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How Do Swimming Students' Anthropometric Characteristics Affect Short-Course Swimming Performance?

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Abstract

It has been found that anthropometric swimming performance factors may be related to and affect swimming performance. In light of this, the study's objective was to examine the association between certain motoric and anthropometric traits and 25-meter freestyle swimming performance results. A total of 16 male swimming students from Yozgat Bozok University's Faculty of Sport Sciences (age: 21.75±1.23 years; weight: 78.29±13.04 kg; height: 177±5.44 cm; body fat percentage: 17±7.5 %) took part in the study as volunteers. Height, body mass, skinfold thickness, circumference measurements (biceps in flexion, calf), diameter measurements (humerus epicondyle, femur epicondyle), static flexibility measurements (shoulder flexion, trunk-neck extension, ankle extension), and strength measurements (leg strength, back strength) were carried out to assess the anthropometric measurements of swimming students. In a semi-Olympic swimming pool, short-course freestyle scores of swimming students were recorded. The data appeared to have a normal distribution after the skewness and kurtosis tests, so the Pearson Correlation test was used to look at the correlation between 25-meter freestyle swimming levels and other characteristics. It was discovered that there was no statistically significant correlation between static flexibility and strength tests and 25-meter freestyle swimming performance results, but there was a negative and statistically significant correlation between swimming performance results of swimming students and mesomorph variables (r=-0.529, p=0.035). It is believed that identifying swimmers' somatotype structures may be crucial for talent selection and serve as an indicator of swimming ability.
Keywords: Swimming, Somatotype, Strength, Flexibility, Swimming Degree

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INTRODUCTION

To overcome the frictional force in the water and propel the body forward, swimming is a movement style defined by the periodic movement of the upper and lower extremities (Barbosa et al., 2013; Bartolomeu et al., 2018). On the other hand, competitive swimming is seen as a type of cyclic sport that is done to travel a given distance as quickly as feasible (Barbosa et al., 2010). Similar to other sports, swimming performance is mostly determined by a person's aerobic, anaerobic, strength, flexibility, coordination, stroke technique, beginning turns, and anthropometric characteristics (height, weight, and body fat percentage) (Lätt et al., 2010; Sammoud et al., 2018; Zamparo et al., 2005).

The qualities that govern technique, meaning the mechanical application of force and power to the water that results in forward motion, substantially complicate the relationship between force, power, and swimming speed. Height and arm length are two characteristics that will boost mechanical power production. Leading sprinters typically stand taller on average than swimmers from other groups. Usually, the neck's length and the fathom's length are equal. On the other side, the stroke length is often 6–10% longer than the height of good sprinters. The same applies to hand and foot length. It has been observed that the swimmers who perform the best toe strikes are also the best sprinters (Stager and Tanner, 2005).

Evidence in the literature shows that anthropometric factors are related to swimming performance. It was shown that swimmers with longer lengths and limb lengths had superior swimming economy and stroke length in the study by Toussaint et al. (1991) on male freestyle swimmers. Nevill et al.'s (2015) study discovered that young swimmers had a variety of factors that contributed to their personal best 100-meter freestyle swimming times, including a higher foot-to-lower leg ratio, larger feet, shorter lower legs, and more lean body mass proves that it offers.

Sammoud et al., (2018) found that an increase in forearm circumference or volume will improve 100-meter breaststroke swimming performance and that young swimmers' hand and leg lengths substantially impact their performance. The segment length ratio (arm ratio and circumference ratio) was found to be favorably connected with the average speed performance of the 100-meter breaststroke. According to Nevill et al.'s study from 2020, swimmers perform better when they have lower body fat percentages, larger shoulders, wider stroke lengths (shorter forearm lengths), smaller arm circumferences, and wider forearm circumferences. Revealed seven traits that all swimmers share.

It is clear from the research conducted as a consequence of the literature review that physical ability and anthropometric traits influence swimming performance. In light of this, this study aims to investigate the association between anthropometric characteristics, a few motor characteristics, and 25-meter freestyle swimming abilities. It was regarded as an investigation with the objective of collecting knowledge that would benefit swimming sport coaches, athletes, and sports in general.

METHODS

Research Model

In order to evaluate 25-meter short course performance in relation to anthropometric factors and a few motor abilities, this study used an experimental cross-sectional research method.

Sampling

A total of 16 male swimming students from Yozgat Bozok University's Faculty of Sports Sciences, who consistently attend swimming lessons two days per week, have no recent sports-related injuries and are enrolled in the study voluntarily, were recruited for this research. The study's potential dangers were explained to the participants before it began, and they voluntarily provided their signatures on the participant consent form. The ethics committee approved our research for this reason. The descriptive characteristics of swimming students are given in Table 1.

Table 1. Descriptive characteristics of the participants

Descriptive Characteristics	N	M	SD
Age (year)	16	21.75	1.23
Height (cm)	16	177	5.44
Weight (kg)	16	78.29	13.04
Body Fat (%)	16	17	7.5
Swimming Time (s)	16	20.82	2.62

Mean (M), Standard deviation (SD)

Data Collection Tools

Height and Body Weight Measurements: A tape measure that was attached to the wall was used to measure the height of the swimming students. Body weight was determined with bare feet and only swimwear on using a SECA brand (Germany) digital scale with a precision of 0.1 kg (Lohman et al., 1988).

Body Fat Percentage (%) Calculation: The body fat percentage (%) was calculated using Yuhazs's method.

The percentage of fat calculated using Yuhaz's formula is equal to 5.783 + 0.153 (triceps skinfold thickness +supra iliac skinfold thickness + abdominal skinfold thickness).

Skinfold Thickness Measurements: Skinfold thickness measurements were taken from the subscapular, triceps, biceps, chest, abdominal, supra iliac I, supra iliac II, thigh, calf, and midaxillary regions with a Holstein brand (UK) skinfold caliper. Measurements were made on the right side of the body. After grasping the thickness of the subcutaneous fat layer with the thumb and forefinger and gently pulling, the caliper was placed approximately 1 cm away from the fingers. The distance between the ends of the caliper pressing on the skin folds was read from the indicator after waiting for 1-2 seconds and recorded in mm (Lohman et al., 1988).

Circumference Measurements: Circumference measurements were made from the flexed biceps and calf regions using a Gulick anthropometric tape measure (UK). Measurements were taken twice on the right side of the body, and the average of the two measurements was used when calculating. Measurements were completed as suggested by Callaway et al. (1998).

Diameter Measurements: Diameter measurements were taken from the humeral epicondyle and femoral epicondyle with Lafayette brand (USA) sliding caliper. Appropriate areas on the body were identified before measurements were taken, and the tip of the caliper was used by applying as much pressure as possible. Measurements were made as suggested by Wilmore et al. (1988).

Somatotype Evaluation: Somatotype values were determined by Heath Carter Somatotype Method. Formulas were determined using body weight, height, flexion biceps, calf circumference, femur and humerus diameter measurements, and somatotype values for triceps, subscapular, supra iliac, biceps, and calf skinfold thickness (Carter, 2002).

Endomorphy= $-0.7182+0.1451*x-0.00068*x^2+0.0000014*x^3$ (x=Triceps skinfold thickness+suprailiac skinfold thickness+subscapula skinfold thickness)

Height Correction Formula= x*170.18/height (cm)

Mesomorphy= [0.858+0.601*elbow width-humerus diameter (cm)+0.601*knee width-femur diameter (cm)+0.188*arm circumference (cm)+0.161*calf circumference (cm)]–[height (m)* 0.131]+4.50

Ectomorphy= (Length-to-weight ratio)*0.732–28.58 (Length-to-weight ratio= Height/3√ Weight)

Measuring Static Flexibility: With the aid of a tape measure that was fastened to the wall, measures of ankle extension, trunk-neck extension, and shoulder flexion were taken. The best result was achieved after two measurements, and it was noted on the data sheet. To evaluate shoulder flexion, participants lie on their backs with their arms shoulder-width apart and raise their arms as high as they can while keeping their torsos off the ground. It was determined how far the hand's tip was from the acromial point. The participants were in the prone position with their hands folded behind their backs, raising their heads as high as they could for the measurement of trunk-neck extension. The measurement in millimeters was made at the point that corresponded to the nose level. The participants stretched their right leg as far as they could while seated to measure ankle extension, and the point on the tape measure that touched the ground was considered to be zero. According to Özer (2013), a measurement was made between the wrist extension and the ground and the top of the foot.

Strength Measurements: Strength measurements were measured with a Takei brand (Japan) digital back-leg dynamometer. In the measurement of leg strength, the participants placed their feet on the dynamometer bench and pulled the dynamometer bar, which they grasped with their hands, vertically using their legs, while the knees were bent, the arms were tense, the back was straight, and the body was slightly bent forward. The value on the display is recorded in kilograms. In the measurement of back strength, the participants placed their feet on the dynamometer table and pulled the dynamometer bar vertically up, with the knees and arms stretched, the back straight and the body slightly bent forward. The value of the indicator was recorded in kilograms (Aslan et al., 2011).

25 m Swimming Performance Measurements: Students' performances in the 25-meter swim were measured using a hand timer made by the Casio company. After the prescribed warm-up routine, which consisted of 10 minutes of on-land jogging and 10 minutes of slow swimming in a pool, the students were allowed to participate in the test (Yarar et al., 2021). The directive to exit the sprint stone signaled the start of the timer, and 25 meters of freestyle swimming were entered on the athlete information form.

Ethical Approval

During the research Helsinki Declaration was followed and this study was approved by of Yozgat Bozok University Clinical Research Ethics Committee (Date: 29.12.2022; Decision no: 2017-KAEK-189_2022.12.29_05)

Collection of Data

All measurements were completed within 3 days. Anthropometric, static flexibility and strength measurements were made on the first day. Then one day was suspended. On the third day, short-term performance measures were collected. Short lane measurements were repeated three times. Participants rested after each repetition until they recovered completely. The best of three measurements was taken and included in the statistical analysis. For the analysis of the data, the short course performance results of the swimming students' were collected after anthropometric tests.

Analysis of Data

The data obtained for the statistical analysis and evaluation of the study were analyzed using the SPSS 22.0 program. The skewness and kurtosis tests were used to determine whether the data showed a normal distribution, and it was seen that the data showed a normal distribution. Pearson Correlation test was applied to examine the relationship between 25 meters freestyle swimming performance results and other variables. The level of significance in the study was accepted as $p<0.05$.

RESULTS

The findings regarding the correlation values of swimming students' somatotype, static flexibility, and strength tests, and 25 meters freestyle swimming performance results are given in Table 2.

Table 2. Correlation values of swimming students' somatotype, static flexibility, and strength tests, and 25 meters freestyle swimming performance results

Variables	N	M	SD	R	p
Endomorph	16	5.02	1.86	0.142	0.59
Mesomorph	16	4.92	1.70	-0.529	**0.03***
Ectomorph	16	1.92	1.16	0.121	0.65
Shoulder Flexion (cm)	16	50.84	9.83	-0.418	0.10
Trunk-Neck Extension (cm)	16	39.18	6.71	-0.292	0.27
Ankle Extension (cm)	16	11.15	2.26	0.021	0.93
Leg Strength (kg)	16	144.18	29	-0.497	0.05
Back Strength (kg)	16	170.68	38.25	-0.369	0.15

Mean (M), Standard deviation (SD), Correlation coefficient (R), **$*p<0.05$**

When the relationship between swimming students' somatotype structures and their 25-meter freestyle swimming degrees is examined, it is found in Table 2 that there is a negative, moderate, and statistically significant relationship between swimming performance results and mesomorph variables (r=-0.529, p=0.035), but no significant relationship was found between endomorph (r=0.142, p=0.599), and ectomorph (r=0.121, p=0.655) variables. No statistically significant correlation was found between swimming performance results and static flexibility test variables such as shoulder flexion, trunk neck flexion and ankle extension (Respectively: r=-0.418, p=0.108; r=-0.292, p=0.272; r=0.021, p=0.938). In addition, no statistically significant relationship was found between swimming performance results and strength test variables such as, leg strength and back strength (Respectively: r=-0.497, p=0.050; r=-0.369, p=0.159).

DISCUSSION AND CONCLUSION

Knowing the physical and anthropometric characteristics that underlie swimming performance is crucial for skill development and appropriate program targeting (Bond et al., 2015). Range of motion (ROM), power force on land, and anthropometric qualities are the specific technical factors that an athlete uses to maximize the average race pace (Nicol et al., 2022). Accordingly, the study looked into the correlation between anthropometric characteristics, a few motor characteristics, and 25-meter freestyle swimming performance. This study is limited to 16 male volunteer participants studying at Yozgat Bozok University Faculty of Sport Sciences. Only the assessment of back and leg strength was applied to the volunteer participants.

There was no difference between the 50 m freestyle swimming stroke rate and 50 m freestyle swimming degrees in the study by Ozlu and Akkus (2016), which involved 31 male swimmers and measured the effect of 50 m freestyle stroke rate on performance. Freestyle swimming performance also increased as body weight went up. It has been found that the swimmers have an endo-mesomorph body type is an important finding pointing to an increase in performance. In Ozkadi's (2019) thesis study, which included 40 swimmers, 20 male and 20 female, aged 16 to 17, it was discovered that long jump, aerobic endurance, speed characteristics, and flexibility in men significantly affect swimming performance. In contrast, women's swimming performance is significantly influenced by height, hand, foot, forearm circumference, body composition, long jump, speed, agility, and balance characteristics. In the study of Tahıllıoğlu et al., (1999) on 24 male elite swimmers aged 18-21 years, it was seen that the somatotype structures of the swimmers were mesomorphic and when their anthropometric characteristics were examined, they were taller, broader-shouldered, and more muscular, and the muscle density was especially in the shoulders and upper body. It has also been stated that height provides a significant advantage to the athletes during the start, races, turns, and finishes. Yarar et al. (2021), in which he investigated the effects of physical and anthropometric features on sprint swimming performance on 15 male swimmers aged 19-23 years, and found that anthropometric features such as height, arm length, stroke length, leg length, and body length were particularly effective in 50 m freestyle sprint swimming performance. In addition, it is recommended to pay attention to these features when choosing athletes for short-distance swimming or when creating a team.

It was determined that there was a relationship between anthropometric features and swimming performance after looking at studies with similar research designs in the literature. This relationship included somatotype, some motoric features, and anthropometric features. Swimming results, a performance measure in this study, had a negative, moderate, and statistically significant association with the mesomorph variable. It was shown that swimming time dropped, and performance improved as students got closer to the mesomorph body type. In contrast to similar studies, the variables of static flexibility tests and time of swimming were shoulder flexion, trunk-neck extension, and ankle extension. It is believed that the reason there is no correlation between leg strength and back strength, which is one of the variables of strength tests, is because the swimming students are not at the elite level and train less than the elite level athletes. In Özkadı's (2019) study, the relationship between flexibility and swimming performance results may be because it consists of swimming athletes who have at least 3 years of sports age and participate in competitions.

In a study by Ozkan et al. (2010), 15 female volleyball players aged 14 to 20 competing in the second league had their body composition values, somatotype characteristics, anaerobic performances, and isometric leg-back strength measured. It has been determined that leg-back strength is also a factor in determining anaerobic performance. Additionally, it was noted that volleyball players' body fat percentages are normal. In Muñoz et al.'s (2020) study examining the anthropometric characteristics, body compositions, and somatotypes of 90 elite male runners between the ages of 17-23, the runners were divided into two groups middle-distance runners and long-distance runners according to their specialties. It has been found that middle-distance runners have more height, body weight, upper arm circumference, total upper arm area, and upper arm and thigh muscle area than long-distance runners. It has been stated that normative data that can help trainers in determining the abilities of elite middle and long-distance runners are provided. In the study of Penichet-Tomas et al. (2021), in which 13 elite male and 11 female traditional rowers aged 23-31 participated, the anthropometric profile, body composition, somatotype of rowers, and which variables could be used as determinants of rowing performance were investigated. Male rowers have more muscle mass, girth, and width and are taller and heavier; female rowers were found to have higher skinfold total and fatter mass. Ectomorphs in male rowers; Balanced mesomorph body type was found in female rowers. It was found that height was the best predictor of rowing performance for male rowers, while muscle mass was the best predictor of rowing performance for female rowers. It was stated that the values found can be used as reference values for the coaches and rowers of traditional rowers competing at the national level. In the study of Marinho et al. (2016), in which 8 elite male mixed martial arts athletes between the ages of 26-36 participated, the body compositions, somatotypes, and physical fitness of the athletes were examined. It has been observed that athletes have high lean body mass and predominantly mesomorph body type. It was found that abdominal and upper extremity endurance were at a good level, but lower extremity performances in the long jump were weak. On the other hand, lower maximal power levels were obtained in the squat and bench press tests. It has been suggested that the results can be used in the skill detection process in mixed martial arts athletes.

When the studies in the literature investigating the anthropometric, somatotype, and some motoric characteristics of athletes in branches other than swimming are examined, it is seen that the anthropometric characteristics and somatotype structures of the athletes can play an important role in their talent selection according to the branches and may have an effect on their performance. The outcomes of this study and these results shows similarity. As a result, there was a negative and statistically significant relationship between swimming students' swimming performance results and the mesomorph variable (r=-0.529, p=0.035), while a statistically significant relationship was not found between static flexibility and strength tests and 25 meters freestyle swimming performance results.

The findings of the present study indicated that the somatotype structures of swimmers are regarded to be a significant factor in skill selection and to be a predictor of swimming success. And also, mesomorph variables play a significant role in and 25 meters freestyle swimming performance. In addition, body composition was found to be an important factor in 25 meters freestyle swimming performance of swimmer. The somatotype structures of the athletes can be used to create training plans, and the association between various swimming distances and somatotype structures, anthropometric measurements, and motoric features can be investigated.

Conflict of Interest: There is no personal or financial conflict of interest between the authors in this article.

Authors’ Contribution: Research Design-EE; AO, Data Collection-EE, Statistical Analysis-IK; EE; HY; AO, Manuscript Preparation-EE; IK; HY; AO.

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