($p<0.05$).

SJ and CMJ are widely used tests to measure an athlete's ability to jump. While SJ is used to measure lower body concentric strength, CMJ is used to measure lower body reactive strength (Newton et al., 2006). The SJ can be used as the most basic functional expression of explosive muscle strength as it requires only concentric activation, while, the CMJ requires moderate eccentric activation followed by high concentric activation, and therefore requires a more complex timing and graduation of the motor units. Thus the SJ can serve as a baseline for the potential of explosive muscle strength and CMJ may indicate development of this potential (Bencke et al., 2002). Lower limb strength and power is considered an important factor for a successful start in swimming (Benjanuvatra et al., 2007). As indicated by Bosco et al. (2002) there was a statistically significant gender difference in CMJ and SJ (19% and 25%, respectively). Patterson et al. (2009) concluded that male displayed significantly higher values for relative average power and jump height in SJ than female. Buśko and Gajewski (2011) reported that the male subjects had much better performance than the female subjects of comparable physical conditions did. When consider other sport such as volleyball, Riggs and Sheppard (2009) suggested that there is a significant difference between the male and female beach volleyball athletes for the SJ and CMJ variables, which show that the male volleyball players had a better jumping ability. The findings of the current study are consistent with the literature. Komi and Karlsson (1978) has calculated the total leg force per unit of body weight, and they observed very similar values for males and females. It has been observed that the male swimmers has much better performance than female swimmers of comparable physical conditions, on the other hand, the gender difference in some of the values were insignificant when the results were calculated per body mass (Busko and Gajewski, 2011). Thus, it can be said that when the gender differences are considered the major contributing factor in force production is greater muscle mass in males. Additionally, Perez-Gomez et al. (2008) indicated that the difference in sprint running performance between sexes may be due to the ability of greater ground reaction forces produced by men, and this may explain the findings of the present study, why the male swimmers can jump higher than female swimmers.

When anthropometric measurements and jump performance were examined, Sheppard et al., (2008) reported that skinfold ratio was moderately correlated to spike jumps and its contribution in volleyball athletes, additionally, the height ratio was correlated to CMJ ($r = 0.77$; $p \leq 0.01$) and spike jump ($r = 0.51$; $p \leq 0.05$). On the other hand, there was no correlation between skinfold values and CMJ ($p > 0.05$). Mayhew and Salm (1990) reported that the anthropometric factors have been shown to effect power production during the Margaria-Kalamen, vertical jump, and standing long jump tests, which are used to evaluate anaerobic power in untrained male and female individuals (mean age = 19.44 ±1.63 and 18.84 ± 0.89 years, respectively). The findings of the current study demonstrated that the SJh and CMJh values were significantly related with some anthropometric variables such as height and weight, also significantly related with breadth and girth measurements ($p < 0.01$) in male swimmers. In addition, there was a significant relationship between SJh and ∑8 skinfold values in female swimmers ($p < 0.05$). For these reasons, an important factor affecting the difference in jump heights in male and female swimming can be based on differences between somatotypes, body composition, and ground reaction force abilities.

In conclusion, the findings of the present study indicated that there were significant differences between genders, with favor results for male swimmers. The determination of anthropometric properties may help the trainers to predict and follow the swimmers' performance.

Acknowledgements

The authors would like to thank to swimmers for their willingness to participate in this study.

Conflicts of Interest

The authors have no conflicts of interest to acknowledge.

Corresponding author:

Bircan DOKUMACI
Faculty of Sports Science, Anadolu University, 26555 Eskisehir, Turkey
Tel: +902223213550/6792 Fax: +902223213564
Email: bircanakdogan@anadolu.edu.tr; bircanakdogan@gmail.com

REFERENCES

Ayan V, Kavi N (2016). "The study of the somatotypes and the horizontal jump performance characteristics of the female swimmers aged between 8 and 14." International Journal of Science Culture and Sport (IntJSCS), 4(special issue 1): 23-30.

Bencke J, Damsgaard R, Saekmose A, Jørgensen P, Jørgensen K, Klausen K (2002). "Anaerobic power and muscle strength characteristics of 11 years old elite and non-elite boys and girls from gymnastics, team handball, tennis and swimming." Scandinavian Journal of Medicine and Science in Sports, 12(3):171-178.

Benjanuvatra N, Edmunds K, Blanksby B (2007). "Jumping abilities and swimming grab-start performances in elite and recreational swimmers." International Journal of Aquatic Research and Education, 1(3): 231-241.

Bosco C, Tsarpela O, Foti C, Cardinale M, Tihanyi J, Bonifazi M, Viru M, Viru, A. (2002). "Mechanical behaviour of leg extensor muscles in male and female sprinters." Biology of Sport, 19(3): 189-202.

Busko K, Gajewski J (2011). "Muscle strength and power of elite female and male swimmers." Baltic Journal of Health and Physical Activity, 3(1): 13-18

Cicchella A, Jidong L, Jürimäe T, Zini M, Passariello C, Rizzo L, Stefanelli C (2009). "Anthropometric comparison between young Estonian and Chinese swimmers." Journal of Human Sport and Exercise online, 4(2): 154-160.

Çelebi Ş (2008). "We investigate body structural and functional properties in 9-13 year children who takes swimming training [Yüzme antrenmanı yaptırılan 9-13 yaş grubu ilköğretim öğrencilerinde vücut yapısal ve fonksiyonel özelliklerinin incelenmesi]" Master Thesis, Health Sciences Institute, Physical Education and Sports Department, Erciyes University, Kayseri.

Eston R, Reilly T (Eds.) (2009). "Kinanthropometry and exercise physiology laboratory manual: tests, procedures and data." Volume 1: Anthropometry, USA and Canada, Routledge.

Fagnani F, Giombini A, Di Cesare A, Pigozzi F, Di Salvo V (2006). "The effects of a whole-body vibration program on muscle performance and flexibility in female athletes." American Journal of Physical Medicine and Rehabilitation, 85(12): 956-962.

Geladas ND, Nassis GP, Pavlicevic S (2005). "Somatic and physical traits affecting sprint swimming performance in young swimmers." International Journal of Sports Medicine, 26(2): 139-144.

Guzman RJ (2007). The Swimming Drill Book, Human Kinetics.

Knechtle B, Baumann B, Knechtle P, Rosemann T (2010). "Speed during training and anthropometric measures in relation to race performance by male and female open-water ultra-endurance swimmers." Perceptual and Motor Skills, 111(2): 463-474

Koley S, Kaur SP, Sandhu JS (2011). "Correlations of handgrip strength and some anthropometric variables in Indian inter-university female handball players." Sport Science Review, 20(3-4): 57-68.

Komi PV, Karlsson J (1978). "Skeletal muscle fibre types, enzyme activities and physical performance in young males and females." Acta Physiologica, 103(2): 210-218.

Maglischo EW (2003). Swimming fastest: The essential reference on technique, training, and program design. Human Kinetics.

Mameletzi D, Siatras T, Tsalis G, Kellis S (2003). "The relationship between lean body mass and isokinetic peak torque of knee extensors and flexors in young male and female swimmers." Isokinetics and Exercise Science, 11(3): 159-163.

Mayhew JL, Salm PC (1990). "Gender differences in anaerobic power tests." European Journal of Applied Physiology and Occupational Physiology, 60(2): 133-138.

McLean SP, Hinrichs RN (1998). "Sex differences in the centre of buoyancy location of competitive swimmers." Journal of Sports Sciences, 16(4): 373-383.

Newton RU, Rogers RA, Volek JS, Häkkinen K, Kraemer, WJ (2006). "Four weeks of optimal load ballistic resistance training at the end of season attenuates declining jump performance of women volleyball players." Journal of Strength and Conditioning Research, 20(4): 955-961.

Patterson C, Raschner C, Platzer HP (2009). "Power variables and bilateral force differences during unloaded and loaded squat jumps in high performance alpine ski racers". Journal of Strength and Conditioning Research, 23(3): 779-787.

Perez-Gomez J, Rodriguez GV, Ara I, Olmedillas H, Chavarren J, González-Henriquez JJ, Calbet JA (2008). "Role of muscle mass on sprint performance: gender differences?" European Journal of Applied Physiology, 102(6): 685-694.

Riggs MP, Sheppard JM (2009). "The relative importance of strength and power qualities to vertical jump height of elite beach volleyball players during the counter-movement and squat jump." Journal of Human Sport and Exercise online, 4(3): 221-236.

Rogers C (1990). "Exercise physiology laboratory manual." Dubuque: Wm C Brown Publishers.

Salo D, Riewald SA (2008). Complete conditioning for swimming. Human kinetics

Sheppard JM, Cronin JB, Gabbett TJ, McGuigan MR, Etxebarria N, Newton RU (2008). "Relative importance of strength, power, and anthropometric measures to jump performance of elite volleyball players." Journal of Strength and Conditioning Research, 22(3): 758-765.

Siri WE (1956). The gross composition of the body. Adv Biol Med Phys, 4(239-279): 513

Zampagni ML, Casino D, Benelli P, Visani A, Marcacci M, De Vito G (2008). "Anthropometric and strength variables to predict freestyle performance times in elite master swimmers." Journal of Strength and Conditioning Research, 22(4): 1298-1307