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Associations between anthropometric measurements and vertical jump with 20m front crawl swimming time among young swimmers.

KEYWORDS:
Swimming performance.
Anthropometric measurements.
Vertical jump height. Front crawl.
Young athletes.

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ABSTRACT

The relationships between anthropometric characteristics and fitness abilities is paramount for optimizing training and improving performance. This study investigated the relationships between anthropometric measurements and time to cover 20 m in front crawl swimming. Eighteen participants aged 7 to 14 years (6 boys and 12 girls) were recruited. Anthropometric measurements (height and arm span), vertical jump height, and 20 m front crawl swimming time were assessed. No sex-based differences were observed regarding anthropometric characteristics or performance variables (e.g., 20 m swimming time = 17.8 ± 4.0 seconds, boys; 19.1 ± 5.1 seconds, girls) (all p = .60). Negative partial correlations were found between swimming time with arm span (r = -.51; p = .04) and vertical jump height (r = -.53; p = .04), but not with height (p = .08). These results indicate that participants with greater arm spans (mean 142.8 ± 15.6 cm) and higher vertical (mean 64.4 ± 12.8 cm) jump heights tend to exhibit faster swimming speeds. These findings highlight the importance of arm span and lower limb explosive power in swimming performance among young athletes.

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Associações entre medidas antropométricas e o salto vertical com o tempo nos 20 m de nado crawl em jovens nadadores.

RESUMO

A relação entre as características antropométricas e as capacidades físicas é fundamental para otimizar o treino e melhorar o desempenho. Este estudo investigou as associações entre medidas antropométricas e o tempo necessário para percorrer 20 metros em estilo *crawl*. Foram recrutados dezoito partici-pantes com idades entre os 7 e os 14 anos (6 rapazes e 12 raparigas). Avaliaram-se as medidas antropométricas (estatura e envergadura), altura do salto vertical e o tempo nos 20 metros *crawl*. Não se observaram diferenças esta-tisticamente significativas entre sexos relativamente às características antro-pométricas ou às variáveis de desempenho (e.g., tempo nos 20 m de nado = 17.8 ± 4.0 segundos, rapazes; 19.1 ± 5.1 segundos, raparigas) (todos os p = .60). Verificaram-se correlações parciais negativas entre o tempo nos 20 m de nado e a envergadura (r = -.51; p = .04) e altura do salto vertical (r = -.53; p = .04), mas não com a estatura (p = .08). Estes resultados indicam que os participantes com maior envergadura (média de 142.8 ± 15.6 cm) e maior altura de salto vertical (média de 64.4 ± 12,8 cm) tendiam a apresentar velocidades de nado mais elevadas. Estes resultados destacam a importância da envergadura e da potência explosiva dos membros inferiores para o desempenho na natação em jovens atletas.

PALAVRAS-CHAVE:
Desempenho na natação.
Medidas antropométricas.
Altura do salto vertical.
Crawl. Jovens atletas.

INTRODUCTION

Swimming stands as a sport dependent on the ability of athletes to generate propulsive force through coordinated movements of their upper and lower limbs to navigate through water (Clemente-Suárez et al., 2021; Pyne & Sharp, 2014; Troup, 1999). Performance in competitive swimming is typically determined by the time it takes to complete specific distances. Achieving optimal performance in swimming requires a comprehensive understanding of the factors influencing an athlete's ability to propel through water efficiently. These factors encompass physiological and biomechanical variables, morphological characteristics, metabolic capacities, neuromuscular coordination, and hydrodynamic principles (Clemente-Suárez et al., 2021).

Swimming performance emerges as a complex interplay between the swimmer's physiological attributes and the hydrodynamic forces encountered in the aquatic environment. Thus, elucidating the determinants of swimming performance is paramount for athletes and coaches seeking competitive advantage and researchers aiming to advance our understanding of human locomotion in water. The multifactorial nature of swimming performance underscores the significance of various physiological and biomechanical factors in determining an athlete's proficiency in the water. Notably, studies have underscored the important role of body composition on swimming performance outcomes (Cortesi et al., 2020; Dopsaj et al., 2020; Siders et al., 1993). Anthropometric measurements serve as fundamental indicators of an individual's body composition and structure (Bonilla et al., 2022; Wang et al., 2000), playing an important role in elucidating the relationship between physique structure and athletic performance.

In swimming, anthropometric variables offer valuable insights into the biomechanical dynamics underlying propulsion and drag forces experienced by athletes in the aquatic environment (Shahidi et al., 2023). Studies have consistently shown that certain body dimensions, such as height and arm span are associated with swimming proficiency (Moura et al., 2014; Oliveira et al., 2021; Sammoud et al., 2018). For instance, a study on prepubertal and pubertal swimmers highlighted associations between height and arm span with the 400-m front-crawl swimming test (Jürimäe et al., 2007). This assertion finds additional support in a systematic review, which demonstrated that during the front crawl, there is an advantage of having higher height and arm span measurements (Alves et al., 2022). Integrating anthropometric data into performance analysis frameworks is indispensable for optimising training interventions and fostering athletic development in the swimming community.

Vertical jump performance serves as a valuable indicator of lower limb power, explosiveness, and neuromuscular coordination (Eagles et al., 2015), making it a relevant metric for assessing athletic capabilities across various sports disciplines, including swimming (Calderbank et al., 2021). In the context of swimming performance, the ability to execute powerful push-offs and rapid lower limb movements during turns and starts is critical for achieving optimal speed and efficiency in the water. Moreover, it has been suggested that vertical jump height may correlate with swimming performance (Calderbank et al., 2021). Furthermore, strength training (maximal strength as well as plyometric training) has been shown to improve swimming performance (Yu Kwok et al., 2021). Therefore, incorporating vertical jump assessments into comprehensive performance evaluations can provide valuable insights into the dynamic interplay between lower limb strength, power production, and swimming proficiency.

Considering the relevance of anthropometric measurements and vertical jump for swimming performance, the primary objective of this study was to investigate the correlations between anthropometric measurements and vertical jump performance with speed in front crawl swimming among young athletes. By examining these relationships, we aimed to enhance our understanding of the anthropometrical and neuromuscular factors influencing swimming performance in this population. It was hypothesized that greater arm span and vertical jump height would be significantly correlated with faster 20 m front crawl swimming performance.

METHOD

PARTICIPANTS

A priori power analysis was conducted using GPower (v 3.1.9.7) (Faul et al., 2007) to determine the required sample size, with the significance level set at α = .05 and statistical power at 0.80. Based on a partial correlation coefficient of -.688 reported in a previous study (Jürimäe et al., 2007), the corresponding effect size was calculated as f^2 = .897. Given the inclusion of two covariates (age and sex) in the analysis, the required sample size was estimated to be 15 participants. A total of 18 healthy and injury-free participants (6 males and 12 females), aged between 7 and 14 years old were recruited to participate in this study. Participants were competitive swimmers, and only individuals who had not sustained any injuries or limitations affecting their swimming performance within the past six months were included. Prior to enrolment, all participants underwent a screening session to ensure their suitability for participation. Additionally, participants were required to maintain a consistent training regimen, attending one to two practice sessions per week, to ensure a sufficient level of physical conditioning and familiarity with the sport.

PROCEDURES AND INSTRUMENTS

At the beginning of the session, participants were provided with detailed instructions regarding the execution of exercises, ensuring standardised administration of the protocol, as well as familiarisation with the procedures. Afterwards, anthropometric measurements including height and arm span were obtained. Subsequently, participants underwent evaluations of physical performance in which participants performed maximal vertical jumps to assess explosive lower limb power. Lastly, participants' aquatic performance was evaluated, with the time taken to swim 20 m at maximal velocity. Swimming performance was assessed in a 20 m swimming pool with water temperature between 26°C and 27°C. Prior to their involvement in the study, written informed consent was obtained from all participants and their legal guardians, ensuring ethical conduct and adherence to regulatory guidelines. All data, including anthropometric measurements and performance evaluations, were collected by the same researcher to ensure consistency and minimise potential biases. This study was conducted following the principles outlined in the Declaration of Helsinki ("World Medical Association Declaration of Helsinki: Ethical principles for medical research involving human subjects," 2014) and received approval from the Institutional Ethics Committee (Reference: P02-S09-27042022).

Participants' body height was measured using a stadiometer (SECA 213, Bacelar & Irmão Lda, Portugal). Subsequently, participants stood with their backs against the wall and extended their arms at shoulder level, palms facing outward, to measure arm span, defined as the greatest distance between the tips of the middle fingers. This arm span measurement was taken using a 3 m measuring tape. All measurements were performed with participants barefoot and wearing minimal clothing to ensure precision and accuracy. Vertical jump was assessed using the protocol part of the FITescola® battery test (Directorate-General for Education, 2021). To measure the vertical jump, a measuring tape was affixed to the wall, providing a reference for height measurement. Participants positioned themselves perpendicular to the wall, feet shoulder-width apart, directly over the marked jump line. The participant extended the arm closest to the wall to allow the researcher to record the initial height, marked with chalk, serving as a reference for calculating the maximum distance. With knees flexed and arms pulled back to generate momentum, participants jumped as high as possible. The researcher responsible for all measurements positioned himself facing the jump area to accurately record the maximum height reached. Subsequently, participants marked the wall with chalk to indicate the highest point reached. The jump result was determined by calculating the difference between the initial and maximum heights reached. Each participant performed three jumps (60 seconds between attempts), and the best result of the trials was recorded in centimetres, following the outlined protocol.

20-METER SWIMMING PERFORMANCE

Participants swam 20 m at maximum velocity using the front crawl. The 20 m distance was selected as it represents a commonly used sprint distance in swimming assessments, enabling the evaluation of short-duration, high-intensity performance that emphasises explosive power, technique, and speed, which are critical attributes in competitive swimming (Sengoku et al., 2024). Timing commenced when participants removed their feet from the starting block. Two attempts were made, with a 5-minute passive recovery period provided between each attempt to ensure participants' readiness and minimise fatigue effects. Five minutes was chosen based on prior research indicating that a 4-minute passive recovery period was more effective in preserving performance compared to both active recovery strategies and shorter recovery durations (Kostoulas et al., 2018). The best result from the two attempts was recorded for subsequent analysis. The initiation of each trial was determined by the investigator, who used a manual stopwatch to obtain the timing.

DATA ANALYSIS

The statistical analysis of the obtained data was conducted using SPSS Software version 28 (IBM Corp., Armonk, New York). The data were assessed for normality using the Shapiro-Wilk test, and homogeneity of variances was examined using Levene's test. As these were confirmed, parametric tests were utilised. To assess the differences between sexes, the independent t-test was used. Pearson correlation tests were performed with the combined sample considering the disparate number of male and female participants. Correlation coefficients were interpreted as follows: those < .30 were considered weak, those between .30 and .70 were considered moderate, and those > .70 were considered strong (Field, 2005). As anticipated due to the variability in participants' age range (7 to 14 years) and its influence on anthropometric characteristics (Quanjer et al., 2014) and vertical jump (Nikolaidis, 2014), a strong association was observed between age and the time taken to swim 20 m (r = -.78; p < .001), height (r = .89; p < .001), arm span (r = .86; p < .001), and vertical jump (r = .75; p < .001), as determined by Pearson's correlation test. Therefore, the association between anthropometric measurements and vertical jump with the time taken to swim 20 m was assessed using partial correlation analysis, adjusting for age and sex to mitigate their direct influence on the data. Descriptive results are presented as mean ± standard deviation (including minimum and maximum values), and significance was assumed at a p-value below .05.

RESULTS

Table 1 presents the descriptive characteristics of the total sample and sex-based differences. It displays the anthropometric measurements (height and arm span), the recorded values for verti-cal jump, and the time taken to cover 20 m. No sex-based differences were observed.

TABLE 1. Descriptive characteristics for the whole sample.

Variable	Total (n = 18)	Boys (n = 6)	Girls (n = 12)	p-value
Age (years)	10.2 ± 2.5	9.8 ± 2.2	10.3 ± 2.9	.764
Height (cm)	142.8 ± 16.1	143.5 ± 10.5	142.5 ± 18.7	.905
Arm span (cm)	142.8 ± 15.6	145.3 ± 9.1	141.6 ± 18.8	.654
Vertical Jump (cm)	64.4 ± 12.8	66.8 ± 11.6	63.2 ± 14.3	.594
20 m time (s)	18.7 ± 4.3	17.8 ± 4.0	19.1 ± 5.1	.596

Regarding the partial correlation tests, Table 2 and Figure 1 illustrate a negative correlation between the time to swim 20 m and the variables height, arm span, and vertical jump. A negative correlation was observed between arm span and the time to swim 20 m, indicating that a greater arm span corresponded to a shorter time. Similarly, a negative correlation was noted between vertical jump height and the time taken, suggesting that a higher jump correlated with a shorter time. However, height was the only variable that did not exhibit a statistically significant correlation, although a trend was observed in which taller athletes exhibited shorter times to swim 20 m.

TABLE 2. Partial correlations (adjusted for age and sex) between height, arm span, and vertical jump, with the time taken to cover 20 m.

Variables	20 m time		
	r	*p*-value	95% CI
Height	-.446	.084	[-.91; .02]
Arm span	-.510	.044 *	[-.96; -.06]
Vertical jump	-.527	.036 *	[-.97; -.08]

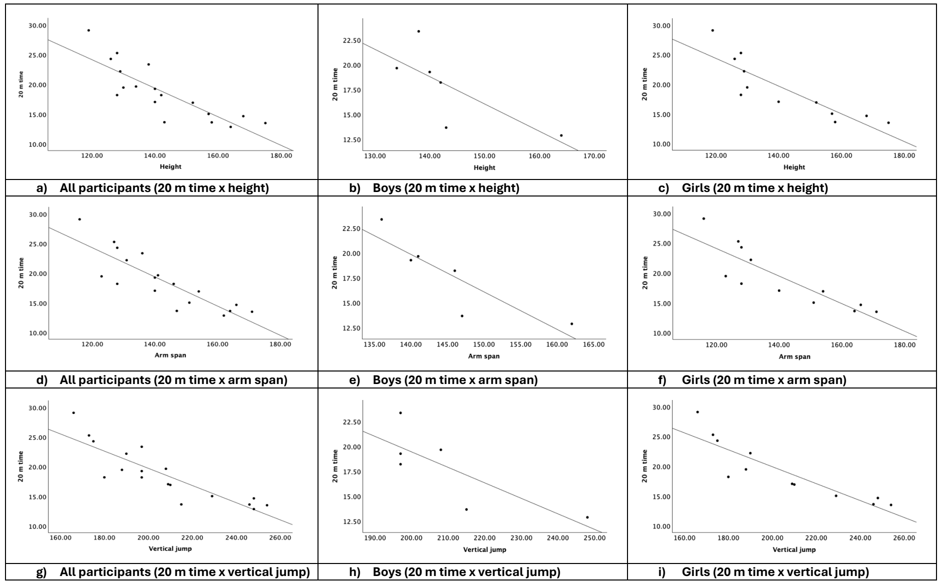

FIGURE 1. Correlations between height, arm span, and vertical jump, with the time taken to cover 20 m.

DISCUSSION

This study investigated the correlations between arm span and vertical jump performance with speed in front crawl swimming among young athletes. Our findings revealed significant negative correlations between the time to swim 20 m and variables such as arm span and vertical jump height. Specifically, a greater arm span and higher vertical jump were associated with shorter swimming times, suggesting their potential influence on swimming speed in this demographic. Comparing our results with previous research, our findings are consistent with studies demonstrating associations between anthropometric characteristics and swimming performance outcomes (Alves et al., 2022).

Similar correlations between arm span and swimming speed were found in adolescent swimmers (Moura, 2014). Additionally, it was found that individuals with longer arm spans tended to exhibit faster swimming times, suggesting that a larger arm span may contribute to reduced water resistance and enhanced propulsion efficiency (Oliveira, 2021). Similarly, significant correlations between anthropometric variables, including height and arm span, and swimming performance metrics were observed among young swimmers (Sammoud et al., 2018). Moreover, associations between height and arm span with swimming times were also observed in prepubertal and pubertal swimmers (Jürimäe et al., 2007). These studies collectively support the notion that specific body dimensions play a crucial role in determining swimming proficiency, highlighting the importance of considering anthropometric characteristics in training and talent identification programs within the swimming community.

Our study is consistent with previous research emphasizing the importance of lower limb power and explosiveness in swimming performance, as assessed by vertical jump performance (Carvalho et al., 2023). For instance, a positive relationship between vertical jump performance and swimming speed was found among competitive swimmers, highlighting the potential of lower limb strength training to enhance swimming performance (Calderbank et al., 2021). Furthermore, it has been suggested that vertical jump height serves as a valuable indicator of lower limb power, neuromuscular coordination, and explosive strength, attributes that are essential for executing powerful push-offs and rapid lower limb movements during swimming starts and turns (Eagles et al., 2015). The observed negative correlation between vertical jump height and swimming time in our study suggests that individuals with greater lower limb power may generate stronger propulsion forces, leading to faster swimming speeds. These findings underscore the importance of incorporating lower limb strength and power development exercises into training regimens to optimize swimming performance among young athletes.

The findings of this study have practical implications for coaches, trainers, and athletes involved in youth swimming programs. By understanding the importance of anthropometric variables and lower limb explosive power in swimming performance, coaches can design more targeted and effective training programs tailored to individual athlete characteristics. For instance, athletes with longer arm spans may benefit from specific technique refinement drills aimed at maximizing propulsion efficiency, while those with lower levels of lower limb power could engage in strength and plyometric training to enhance their explosiveness and push-off capabilities. Moreover, coaches and talent identification personnel can use anthropometric measurements (such as arm span) and vertical jump assessments as screening tools to identify young swimmers with inherent physical attributes conducive to success in the sport. By integrating these findings into coaching practices and talent development pathways, youth swimming programs can better nurture the potential of aspiring athletes and optimize performance outcomes in competitive settings.

Although this study demonstrated correlations between arm span, vertical jump performance, and front crawl swimming speed in among young athletes, several limitations must be acknowledged. The considerable variability in age within the participant cohort, spanning from 7 to 14 years, may introduce confounding effects since differences in growth, maturation, and sex can influence different performance components of young swimmers, which will affect swimming time (Silva et al., 2019). However, partial correlations were employed to mitigate this limitation, adjusting for age (and sex) to attenuate its potential impact on the findings. Moreover, the relatively modest sample size and assessment of only one swimming stroke technique might constrain the generalizability of the results to broader populations of young swimmers and different techniques. Additionally, the study's cross-sectional design precludes the establishment of causal relationships between the variables under investigation, although biological plausibility is aligned with the observed findings. Finally, during data collection, it was not possible to obtain information about the participants' World Aquatics rankings, which could have enhanced our understanding of the results. Future investigations would benefit from larger and more diverse participant samples, assessing different stroke techniques, employing longitudinal designs to capture developmental changes, and comprehensive assessments encompassing additional factors like technique biomechanics and psychological variables. Addressing these limitations and adopting a more holistic approach in future studies would deepen our understanding of the multifaceted determinants of swimming performance among youth athletes.

CONCLUSION

In conclusion, this study highlights the relationships between arm span, vertical jump performance, and speed in front crawl swimming among young athletes. The observed correlations highlight the importance of both anthropometric variables and lower limb explosive power in swimming performance. These findings contribute to a deeper understanding of the factors that influence swimming speed in young swimmers, potentially informing more targeted training programs to improve performance.

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Cultural adaptation and validation of the AQUA© Questionaire in Portuguese athletes.

KEYWORDS:

Allergy. Swimming.
Training. Triathlon. Volume.

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ABSTRACT

Respiratory symptoms are often overlooked by athletes and coaches. The goals of this study were to test the validity and reliability of the European Portuguese version of AQUA© and to analyse respiratory symptoms in Portuguese endurance athletes. Questionnaires were disseminated to Portuguese swimming and triathlon clubs. To test the construct validity, we analysed the relationships between the measure and the scores of other variables. The European Portuguese version of the EQ-5D-5L questionnaire was used for the criterion validity of the European Portuguese version of the AQUA© questionnaire. The sample consisted of 110 participants. Athletes with average training session volumes between 1 and 2 hours showed significantly lower values of AQUA© scores than athletes who performed sessions of more than 3 hours. A moderate and significant negative correlation was observed between the AQUA© score and the EQ-5D-5L index. The association between the AQUA© score allergy prediction and the physician's allergy diagnosis (NRA or PRA) was assessed. Results showed that the PRA group had 100% of the athletes with a positive AQUA© score, and the NRA group had 34.2% with a positive AQUA© score. The AQUA© score was shown to have excellent reliability (ICC = .93). The European Portuguese version of the AQUA© Questionnaire showed excellent reliability. Additionally, the strong association between the AQUA© score allergy prediction and the reported allergy and asthma diagnosis corroborates previous literature, specifically, its exact precision to rule out allergic diseases and asthma.

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