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Age-related physical and performance changes in young swimmers: The comparison of predictive models in 50-meter swimming performance

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Keywords

Anthropometric, Motor Performance, Swimming Styles

Cover Page Footnote

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Article

Age-related physical and performance changes in young swimmers: The comparison of predictive models in 50-meter swimming performance

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Abstract: Introduction: The purpose of the study was to investigate the age-related anthropometric and motor performance changes over time and their contributions to swimming style-specific performance in young different chronological age swimmers. Material and Methods: The study was conducted on a total of forty swimmers who were divided into 2 groups. The Anthropometric measurements were executed from 12 body parts, and body composition analysis was determined by using the skinfold method. The motor performance tests were performed for the assessment of standing horizontal jump, handgrip strength, flexed-arm hang strength, sit-up, flexibility, aerobic endurance, speed, agility, and balance. Simple Linear Regression analysis was performed to build the models for each of the swimming styles. Results: All the models indicated that aerobic endurance was a significantly predictive variable on all swimming styles ($p < 0.001$). The results indicated that the anthropometric and motor performance predictors changed depending upon the age progression in each swimming style ($p < 0.001$). Conclusions: The effect of many variables on swimming performance is seen to be more evident in the following periods based on the increase of age. Aerobic endurance is a common variable that shows effectiveness on swimming performance for both all age groups and swimming styles.

Keywords: anthropometric, motor performance, swimming styles.

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1. Introduction

Training experience that is gained through regularly attending formal training is one of the major determinants for peak performance in sports [1, 2]. The phenomenon of progressive biological maturation is affected gradually and periodically increasing intensity by more extensive training [3]. An age-related peak and decline in sports performance have been investigated in many previous studies [4–9]. For example, in the literature studies that investigated swimming peak performance age, Schulz and Curnow [9] reported that the age of peak performance in swimming was about 20 years. In another study, the peak performance in freestyle swimming was determined at ~18 years of age for 1,500 m race distances, and at ~23 years for 50 m distances [10]. Tanaka and Seals [4] found that peak performance was achieved at 30–35 years for women and 25–40 years for men in

1,500 m freestyle swimming, in the 50 m freestyle swim it was at 20–30 years for both genders. Rüst et al. [5] reported that female swimmers showed peak swimming speed at ~20–21 years for distances of between 50 m and 400 m freestyle, and for men, the age of peak swimming speed was achieved between ~22–23 years and ~25–27 years for distances of 50 m and 1,500 m freestyle, respectively. Elite young athletes' success is supported by a range of age and maturity-related anthropometric and bio-motoric variables that play the determining role in sport-specific performance [11]. Individual differences, including posture, body mass, and muscle mass, marked increases in muscle strength and muscle power, the muscle enzyme profile to promote the anaerobic generation of energy, and aerobic fitness are most pronounced at 12–15 years when participating in sport [11].

To our knowledge, the anthropometric and motor performance changes based on chronological age, and the affecting properties over time in four style swimming performance have not been investigated enough, except for a few studies [12, 13] that have not been directly related to our study design. Therefore, the purpose of this study was to investigate the age-related anthropometric and motor performance changes over time and their contributions to four swimming style-specific performances in young swimmers of different chronological ages. It was hypothesized that the contributions of age-related properties to each swimming style were changeable in 50-meter swimming performance.

2. Materials and Methods

2.1. Participants

The study involved forty swimmers (boys aged 12–13 years, *n* = 20; and boys aged 14–15 years, *n* = 20). All the swimmers were divided into 2 groups based on chronological age. The age was computed from the year of birth. The age groups of 12–13 and 14–15-year-olds were named as group 1 (G1) and group 2 (G2), respectively. Swimmers from both age groups had at least three years of training and competition experience. The swimmers' demographic data are summarized in Table 1. The swimmers performed formal training programs that mentioned the training procedures and did not participate in any additional swimming or conditioning training programs. Before the study, a written informed consent form was signed by the parents, because the participants were under 18 years of age. The study was approved by the ethics committee of the Hitit University (protocol code: 2018-11), with consideration for the Declaration of Helsinki for research involving human participants.

2.2. Training Process

Group 1 (swimmers from the 12–13-years-old age group) had 2 peak competitions and a 40 week-long training microcycles during the training season. The training procedure consisted of 3 or 4 training sessions weekly, and an average of 3 or 4 km swimming training per session. Besides, 30-minute dry-land training before swimming training was performed twice a week. The training season for Group 2 (swimmers from the 14–15-years-old age group) consisted of 3 peak competitions and 46 week-long training microcycles. The training procedure included five or six training sessions, two of them were dry-land training, and an average of four or five km of swimming training was performed per session.

2.3. Design and Procedures

The participants did not engage in swimming training at least 24 hours and did not eat for at least three hours before the performance tests. In addition, the participants were warned not to use stimulant supplements. All the participants started with a 10-min warm-up before the motoric tests and then performed all of them in a systematic order for two days without affecting each other. The four swimming style times were obtained in a 50-meter official competition in 2018, 2 weeks after performing all motoric tests and anthropometric measurements.

2.4. Body Composition and Anthropometry

Before performing the motoric tests on the first day, body composition and anthropometric measurements were taken from all participants according to the standardized procedure. The subjects' body height and mass were measured to the nearest 0.5 cm and 0.1 kg (Seca 220 Germany), respectively. Body fat mass (%) and fat-free mass (kg) were measured by using the skinfold method, which was performed by an expert person. Skinfold thickness (mm) was taken from swimmers at three identified anatomical sites (chest, abdomen, thigh) using a Holtain caliper. The Jackson-Pollock equation was used to calculate body fat (%) [14].

The anthropometric measurements (arm span, hand length, foot length, biceps circumference in flexion, forearm circumference, thigh circumference, calf circumference, chest circumference, hip circumference, waist circumference, wrist diameter, ankle diameter) were taken using a Holtain anthropometric set by an expert practitioner according to the techniques recommended by Adam and Beam [15].

2.5. Motoric Performance

The performance tests were performed on separate two days. On the first day: after 10-minute standardized warm-up (low-intensity running and stretching exercises), flexibility tests with 30-second rest were performed in the following order: sit and reach flexibility test, trunk–neck flexibility test, and shoulder flexibility test. Each test was performed by the participants twice, and the better score was recorded. After the flexibility tests, the standing horizontal jump test was performed twice with one-minute rest, and the better score was recorded. The handgrip strength test was performed for right and left hands with one-minute rest, and the better score was recorded. The sit-up test was performed within a one-minute time period to measure abdominal muscle endurance. The flexed-arm hang strength test was performed, and the time of the test was recorded. The Flamingo balance test (count the number of falls in one minute of balancing on a leg) was performed [15]. 3-minute rest break was given to recover between each of the performance tests.

On the second day: after 10-minute standardized warm-up, the swimmers undertook a sprint running test consisting of 2 maximal sprints of 30 m, with a 3-minute rest period between each sprint, and the better score was recorded. An Illinois test was used to determine agility. An athlete got up as quickly as possible and runs around the course in the direction indicated, without knocking the cones over, to the finish line, at which the timing is stopped and the score was recorded in seconds. 15 minutes later, an aerobic endurance test was performed with the Cooper test (12 minutes), and at the end of the time, the distance covered by the swimmers was recorded. The test procedures were explained and demonstrated to the subjects before each of the tests [15].

2.6. Swimming Performance

Freestyle, breaststroke, butterfly, and backstroke swimming performance results were obtained in the official competition that was held during the 50-meter season in 2018. The swimming performance was recorded with one-hundredth of a second accuracy for each of the styles.

2.7. Statistical Analysis

Statistical analyses were performed to assess the sample's power. The Shapiro-Wilk test was used to test the normality of the data distribution. After normality assumptions were checked, a parametric test (independent two-sample t-test) was conducted for the normality of the data distribution, and a non-parametric test (Mann Whitney U) was used for not normally distributed data. Variables were expressed as means ± standard deviations (SD) and median (min-max) including 95% of the confidence interval. Simple linear regression analysis was performed to estimate the effects of the independent variables (anthropometric and motoric skills as a total of 27 variables) on the dependent variable (each of four competitive swimming styles). According to the correlation analysis results, the variables that showed $r \geq 0.70$ values were taken for the regression models for each of the swimming styles. All statistical procedures were performed for each age group separately, and SPSS 22.0 Statistical Package (SPSS Inc., Chicago, IL, USA) was used for all variables. The level of statistical significance was set at $p < 0.05$.

3. Results

The study results were presented by comparing statistically descriptive information (Table 1), anthropometric features (Table 2), and performance components according to age groups (Table 3). The comparison of predictive models was obtained using a simple linear regression analysis, presented in Figures 1–4, according to each of the swimming styles. Statistically significant differences were found in all characteristic features between the age groups (Table 1). The study results in Table 2 showed that statistically significant differences were found in hand length (HL), foot length (FL), chest circumference (CC_b), wrist diameter (WD), ankle diameter (AD), and according to the age groups. The performance parameters that included standing horizontal jump (SHJ), handgrip strength (HGS), flexed-arm hang strength (FAHS), abdominal muscle endurance (AME), sit and reach flexibility(S&R), trunk-neck flexibility (TNF), shoulder flexibility (SF) were found statistically significant differences between the age groups in Table 3.

Table 1. The swimmers' demographic data according to the age groups.

	G1 Mean ±Sd Median (min–max)	G2 Mean ±Sd Median (min–max)	MD	%	*p*
Age	12.50 ±0.51 12.50 (12.00 – 13.00)	14.35 ±0.48 14.00 (14.00 – 15.00)	1.85	14.8	**0.000**
BH (cm)	161.6 ±9.98	169.8 ±6.53	8.23	5.1	**0.004**
BM (kg)	52.48 ±7.17 55.55 (39.50 – 61.00)	61.45 ±8.88 63.85 (46.40 – 78.20)	8.97	17.1	**0.003**
BF (%)	8.25 ±3.61	5.76 ±1.06	2.49	-30.2	**0.007**
FFM (kg)	48.08 ±6.45	57.94 ±8.66	9.86	20.5	**0.000**
SE (year)	3.95 ±0.82	5.35 ±1.22	1.41	35.4	**0.001**

$p < 0.05$, **G1:** 12–13-year-olds; **G2:** 14–15-year-olds; **BH:** body height; **BM:** body mass; **BF:** body fat; **MD:** mean difference; **SE:** sport experience

Table 2. The participants' anthropometric features according to the age groups.

	G1 Mean ±Sd / Median (min–max)	G2 Mean ±Sd / Median (min–max)	MD	%	*p*
AS (cm)	166.5 ±12.05 / 160.75 (148.00 – 185.00)	174.0 ±7.61 / 173.20 (159.00 – 189.00)	7.56	4.5	0.063
HL (cm)	18.68 ±2.01 / 18.50 (15.80 – 23.00)	20.88 ±2.45 / 20.00 (18.00 – 25.00)	2.20	11.8	**0.005**
FL (cm)	25.34 ±1.37	27.45 ±1.82	2.10	8.3	**0.000**
BFC (cm)	26.47 ±1.87 / 26.00 (23.00 – 29.40)	27.44 ±2.10 / 27.00 (25.00 – 31.00)	0.98	3.7	0.289
FC (cm)	23.74 ±1.94	24.24 ±2.14	0.50	2.1	0.445
TC (cm)	46.20 ±3.62 / 46.25 (37.50 – 52.00)	46.76 ±4.07 / 48.60 (38.00 – 50.00)	0.56	1.2	0.369
CC_a (cm)	32.00 ±2.28	34.01 ±2.86	2.01	6.3	0.435
CC_b (cm)	80.02 ±6.40 / 78.50 (71.00 – 89.00)	86.29 ±6.64 / 87.00 (76.00 – 96.00)	6.26	7.8	**0.006**
HC (cm)	83.80 ±7.63 / 86.50 (69.00 – 94.00	86.89 ±5.60 / 85.50 (79.00 – 97.00)	3.10	3.7	0.529
WC (cm)	69.25 ±5.74 / 69.50 (62.00 – 83.00)	70.64 ±3.52 / 71.00 (64.00 – 75.00)	1.39	2.0	0.091
WD (cm)	5.12 ±0.35 / 5.00 (4.50 – 6.00)	5.44 ±0.46 / 5.45 (4.40 – 6.10)	0.32	6.3	**0.014**
AD (cm)	6.02 ±0.45	6.47 ±0.45	0.45	7.5	**0.004**

AS: arm span; **HL:** hand length; **FL:** foot length **BFC:** biceps circumference in flexion; **FC:** forearm circumference; **TC:** thigh circumference; **CC_a:** calf circumference; **CC_b:** chest circumference; **HC:** hip circumference; **WC:** waist circumference; **WD:** wrist diameter; **AD:** ankle diameter

Table 3. The performance components according to the age group.

	G1 Mean ±Sd Median (min–max)	G2 Mean ±Sd Median (min–max)	MD	%	*p*
SHJ (cm)	152.0 ±19.7	201.9 ±35.93	49.93	32.8	**0.000**
HGS (kg)	26.71 ±6.42 27.80 (16.80 – 36.00)	35.51 ±8.64 40.00 (25.00 – 48.00)	8.80	32.9	**0.004**
FAHS (sn)	8.69 ±4.16	16.41 ±8.47	7.45	88.8	**0.001**
AME (nr.min^{-1})	37.65 ±7.00	42.40 ±7.49	4.75	12.6	**0.045**
S&R (cm)	16.80 ±7.29	28.70 ±4.98	11.90	70.8	**0.000**
TNF (cm)	54.45 ±7.46	61.70 ±5.36	7.25	13.3	**0.001**
SF (cm)	54.90 ±14.08 56.50 (28.00 – 72.00)	64.00 ±9.56 67.50 (48.00 – 76.00)	9.10	16.6	**0.024**
AE (m)	2410 ±180.3	2490 ±180.3	80.00	3.3	0.169

$p < 0.05$ **SHJ:** standing horizontal jump; **HGS:** handgrip strength; **FAHS:** flexed-arm hang strength; **AME:** abdominal muscle endurance; **S&R**: sit and reach flexibility; **TNF:** trunk-neck flexibility; **SF:** shoulder flexibility; **AE:** aerobic endurance; **nr.min^{-1}:** number of repetitions per minute; **nf.min^{-1}:** number of falls per minute; **s:** second

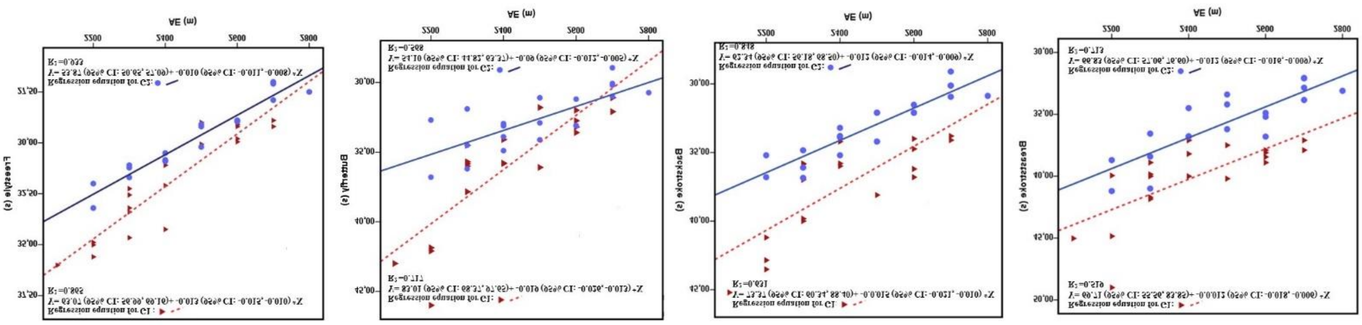

Figure 1. The simple linear regression model results with scatter plots that belong to four swimming styles for both age groups

Simple linear regression models indicated in both age groups that aerobic endurance (AE) was a significant predictive variable in swimming performance for all styles (Figure 1). It can be seen that the contribution (AE: adjusted R2 = the range of 0.519 to 0.865) to the models consisted of freestyle, backstroke, butterfly, and breaststroke in swimming performance, 86.5%, 63.1%, 71.7%, 51.9%, respectively, for G1 ($p < 0.001$ for all styles). In G2, the following contribution (AE: adjusted R2 = the range of 0.568 to 0.933) to the models was found: 93.3%, 84.8%, 56.8%, 71.3%, respectively (Figure 1).

The simple linear regression model results for G1 indicated that FC, AME, TNF, and agility were significantly predictive variables (54.3%, 70.2%, 75.3%, 51.7%, respectively) in freestyle swimming performance. The BH, AS, CC_b, and ffm variables were the significant predictive ones with the rate of 56.7%, 66.0%, 52.7%, and 51.6%, respectively for G2 (Figure 2).

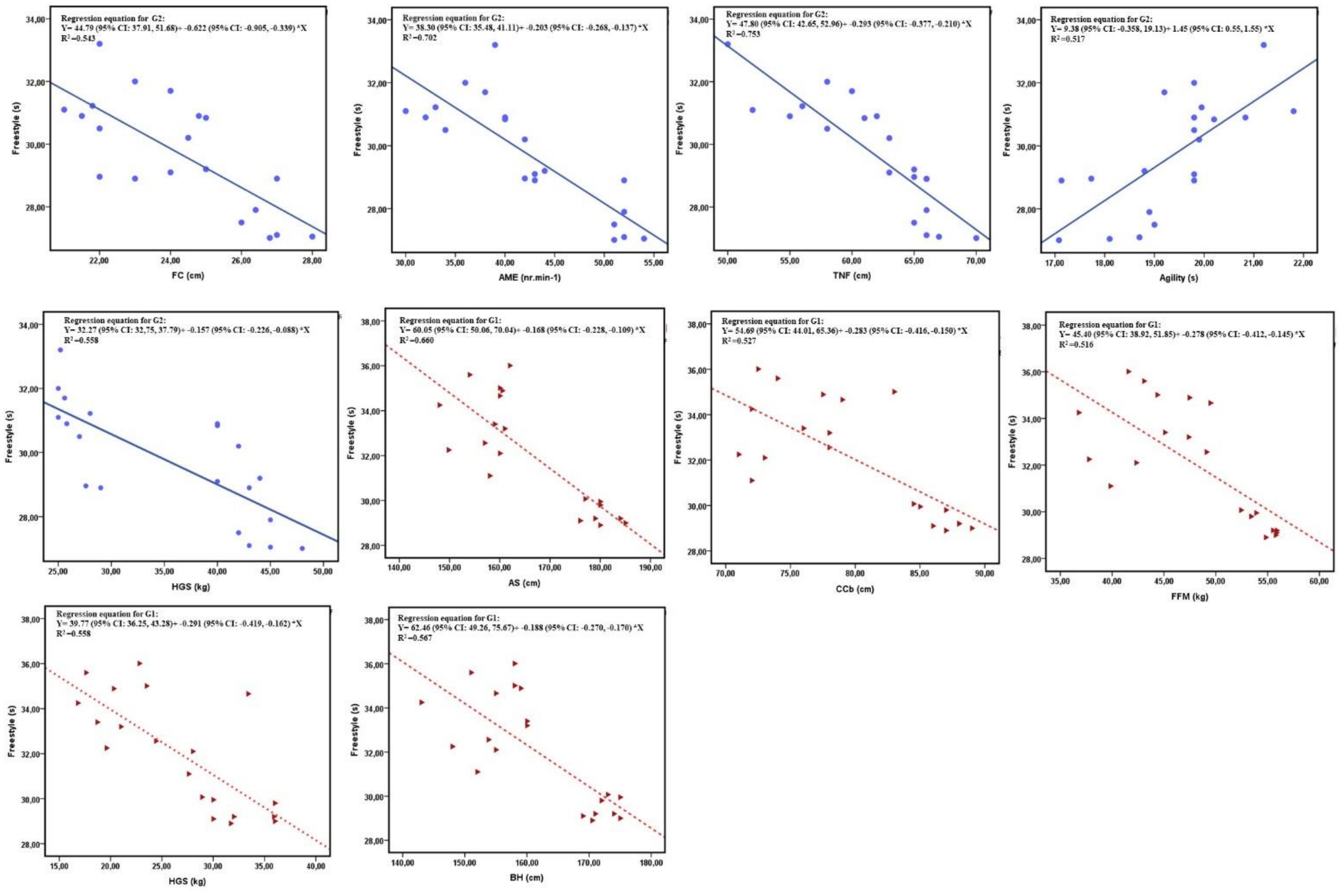

Figure 2. The simple linear regression model results with scatter plots that belong to the freestyle swimming style for each age group.

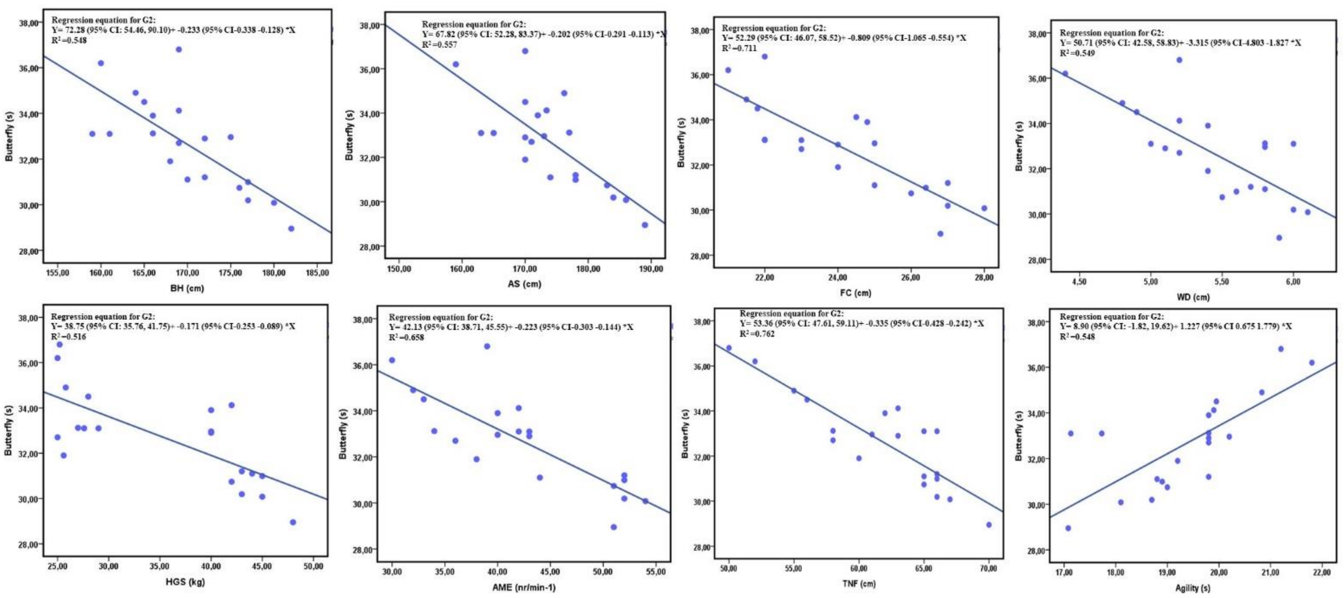

Figure 3. The simple linear regression model results with scatter plots that belong to the butterfly swimming style for Group 2.

The simple linear regression model results for G2 showed that height, AS, FC, WD, HGS, AME, TNF, and agility were significantly predictive variables (54.8%, 55.7%, 71.1%, 54.9%, 51.6%, 65.8%, 76.2%, 54.8%, respectively) in butterfly swimming performance (Figure 3).

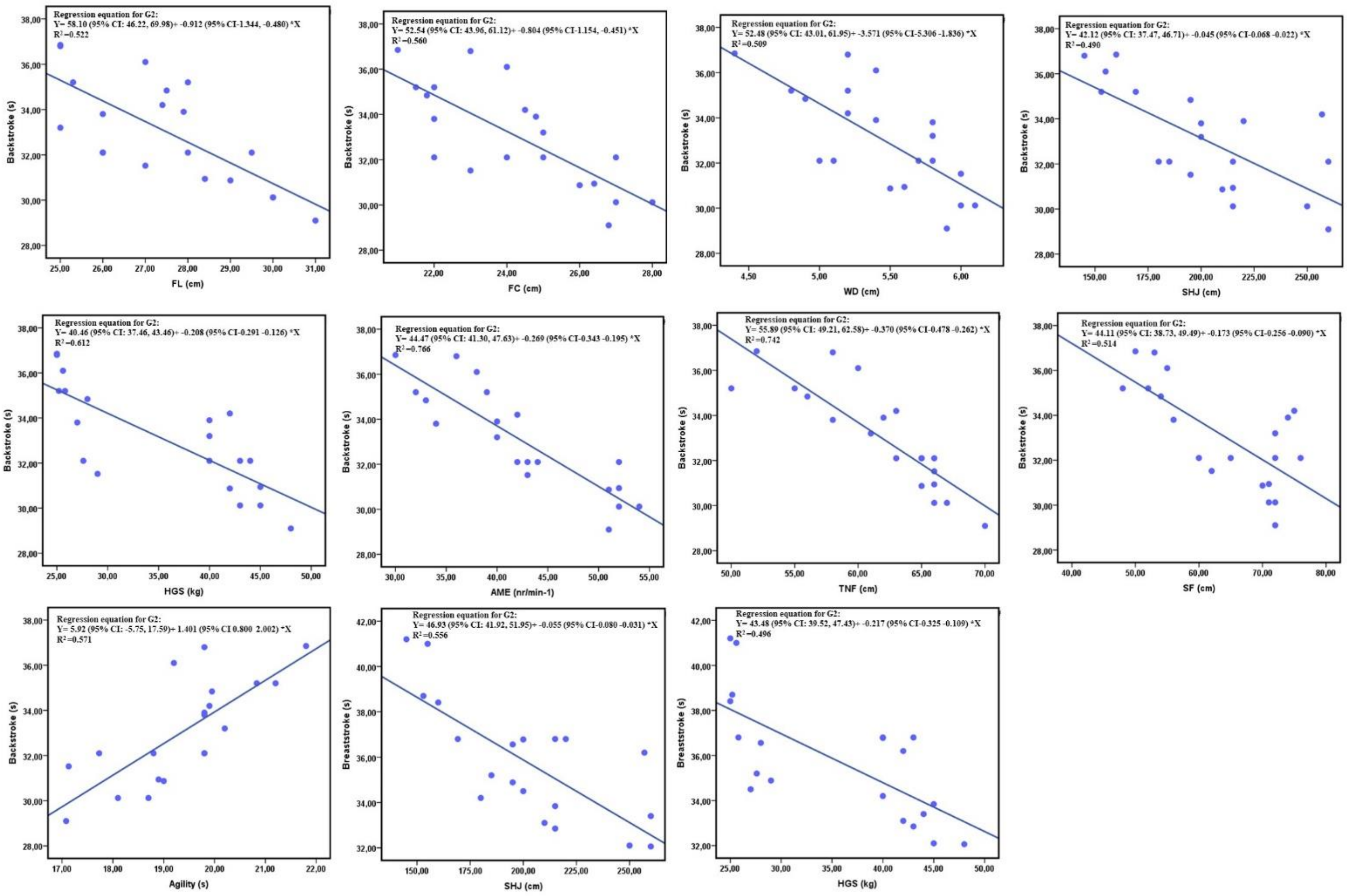

Figure 4. The simple linear regression model results with scatter plots that belong to backstroke and breaststroke swimming styles for Group 2.

Figure 4 presents results with scatter plots for G2. It was found that FL, FC, WD, SHJ, HGS, AME, TNF, SF, and agility were significantly predictive variables (52.2%, 56.0%, 50.9%, 49.9%, 61.2%, 76.6%, 74.2%, 51.4%, 57.1%, respectively) in backstroke swimming performance. SHJ and HGS were found to be the significant predictive variables (55.6% and 49.6%, respectively) in the breaststroke swimming style.

4. Discussion

This study investigated the contribution of different anthropometric parameters and performance components to fifty-meter swimming performance according to the age groups. The study findings may also reveal important differences, and dominant components that have importance in swimming performance by the chronological age. This study primarily compared the characteristic, anthropometric, and performance components to determine the changes that would be executed with chronological age progression. The initial findings showed significant differences among all of the participants' characteristic features (Table 1). With the age increases, BH, BM, and ffm increased (5.1%, 17.1%, 20.5%, respectively); however BF (-30.2%) significantly decreased. The anthropometric variables, HL, FL, CC_b, D, and AD (11.8%, 8.3%, 7.8%, 6.3%, and 7.5%, respectively) in G2 were significantly longer and larger than among G1 swimmers (Table 2).

The study findings revealed that when comparing BH and arm span, especially in G2, the arm span was seen longer than BH according to the results with scatter plots in Figure 3. Based on this finding, having a longer arm span may provide a mechanical advantage to the swimmers to pull more water for making propulsion. Ferraz et al. [16] reported that anthropometric characteristics, particularly the length of body segments, influenced the efficiency of swimmers' segmental movements. In the performance components that included SHJ, HGS, FAHS, AME, S&R, TNF, and SF (32.8%, 32.9%, 88.8%, 12.6%, 70.8%, 13.3%, and 16.6%, respectively) except AE, speed, agility, and balance were significantly different between swimmers from the 12–13-year-old age group and the 14–15-year-old age group (Table 3). The study findings indicate that especially with the fat percentage decrease, the increased height, body mass, and ffm in together with biological maturation may lead to improved performance among the 14–15-year-old swimmers. These findings are in agreement with previous studies. Albaladejo-Saura et al. [17] stated that biological maturation showed to have a significant relationship with the kinanthropometric and physical fitness variables in males. Early maturity indicated higher values of body mass, height, BMI, and fat mass percentage. In addition, they showed better results in physical fitness tests including medicine ball throw, handgrip strength, countermovement jump, and standing jump. However, a relationship between aerobic endurance and flexibility (sit and reach) results and the maturity status was not found [17]. A study conducted by Lesinski et al. [18] investigated maturity, age, and sex-specific differences in anthropometric and physical fitness in young athletes from various sports. The findings showed that with increasing maturity status and chronological age, body height and mass significantly increased. They stated that physical fitness outcomes including countermovement jump height, drop jump height, drop jump performance index, T-test, and handgrip strength improved with increasing chronological age (i.e., 12 = 13 < 14 < 15 years). Demirkan [2] reported that height, body weight, fat-free mass, and arms–legs anaerobic power and capacity, speeds, and handgrip strengths increased both in one age range and in two age ranges together with age progression (age: 15, 16, 17 respectively). The improved strength during puberty coinciding with the increased muscle mass was one of the main factors responsible for improving strength [19]. Nevill et al. [20] demonstrated an increase in strength among adolescents from 8 to 17 years old associated with body height and body mass increases.

In another study, Costa et al. [21] revealed that the greatest increase in strength was found to occur from 13 to 14 years of age in boys. They stated that no significant difference was found in muscle mass between 10- (26.7 ± 2.7 kg) and 13-year-old (37.1 ± 9.1 kg) boys. Demirkan et al. [1] conducted a study examining the physical and physiological differences as dependent on the age of young wrestlers. They reported that height, body mass, fat-free mass, and arms–legs anaerobic power and capacity, speeds, and handgrip strengths increased both in one age range and in two age ranges together with age progression. In addition, Sokołowski et al. [3] reported that the swimmers who had higher maturity levels were likely to achieve better performance than their less mature peers because of their greater aerobic and anaerobic abilities.

The main findings related to the predictive models differed depending on whether the variables predicted more than one swimming style or only one style. In the case of more than one swimming style, 1) the study findings showed that AE was the main contributor to performance components in swimming performance for all age groups and styles (Figure 1). 2) It was found that the HGS was the predictive variable for swimmers from the 14–15-year-old age group in all swimming styles (Figures 2–4). 3) The FC, AME, TNF, and agility variables were seen to be predictive components for swimmers from the 14–15-year-old age group in all swimming styles except the breaststroke style (Figures 2–4). 4). Body height and arm span parameters were found as predictive variables in all age groups for only freestyle and butterfly swimming performance (Figures 2–3). 5) SHJ and WD were found as the predictive parameters in backstroke – breaststroke (Figure 4), and backstroke – butterfly (Figure 3–4) swimming styles respectively for swimmers from the

14–15-year-old age group . For one swimming style: FL and SF were seen as the predictive parameters for only backstroke swimming performance in the 14–15-year-old age group (Figure 4).

Based on the findings, it can be suggested that the anthropometric features and physiological components, except for aerobic endurance, have not been an evident contributor, and their contribution increases in long-term swimming performance by the biological development depending on age progression (Figures 1–2). The finding could be supported by a study conducted on age-related performance determinants of variables on young swimmers in 100 and 400-m events by Seffrin et al. [22]. They stated that strength and power training in young swimmers were important to improve performance only after the age of 13 years old. Our study results indicate that the anthropometric and motor performance components that influenced swimming performance may change depending upon age and swimming styles. In previous literature on swimmers, Morais et al. [23] reported that young swimmers' performance was dependent on a multifactorial phenomenon consisting of anthropometric, kinematic, and efficiency features, where different factors play significant roles, and also the factors could change over time with the training program. Another study conducted by Pla et al. [24] indicated that speed increased with body height, and a taller swimmer would have a better possibility to win than a shorter swimmer. The findings from the study [24] showed that height importance was positively associated with speed. Together with body height, increased body mass was also highly related to higher speed for male sprinters, but it was associated with a lower speed for 100 m and longer distances. Dopsaj et al. [25] reported that competitive swimmers, especially Olympic elite swimmers, were found to be taller than sub-Olympic ones. They stated that enhanced swimming performance, such as sprint-swimming in both males and females, had a high level of relationship with optimal balance between FFM and fat tissue. Morais et al. [26] stated that better swimming techniques always provided better swimming performance together with larger body dimensions including higher arm span, height, and upper limbs. Geladas et al. [27] reported that total upper extremity length, leg power, and handgrip strength were the predictive components in 100-m breaststroke swimming performance in 12–14-year-old boys. Mezzaroba and Machado [12] conducted a study examining the influence of age, anthropometry, and distance on stroke parameters and performance of children and adolescent swimmers (age 10–17 y). They stated that the stroke index together with body height, limb length, and advancing age proved to be the best technical parameter to predict performance from 100 to 400 m for young swimmers, but with significant changes around 14 years of age. Demirkan et al. [28] found that performance variables, including aerobic capacity, horizontal jump, and flexibility, were highly predictive variables and they were related to the swimming race time. Saavedra et al. [29] stated that sitting height, speed, aerobic endurance, and swimming index explained 82.4% of competitive swimming performance among 11–12-year-olds. Lätt et al. [30] reported that arm span was the best anthropometric predictor, and the stroke index was the best predictor of performance. The study findings [30] indicated that the stroke index and the stroke rate alone explained 92.6% of the variance in competitive performance. They found that 100-m breaststroke swimming time was significantly related to body height and arm span. Dimitric et al. [31] reported that anthropometric variables such as arm span, length of upper and lower limbs, and performance variables including strong abdominal muscles, arm strength, and jump performance were contributor variables in swimming performance for each style. Figueiredo et al. [32] found that anthropometric variables, including higher values of arm span, height, hand length, body mass, foot length, foot width, and hand width, and the performance components, such as speed and aerobic endurance, were related to a strong influence on front crawl sprint swimming performance in 11–13-year-old swimmers. Malina et al. [33] stated that maturation progress that was based on the individuals' skeletal and sexual maturation was directly related to improved motor performance. The literature studies indicated that swimming performance was a multi-component phenomenon that included anthropometric and physiological efficiency, and the effectiveness of the variables could change over time with maturation related to age progression.

5. Conclusions

The study findings present that based on the increase in age, the effect of many variables (for example, common variables for all styles: AE, HGS; in freestyle, backstroke, butterfly: FC, AME, TNF, and agility; in backstroke and breaststroke: SHJ) in swimming performance are seen to be more evident in the following periods. However, the findings indicate that aerobic endurance is the common contributor component in four styles of swimming performance for all age groups. In line with this finding, it may be suggested that aerobic endurance should be focused on more than the other performance variables in early-age swimmers. Considering age-related changes of the anthropometric and motor performance could help to focus on the prominent performance properties in each swimming style based on the age progression, and to design an appropriate training program for the coaches. In addition, the coaches may take into account in the training program design from early for the 12–13-year-old swimmers, considering the motoric performance variables which are prominent in the later age group. The findings may be beneficial for talent identification according to the swimming styles, and they also present the age-related normative data of young swimmers.

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