HUMAN MOVEMENT (ISSN 1899-1955)
2023; 24(2): 85–93

Contribution of biological maturation and power of upper and lower limbs to crawl swim performance in adolescent athletes

original paper
DOI: https://doi.org/10.5114/hm.2023.117469

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ABSTRACT
Purpose. There is no consensus in literature data about the influence of biological maturation (BM) on swim performance in young athletes. We analysed the relationship of BM, upper-limb power (ULP), and lower-limb power (LLP) with adolescent athletes' performance in crawl swim.
Methods. This observational study determined the BM of 16 competitive swimmers (50% males and 50% females; 12.90 ± 0.88 years) by a mathematical model based on bone age and anthropometric measures. ULP and LLP were established by the horizontal launch test and the vertical and countermovement jump tests on a force platform, respectively. Swim performance was evaluated by the average speed in a 100-m crawl sprint.
Results. BM was related to ULP (males: $r = 0.76$, $p = 0.001$; females: $r = 0.39$, $p = 0.02$), LLP (males: vertical jump $r = 0.80$, $p = 0.02$, countermovement jump $r = 0.48$, $p = 0.02$; females: vertical jump $r = 0.30$, $p = 0.04$, countermovement jump $r = 0.80$, $p = 0.01$), and crawl swim performance (males: $r = -0.91$, $p = 0.001$; females: $r = -0.72$, $p = 0.04$). BM had a 87% contribution to crawl swim performance in males and a 66% contribution in females. ULP and LLP showed < 50% contribution to crawl swim performance in both females and males.
Conclusions. BM was associated with crawl swim performance of adolescent athletes of both sexes. BM exhibited a stronger contribution to crawl swim performance than ULP and LLP in adolescent swimmers at the puberty window.
Key words: puberty, muscle potency, young athletes, swimming, sport

Introduction

Swimming performance reflects the ability of crossing a certain distance in the water within the shortest time. A minimum improvement in the efficiency of swimming can be crucial, especially in short courses (i.e., 50–100 m) [1, 2]. To achieve a high swimming performance, it is necessary to deliver an efficient propulsion, which is related to the strength and power of the limbs [3, 4]. So, elite athletes display higher strength and power than recreational athletes [5, 6].

In adolescent athletes, in the puberty window, it is thus demanded to consider parallel factors that are associated with the strength and power parameters, such as the biological maturation (BM) [7]. Strength is the biomechanical effort (power) of moving against a particular resistance, and power is the capability of generating energy in a due time [8, 9]. In puberty,

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Received: December 15, 2021
Accepted for publication: July 04, 2022

Citation: Almeida-Neto PF, de Assis GG, do Carmo Silva BR, Medeiros RMV, Bulhões-Correia A, Oliveira VMM, de Queiros VS, de Paiva PHM, Dantas PMS, de Araújo Tinoco Cabral BG. Contribution of biological maturation and power of upper and lower limbs to crawl swim performance in adolescent athletes. Hum Mov. 2023;24(2):85–93; doi: https://doi.org/10.5114/hm.2023.117469.

a number of events that characterize BM, including endocrine, neurological, and musculoskeletal changes, might occur in a delayed, synchronized, or accelerated manner, so young athletes matched by age can present distinct stages of maturation [10, 11]. Such differences in BM may influence the athletes' performance and biodynamics, as has been evidenced in strength and muscle power [12, 13].

We have previously demonstrated that BM is associated with the muscle power of upper and lower limbs in adolescent athletes (females and males), revealing the importance of considering BM stages in the development of training strategies, a opposed to traditional methods which focus only on performance parameters [12–16]. It has been observed that upper-limb strength is associated with performance in the crawl swim [7]. Furthermore, BM appears to be related to the strength in both the upper and lower limbs of young swimmers [17]. However, these preliminary studies are inconclusive because the influence of BM on upper-limb power (ULP) and lower-limb power (LLP) has yet not been considered [15–19].

Pursuant to this, the aim of the present study was to analyse the contribution of BM, as well as ULP and LLP, to crawl swim performance in young adolescents at the puberty window. Our primary hypothesis was that BM would be related to ULP and LLP of adolescent swimmers and, consequently, to their swim power. Secondarily, we hypothesized that BM contributed to the development of ULP and LLP in a different manner, depending on the orientation of neuromotor system development.

Material and methods

Participants

A total of 16 swimmers in a pre-competitive training period (50% males and 50% females; 12.90 ± 0.88 years) classified as national level competitors in accordance with McKay et al. [20] performance assessment for young athletes were recruited from the state team (Rio Grande do Norte, Brazil). The inclusion criteria comprised: (i) participation in the physical education practices at school; (ii) practising in a systematic training regime (> 3 hours per day, > 4 days per week); (iii) belonging to major teams in sports clubs; and (iv) participation in national and/or international competitions. Athletes with any neuromotor limitation or consuming exogenous substances were excluded. This study followed the STROBE checklist for observational studies [21].

Data collection

The athletes and their legal guardians were informed about the risks of the research and were required to consent to the research terms. After the anthropometric evaluation, the power and crawl swim tests were performed on the following day, with a 24-hour interval (Figure 1).

Anthropometry and body composition

The measurements were performed with the participants barefoot and wearing light clothing. Body mass was evaluated with Filizola® digital scales with a capacity to 150 kg and accuracy of 0.10 kg (São Paulo,

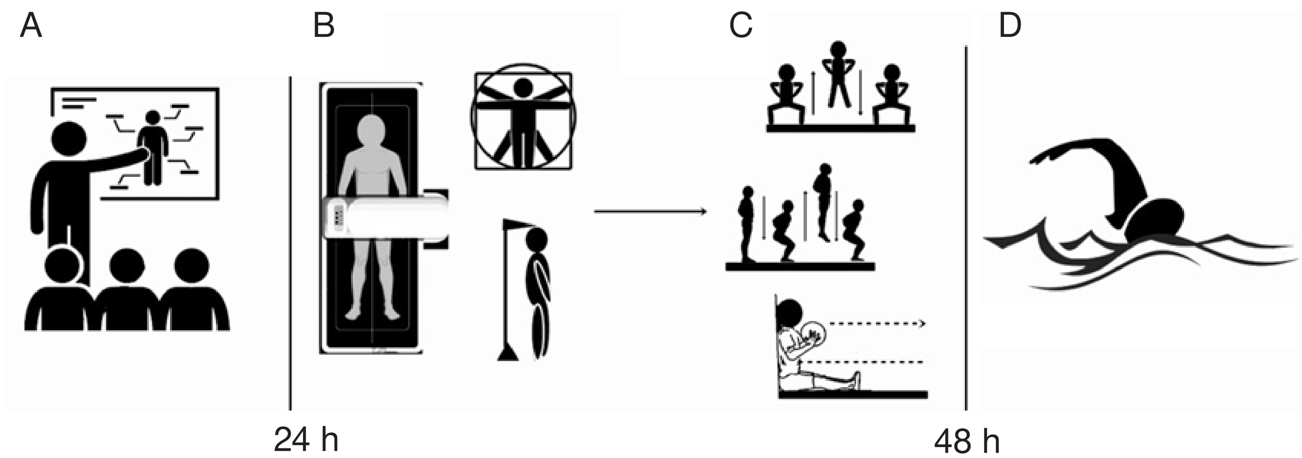

Figure 1. Data collection flow: (A) Research explanation. (B) Anthropometric evaluation (dual-energy X-ray absorptiometry). (C) Power tests. (D) Crawl swim test

Brazil). Stature was determined with a Sanny® stadiometer (0.1 mm accuracy) (São Paulo, Brazil), triceps skinfold with a Sanny® scientific adipometer (0.1 mm accuracy) (São Paulo, Brazil), biceps perimetry with a Sanny® anthropometric tape (São Paulo, Brazil), and bone diameters (humerus and femoral) with a Sanny® calliper (São Paulo, Brazil). All evaluations followed the International Society for the Advancement of Kinanthropometry (ISAK) protocol [22].

Body composition was assessed by using dual-energy X-ray absorptiometry, which is considered the most reliable standard for measuring body composition. The appropriate algorithms for the paediatric population were applied [23, 24].

Chronological age analysis

The chronological age in months was determined as the sum of the individual's months of life, from the date of birth until the date of the present study analysis. The sum of months of life was divided by 12, which resulted in the chronological age in years [25].

Biological maturation

BM was established in accordance with the following mathematical model [25]:

$$\text{biological maturation} = \text{bone age (years)} - \text{chronological age (years)}$$

Depending on the equation results, the participants were classified into 3 maturational stages in relation to chronological age [25]: delayed (results ≤ -1), synchronized (results between –1 and 1), and accelerated (results ≥ 1). Next, bone age was determined by using the indirect model by de Araujo Tinoco Cabral et al. [26] for adolescents aged 8–14 years, as follows:

$$\text{bone age} = -11.620 + 7.004 \cdot \text{height (m)} + 1.226 \cdot \text{(Dsex)} + 0.749 \cdot \text{age (years)} - 0.068 \cdot \text{triceps skinfold (mm)} + 0.214 \cdot \text{corrected arm circumference (cm)} - 0.588 \cdot \text{humerus diameter (cm)} + 0.388 \cdot \text{femoral diameter (cm)}$$

where the Dsex value equals 0 for the male sex and 1 for the female sex.

The following equation was used to find the values of the arm perimeter, in accordance with the ISAK standards [22]:

$$\text{corrected arm circumference (cm)} = \text{contracted biceps circumference (cm)} - \text{triceps skinfold (mm)} / 10$$

Upper-limb power

Before the evaluation day, the participants had abstained from physical effort for 24 hours. For the ULP test, they were sitting on the floor with the back leant against the wall and an angle of 90° in the hips, with extended knees (Figure 1C). The athletes then horizontally threw a 2-kg medicine ball (Ax Esportes®, Tangará, Brazil) using both hands, from the height of their sternum and without assistance of the trunk, as far as possible [27]. Three attempts with 3-min intervals were given to each subject and the best score was considered in further analyses. The time of flying (T_F) and the distance reach (D_R) of the medicine ball were registered and the ULP was calculated on the basis of Newtonian physics [28]:

$$\text{upper-limb power (W)} = \text{medicine ball mass (kg)} \cdot D_R \text{ (m)} / T_F \text{ (s)}$$

Lower-limb power

LLP was determined by 2 tests: (a) vertical jump and (b) countermovement jump, both using a force platform (CEFISE®, São Paulo, Brazil) and following the protocols established by Forza and Edmundson [29]. For the evaluation, the subjects firstly performed each jump to familiarize themselves with the tests and reduce errors during the protocol execution. Afterwards, they started from holding an orthostatic position for 3 s with the knees flexed at 90° and hands fixed on their waist, and then performed a vertical jump with maximum effort. The same procedures were adopted for the countermovement jump, with the exception that the subjects had to first perform one squat followed by the maximum effort jump. There was a 10-min recovery interval between the vertical jump and countermovement jump tests. Three test attempts interspersed with 60 s of passive recovery were executed and the best score was used for data analysis. The data served to determine the relative power (W).

Crawl swim performance

The participants firstly performed a 5-min jogging plus 3 series of 20 jumping jacks and 10 squats with 30-s rests in between as a warm-up. In an Olympic pool (50 m long, 25 m wide, and 2.1 m deep, water temperature: 26°C), at the room temperature of 28°C, the athletes performed a 100-m sprint at maximum effort. They were requested to start the sprint from inside the water, using only one hand to support at the poolside. Start propulsion was not allowed. The sprint time was registered with a digital chronometer (stopwatch model; ChronoSport®, Santa Catarina, Brazil). After the sprint, the individuals also reported their effort on a scale of 0–10, in accordance with the CR10 Borg rating of perceived exertion scale (effortless: 0; very, very light: 0.5; very slightly light: 1; slightly light: 2; moderate: 3; a little severe: 4; strong: 5 and 6; very severe: 7 and 8; very, very severe, almost maximum: 9; maximum effort: 10) [30]. The crawl swim performance was determined as the average speed. Later on, the power of the 100-m crawl sprint was calculated by using the previously mentioned Crowell [28] formula considering the participant's mass.

Statistical analysis

Sample size and sample power

The sample size was determined a priori by observing research data on BM and neuromotor performance of upper and lower limbs [15, 16]. An effect size of 0.72, an $\alpha < 0.05$, and a $\beta = 0.80$ were then estimated, which resulted in a sample power of > 0.80 (a minimum of 8 subjects per group). The open-source G*Power® software (version 3.0; Berlin, Germany) and the configuration 'statistics for tests of the T family' (correlations) were applied. Post-hoc analyses were performed in addition (details in the Results section) and the sample power of > 0.70 was considered acceptable [31].

Data treatment

Data normality was tested with the Shapiro-Wilk test and the *Z*-score of asymmetry and kurtosis (–1.96 to 1.96). Correlations were verified by using Pearson's test, and Cohen's magnitude was determined as small (0.10–0.29), moderate (0.30–0.49), large (0.50–0.79), or very large (≥ 0.80) [32]. Linear regression was applied to verify the level of contribution (percentage) of BM, ULP, and LLP to the crawl swim performance. The Breusch-Pagan and the Durbin-Watson tests served to verify homogeneity and multicollinearity of the regression models, respectively. The coefficient of variation (CV%) was calculated as follows:

$$CV\% = \text{standard deviation} / \text{mean} \times 100$$

A ≤ 1.0% intra-examinator error of measurement was accepted [33]. All analyses were performed with the open-source R software (version 4.0.1; R Foundation for Statistical Computing®, Vienna, Austria), with the consideration of $p < 0.05$.

Ethical approval

The research related to human use has complied with all the relevant national regulations and institutional policies, has followed the tenets of the Declaration of Helsinki, and has been approved by the Committee of Ethics in Research of the Federal University of Rio Grande do Norte (ID: 3.552.010).

Informed consent

Informed consent has been obtained from all individuals included in this study and their legal guardians.

Results

Table 1 presents the anthropometric characteristics of the participants, the records of evaluations, and the perceived effort scores for the swim performance. All adolescent athletes exhibited accelerated BM. An intra-examinator error of < 1% was detected for the anthropometric evaluations.

There was a significant correlation between BM and crawl swim performance (95% CI r: –0.89, –0.33), ULP (95% CI r: 0.44, 0.71), and LLP (vertical jump: 95% CI r: 0.55, 0.84; countermovement jump: 95% CI r: 0.55, 0.85). ULP (95% CI r: –0.92, –0.47) and LLP (vertical jump: 95% CI r: –0.91, –0.44; countermovement jump: 95% CI r: –0.74, –0.33) were also significantly correlated with the crawl swim performance. When segmented by sex, the correlations remained (Table 2).

Regarding the power of the sample, when observing the analyses divided by sex, one can verify that the male group did not present adequate power for correlations between vertical jump, BM, and performance in crawl swim (< 0.70). In the female group, the correlations of ULP and vertical jump with BM and crawl swim performance were also not adequate (< 0.70).

The analysis of swim performance in the total sample showed that BM had a contribution of 70% ($F_{(1.0)}$: 30.5, t: 13.2) to the crawl swim performance (Table 3). ULP exhibited a contribution of 45% ($F_{(1.0)}$: 11.8, t: 2.44) to the crawl swim performance. For LLP, a contribution of 48% (countermovement jump: $F_{(1.0)}$: 12.4, t: 3.48) and 50% (vertical jump: $F_{(1.0)}$: 7.90, t: 1.39) was detected. Considering the crawl swim performance of the male group, there was an 87% ($F_{(1.0)}$: 31.5, t: 8.68) contribution of BM, a 43% ($F_{(1.0)}$: 4.69, t: 2.16) contribution of ULP, as well as a 49% (vertical jump: $F_{(1.0)}$: 5.45, t: 12.3) and a 32% (countermovement jump: $F_{(1.0)}$: 2.77, t: 1.65) contribution of LLP. With regard to the crawl swim performance of the female group, there was a 66% ($F_{(1.0)}$: 6.62, t: 13.0) contribution of BM, a 31% ($F_{(1.0)}$: 1.64,

Table 1. Characteristics of the sample

Variable	Total sample (n = 16)		Male group (n = 8)		Female group (n = 8)	
	Mean ± *SD*	CV%	Mean ± *SD*	CV%	Mean ± *SD*	CV%
Training sessions per week	5.00 ± 0.81	16.2	5.25 ± 0.70	13.3	4.75 ± 0.88	18.5
Training volume (hours/day)	4.00 ± 0.73	18.2	4.25 ± 0.46	10.8	3.75 ± 0.88	23.4
Swimming practice (years)	7.81 ± 1.16	14.8	8.50 ± 0.92	10.8	7.12 ± 0.99	13.9
Chronological age (years)	12.90 ± 0.88	6.8	13.20 ± 0.85	6.4	12.70 ± 0.89	7.0
Bone age (years)	16.60 ± 1.51	9.0	17.00 ± 1.84	10.8	16.30 ± 1.08	6.6
Biological maturation (bone)	3.71 ± 1.02	27.4	3.85 ± 1.18	30.6	3.58 ± 0.88	24.5
Stature (cm)	161.10 ± 8.04	4.9	165.5 ± 7.95	4.8	156.70 ± 5.53	3.5
Arm span (cm)	163.30 ± 8.81	5.3	169.0 ± 6.39	3.7	157.60 ± 7.17	4.5
Weight (kg)	46.80 ± 9.35	19.9	49.80 ± 10.2	20.9	43.90 ± 7.90	17.9
Body mass index (kg/m^2)	17.90 ± 2.47	13.7	18.00 ± 2.78	15.4	17.80 ± 2.30	12.9
Fatty mass (kg)	10.20 ± 2.91	28.5	9.90 ± 2.98	30.1	10.50 ± 3.01	28.6
Lean mass (kg)	35.00 ± 8.96	25.6	38.60 ± 8.60	22.2	31.40 ± 8.28	26.3
Bone density (g/cm^2)	0.94 ± 0.09	9.5	0.95 ± 0.10	10.5	0.92 ± 0.07	7.6
Bone mineral content (g)	2.50 ± 0.93	37.2	2.93 ± 1.06	36.1	2.07 ± 0.57	27.5
Crawl swim performance (m/s)	0.76 ± 0.07	9.6	0.72 ± 0.08	11.8	0.79 ± 0.03	4.8
Power of 100-m crawl swim (W)	63.50 ± 19.2	30.2	71.00 ± 22.60	31.8	55.90 ± 12.10	21.6
100-m crawl sprint RPE (CR10 Borg)	7.06 ± 1.76	24.9	6.62 ± 1.40	21.1	7.50 ± 2.07	27.6
Upper-limb power (W)	32.10 ± 11.5	35.8	38.50 ± 10.50	27.2	25.60 ± 8.82	34.4
Lower-limb power by vertical jump (W)	29.90 ± 8.99	30.0	33.70 ± 11.30	33.5	26.20 ± 3.46	13.2
Lower-limb power by countermovement jump (W)	33.40 ± 9.19	27.5	36.60 ± 6.55	17.8	30.20 ± 10.70	35.4

CV% – coefficient of variation (percent), RPE – rating of perceived exertion

t: 1.27) contribution of ULP, as well as a 10% (vertical jump: $F_{(1.0)}$: 0.38, t: 0.60) and a 46% (countermovement jump: $F_{(1.0)}$: 5.18, t: 2.27) contribution of LLP. Regression models indicated normality and homogeneity of the residues. No multicollinearities were detected.

Discussion

In the present study, we have identified the contribution of BM, ULP, and LLP to the performance of 100-m crawl swim in young adolescent athletes. Our primary hypothesis was that BM would be related to ULP and LLP in the adolescent swimmers, and to their swim power. Also, we hypothesized that BM contributed to the development of ULP and LLP in a different manner, depending on the orientation of neuromotor system development.

Both our hypotheses were confirmed by the following results: (1) BM, ULP, and LLP had an influence on the crawl swim performance. (2) There was a significant contribution of BM to the performance of crawl swim that reached 87% for male and 66% for female athletes. (3) In the male group, the contribution of ULP to the crawl swim performance reached 43%, and the LLP contribution (as assessed by a vertical jump) reached 49%. In the female group, a 46% contribution of LLP (as assessed by a countermovement jump) to the crawl swim performance was found.

These finding are consonant with our previous reports, in which we identified the relationships between BM and ULP and LLP of young athletes in different modalities (volleyball, basketball, handball, jiu-jitsu, karate, and swimming) [12]. This study revealed that BM was associated with ULP and LLP in adolescent athletes, with a stronger effect in the case of the upper limbs.

Similarly, Pinto et al. [16] also reported a stronger effect of BM on ULP among adolescent athletes of both sexes. Intriguingly, such a tendency observed in the development of strength and power of upper and lower limbs in adolescent athletes might reflect the cephalocaudal direction of the neuromotor system development – downward growth of neuromotor circuits, first from the head, then to the trunk region, and last to the feet [11–25]. In this sense, Oliveira et al. [19] implied an influence of BM on upper-limb propulsion among adolescent athletes in the crawl swim, whereas in a previous study, we did not find an effect of BM on LLP in elite adolescent swimmers [15]. In turn, Strzała et al. [34] demonstrated that countermovement jump, as well as the isometric strength of lower limbs were associated with crawl swim (50-m) performance in adoles-

Table 2. Correlations between biological maturation, crawl swim performance, upper-limb power, and lower-limb power in adolescent athletes

Variable	*r*	*p*	Sample power (post-hoc)
Total sample			
Biological maturation (bone)			
Crawl swim performance (m/s)	–0.80	0.001	0.99
Upper-limb power (W)	0.50	0.008	0.70
Lower-limb power by vertical jump (W)	0.60	0.01	0.88
Lower-limb power by countermovement jump (W)	0.60	0.01	0.88
Crawl swim performance (m/s)			
Upper-limb power (W)	–0.78	0.0003	0.98
Lower-limb power by vertical jump (W)	–0.77	0.00004	0.98
Lower-limb power by countermovement jump (W)	–0.61	0.01	0.88
Male group			
Biological maturation (bone)			
Crawl swim performance (m/s)	–0.91	0.001	0.99
Upper-limb power (W)	0.76	0.02	0.89
Lower-limb power by vertical jump (W)	0.80	0.02	0.95
Lower-limb power by countermovement jump (W)	0.48	0.02	0.39
Crawl swim performance (m/s)			
Upper-limb power (W)	–0.76	0.01	0.89
Lower-limb power by vertical jump (W)	–0.78	0.02	0.92
Lower-limb power by countermovement jump (W)	–0.56	0.01	0.51
Female group			
Biological maturation (bone)			
Crawl swim performance (m/s)	–0.72	0.04	0.82
Upper-limb power (W)	0.39	0.02	0.28
Lower-limb power by vertical jump (W)	0.30	0.04	0.20
Lower-limb power by countermovement jump (W)	0.80	0.01	0.95
Crawl swim performance (m/s)			
Upper-limb power (W)	–0.67	0.03	0.72
Lower-limb power by vertical jump (W)	–0.23	0.04	0.14
Lower-limb power by countermovement jump (W)	–0.70	0.001	0.88

cent male athletes. Accordingly, the present study reports a correlation between crawl swim performance and ULP and LLP in both female and male adolescent athletes (vertical jump for males and countermovement jump for females).

The efficiency of propulsion is a determinant factor in the swim performance of young athletes. Propulsion mainly depends on the proper technique and biomechanical performance, which in turn relay on ULP and LLP delivered by swimmers [35, 36]. It is well known that the strength in the lower limbs contributes to the energy production and power which then favours swimming performance [37]. In addition, the horizontal position of the body during crawl swim enables the power of the lower-limb work – the flutter kick – to make an essential contribution to the swimmer slide and speed [38]. The findings in the present study reinforce the thesis of a contribution of both ULP and LLP to the performance of crawl swim, and highlight the importance of the BM stage for the development of such capabilities, displaying an 87% contribution (in males) and a 66% contribution (in females) to the performance in crawl swim, while ULP and LLP show less than 50%, regardless of the sex.

Further, dos Santos et al. [18] used an allometric model for predicting the factors contributing to crawl

Table 3. Simple linear regression to verify the contribution of biological maturation to upper-limb power and lower-limb power in relation to crawl swim performance

Variable	r^2	β	95% CI β	p	Sample power (post-hoc)
Total sample					
Biological maturation (bone)	0.700	65.5	53.2; 73.7	< 0.001	0.99
Upper-limb power (W)	0.450	3.39	1.41; 3.83	0.02	0.96
Lower-limb power by vertical jump (W)	0.504	1.45	1.56; 2.35	0.004	0.97
Lower-limb power by countermovement jump (W)	0.489	0.44	0.30; 1.00	0.01	0.93
Male group					
Biological maturation (bone)	0.877	72.0	60.0; 85.9	0.001	0.99
Upper-limb power (W)	0.430	1.47	1.08; 3.03	0.007	0.70
Lower-limb power by vertical jump (W)	0.491	1.40	0.65; 2.81	0.005	0.76
Lower-limb power by countermovement jump (W)	0.324	1.95	0.90; 2.40	0.01	0.51
Female group					
Biological maturation (bone)	0.660	56.0	45.8; 56.1	0.004	0.95
Upper-limb power (W)	0.311	0.65	0.55; 1.68	0.04	0.50
Lower-limb power by vertical jump (W)	0.102	0.81	0.35; 3.35	0.03	0.21
Lower-limb power by countermovement jump (W)	0.465	0.79	0.60; 0.99	0.006	0.74

swim in adolescent athletes and observed that in both females and males, a low fat mass and the upper-limb propulsion force were essential contributors to the 50-m crawl swim performance. Their results are comparable with our current reports of a 43% ULP contribution to crawl swim performance in males and a 30% contribution in females. However, no contribution of BM to the crawl swim performance was detected by their allometric model, whereas in the present study, the analysis of bone age (as a direct indicator of the athlete's BM stage at the moment of evaluation) revealed a contribution of BM to crawl swim. Such incongruence might indicate that the peak height velocity, used in the dos Santos et al. [18] model, a parameter that was also verified as a factor contributing to BM and swim performance in young athletes by Oliveira et al. [19], appears to be less sensible compared with bone age, applied in the present study.

It is essential to understand the variables influencing the mechanisms engaged in propulsion for an optimal swim performance [2]. The present study has identified that BM when analysed by the bone age constitutes a more sensible parameter to determine BM influence on the crawl swim performance in adolescent athletes. In addition, we have shown that, despite the knowledge that both ULP and LLP play an important role in swimmers' performance, BM turns out to be a more influent factor for the performance in crawl swim in young adolescent athletes in the puberty window.

Limitations

The present study refers to a cross-sectional design; therefore, it is limited to provide evidence of causal nexus. Further studies addressing the stages of BM and outcomes of power would be recommended.

Conclusions

Our findings suggest that BM must be considered as a relevant factor when developing training strategies to improve the performance of competitive crawl swim in young adolescents, specifically with regard to individual differences. In this sense, BM can also constitute a criterion for the selection and recruitment of young talents into the sport.

Practical applications

Considering that maturation contributes to crawl swimming performance, we highlight that maturation is associated with upper- and lower-limb muscle power and that muscle power is associated with swimming performance in swimmers. In addition, we reinforce that as BM advances, the efficiency of glycolytic metabolism increases, favouring the energy pathway used for muscle power production. Thus, we suggest as a practical application that young athletes in advanced stages of maturation be allocated to speed tests that require greater use of muscle power in relation to endurance tests.

Acknowledgements

We thank the Physical Activity and Health Research Group (AFISA) and the Child and Adolescent Maturation Research Group (GEPMAC) of the Federal University of Rio Grande do Norte, as well as the National Council for Scientific and Technological Development (CNPq) and the Coordination for the Improvement of Higher Education Personnel (CAPES) for the support and encouragement for the development of this paper.

Disclosure statement

No author has any financial interest or received any financial benefit from this research.

Conflict of interest

The authors state no conflict of interest.

Declaration of data availability

The database for this study is publicly available at https://figshare.com, under the doi: 10.6084/m9.figshare.15101742.

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