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Comparative Study of Morphological Parameters Between Female Swimmers from South-East and North-East of Algeria (12-13 years old)

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Abstract

Performance variations throughout a swimmer's career result from the interaction between training and genetic and environmental factors. Our study aims to compare several morphological parameters (height, weight, body composition) between two groups of young swimmers from the Northeast and Southeast of Algeria. These two geographical regions may present significant differences in genetics, climate, and environment, which could influence the swimmers' morphological characteristics and performances. The goal is to analyze how these differences may impact their performance levels. Body measurements were taken using a bioelectrical impedance analyzer, and performances in the 50m and 400m freestyle were recorded in a sample of 26 competitive swimmers aged 12-13 years: 13 from the Northeast (Constantine/Sétif) and 13 from the Southeast (Biskra/Ouargla).
The results show that swimmers from the Northeast have significantly greater height and weight, which advantages them in the 50m and 400m freestyle events compared to their Southeast counterparts. However, no variations were observed in muscle mass, fat mass, and body mass index.

1. Introduction

Nowadays, swimming is becoming increasingly professionalized. The emergence of technology, media coverage, and the evolution of the professional swimmer's status have led to the development of new performance optimization strategies.

A swimmer's career is built over the years. Their performance relies on the development of various components, physical, physiological, technical, biomechanical, and morphological (Lätt et al., 2009). Today, it is acknowledged that morphology is a key element of performance in swimming (Bejan et al., 2010; Jagomägi et al., 2005), especially among young swimmers where morphological gradients represent a determining factor (Salazar-Lioggiodice et al., 2006; Zuniga et al., 2011., Rozi et al., 2018).

The study conducted by Lätt et al. (2010) on adolescent swimmers revealed that morphological influence was as significant as physiological impact.

Several studies conducted on young swimmers suggest that variation in swimming performance is mainly influenced by morphological factors (Géladas et al., 2005; Salazar-Lioggiodice et al., 2006; Rozi et al., 2018). Consequently, survey results on their morphological characteristics have revealed a strong correlation between growth and performance (Lätt et al., 2010; Zuniga et al., 2011). However, the rate of growth and pubertal age vary from one child to another, with environmental and genetic factors being determining factors.

According to Barbosa et al. (2014), a swimmer's performance throughout their career primarily depends on their training-related abilities as well as genetic and environmental factors. Therefore, studies on young swimmers should not focus solely on physiological and/or biomechanical parameters but also on the analysis of morphological, genetic aspects, and growth (Costa et al., 2015).

In the Algerian context, there is a paucity of research examining the morphological characteristics of young swimmers (Benyelles, 2017; Labar, 2021), especially in the southern region, which represents a potentially untapped reservoir of athletic talent. However, despite the potential in our region, the performances achieved by our swimmers, particularly females, remain modest and sometimes below expectations. Given the established correlation between morphology and swimming performance, it is imperative to conduct a comparative analysis of the morphological parameters of young female swimmers from southern Algeria vis-à-vis their northern counterparts.

Indeed, these distinct geographical regions may exhibit significant disparities in genetic composition, climatic conditions, and environmental factors, which could potentially modulate the morphological characteristics and subsequent performance outcomes of resident swimmers. Such characterization could elucidate potential discrepancies between swimmers from southern and northern Algeria.

In light of these observations, the following research questions emerge :
1. Are there discernible morphological differences between young female swimmers (aged 12-13 years) from southern and northern Algeria ?
2. If such differences exist, to what extent do these morphological parameters influence their respective performance levels?

This inquiry aims to contribute to a more nuanced understanding of regional variations in swimmer morphology and their potential impact on athletic performance within the Algerian context.

To address these research questions, we hypothesize that young swimmers from southern Algeria exhibit distinct morphological characteristics that differentiate them from their northern counterparts. This morphological divergence may be attributable to a confluence of genetic and environmental factors (including heredity, climatic conditions, and socioeconomic variables), potentially elucidating the observed performance disparities among young southern swimmers.

The primary objective of this study is to identify and quantify specific morphological parameters (including stature, body mass, and body composition) in competitive female swimmers (aged 12-13 years) from the southeastern region of Algeria (encompassing Biskra and Ouargla), and compare them with those from the northeastern region of Algeria (Constantine and Sétif), while attempting to analyze the differences that may exist in their performance levels.

2. Method and Materials

2.1. Participants

The study cohort will comprise 26 young competitive male swimmers, aged 12-13 years, stratified into two equal groups : 13 participants from the southeastern region and 13 from northeastern Algeria (Table 1). All participants are affiliated with various swimming clubs and engage in a minimum training frequency of 5-6 sessions per week.

This methodological approach will facilitate a robust comparative analysis of morphological parameters and performance outcomes between female swimmers from distinct geographical regions within Algeria, potentially

unveiling insights into the interplay between environmental factors, morphology, and swimming performance.

Table N° 01 : *Number and average age of the sample*

Wilayas	Age (years)	N°	N° /Region	N°/total	Average Age
Constantine	**12**	**06**	**13**	**26**	**12,54±0,50**
Setif	**13**	**07**			
Ouargla	**12**	**06**	**13**		
Biskra	**13**	**07**			

2.1. Bioeletrical Impedance :

Body composition parameters, including fat mass (FM), muscle mass (MM), body mass index (BMI), and anthropometric dimensions (height and weight), will be assessed using a "SeeHigher BCA-M2" bioelectrical impedance analyzer. This methodology offers a non-invasive, precise, and efficacious alternative to conventional anthropometric techniques.

2.2. Materials

Figure 1. bioelectrical impedance analyzer "SeeHigher BCA-M2"

2.3. 50m and 400m Freestyle (crawl) Performance Assessment

The performance will be evaluated over distances of 50 m and 400 m freestyle. Our choice is based on the following reasons :

- Both distances are scheduled in the national competition calendar for our age category (12-13 years), which allows us to obtain results that reflect their optimal performance levels.
- The 400 m event is often adopted as a reference test to determine the swimmer's maximal aerobic speed (MAS). Meanwhile, the 50 m performance is used to develop anaerobic pathways (Rodriguez and Mader, 2003, 2010).

2.4. Statistical Analysis

The statistical analysis will comprise the following:

- Student's test (t-test) : To evaluate inter-group disparities in mean values, determining the statistical significance of observed variations.
- Linear regression coefficient : To examine the magnitude of correlation between measured indices and the performances of the 50 and 400 m freestyle.

➢ Data analysis will be conducted using IBM SPSS Statistics 29 (2022) software.

3. Results

Table N° 02. Descriptive results of normality ‘’Shapiro-Wilk test’’ for morphological parameters, 50m and 400m freestyle events.

Parameters	Shapiro-Wilk			
	Mean	Standard deviation	Statistiques	Sig.
Height / (cm)	155,27	5,06	0,97	0,74
Weight / (Kg)	46,61	7,11	0,94	0,14
Muscle mass (MM) / (Kg)	20,21	2,98	0,95	0,28
Fat mass (FM) / (Kg)	9,02	2,09	0,93	0,08
Body Mass Index (BMI) / (kg/m²)	19,82	2,79	0,86	0,003
50 m freestyle event (FL)/ (sec)	35,29	2,54	0,87	0,004
400 m freestyle event (FL)/ (mn)	5,66	0,54	0,81	0,001

*Significance threshold: *p < 0.05*

Table N° 2 indicates that the Shapiro probability for the variables : height, weight, Muscle mass (MM), Fat mass (FM) for female swimmers (0,74 ; 0,14 ; 0,28 ; 0,08) are higher than the error rate (0.05), which indicates that the data are normally distributed. However, the Shapiro probability for the BMI, 50 m and 400 m freestyle competition index (0,003 ; 0.004 ; 0,001) is

lower than the error rate (0.05). This highlights that the results are not normally distributed.

Table N° 03 : Presentation of the differences in morphological parameters and the performance in 50 m and 400 m freestyle between feamale swimmers from the North-east and South-east:

paramters	North-East Swimmers		South-East Swimmers		Appropriate diff. test	Probability
	Mean	Standard deviation	Mean	Standard deviation		
Height	***158,85***	***3,69***	***151,69***	***3,47***	T test	0.001*
Weight	***50,21***	***7,48***	***43,01***	***4,62***	T test	0.007*
MM	***21,56***	***2,29***	***18,86***	***3,04***	T test	0.18
FM	***8,73***	***2,24***	***9,76***	***1,77***	T test	0,73
BMI	***20,56***	***3,52***	***19,09***	***1,63***	Mann-Whitney	0,45
50 m (FL)	***32,51***	***0,55***	***37,89***	***0,76***	Mann-Whitney	0,01*
400 m (FL)	***5,31***	***0,25***	***5,95***	***0,56***	Mann-Whitney	0.01*

Significance threshold: *p < 0.05

Through Table N° 03, we note that the probability of the T-test and Mann-Whitney test between female swimmers from the Northeast and Southeast for the variables : height, weight, performance in the 50 m and 400 m events, estimated at : (0,001 ; 0,007 ; 0,01 ; 0,01) respectively, are below the error rate of (0.05), indicating that there are statistically significant differences. However, according to the arithmetic means, the height and weig ht index difference was in favor of the North-east swimmers . Consequently, the average performances in the 50 m and 400 m freestyle for the Northern swimmers are lower (32,51 ; 5,31) than those of the Southern swimmers (37,89 ; 5,95), giving the advantage to the lowest time.

Furthermore, the probability of the T-test and Mann-Whitney test for muscle mass (MM), body fat mass and body mass index (BMI) (0,18 ; 0.73, 0.45) is higher than 0.05, indicating that no significant difference is observed for these variables between the South-east and North-east swimmers.

Table N°04 : Results of the influence of morphological indices of North-East female swimmers on the performance in 50 m freestyle swimming.

Morphological indices / 50 m (FL) Perf.	Correlation coefficient	Correlation coefficient probability	Probability of influence	Percentage of influence
Height	-0.88	0.000	0.000	79%
Weight	-0.68	0.000	0.000	47%

Significance threshold: *p < 0.05

The data presented in Table 04 indicate that the probability of influence of the following morphological parameters : height and weight of north-eastern female swimmers on 50 m freestyle performance is lower (0.000) than (0.05), which proves that there is a significant influence of these variables on the recorded 50 m results. However, the rate of influence of height reached 79% and weight 47%.

Table N°5 : Results of the influence of morphological indices of North-East female swimmers on the performance in 400 m freestyle swimming.

Morphological indices / 400 m (FL) Perf.	Correlation coefficient	Correlation coefficient probability	Probability of influence	Percentage of influence
Height	–0.65	0.000	0.000	43%
Weight	–0.35	0.000	0.000	22%

Significance threshold: *p < 0.05

The data presented in Table 05 indicate that the probability of influence of the following morphological parameters : height and weight, of North-eastern female swimmers on the performance of the 400m freestyle swimming is less than (0.000) 0.05, which proves a significant influence of these variables on the recorded 400m results. However, the influence rate of height reached 43% and weight 22%,

Table N°06 : Results of the influence of morphological indices of South-East female swimmers on the performance in 50 m freestyle swimming.

Morphological indices / 50 m (FL) Perf.	Correlation coefficient	Correlation coefficient probability	Probability of influence	Percentage of influence
Height	-0.78	0.000	0.000	58%
Weight	-0.59	0.000	0.000	39%

Significance threshold: *p < 0.05

The results in Table 06 show that the probability of the coefficient of influence of the following morphological parameters : Height and Weight on the 50 m freestyle event for South-East female swimmers which are 0.000 ; 0.000, respectively are lower than 0.05, which means that there is a significant influence of these indices on the swimming speed of 50 m. The percentage of influence reached the values 58% and 39%.

Table N°7 : Results of the influence of morphological indices of South-East female swimmers on the performance in 400 m freestyle swimming.

Morphological indices / 400 m (FL) Perf.	Correlation coefficient	Correlation coefficient probability	Probability of influence	Percentage of influence
Height	-0.61	0.000	0.000	41%
Weight	-0.38	0.000	0.000	24%

Significance threshold: *p < 0.05

The results from Table 07 show that the probability of the influence coefficient of the following morphological parameters : Height and Weight, on the 400 m freestyle event for South-East female swimmers, which are approximately 0.000, 0.000, respectively, are less than 0.05. This indicates a significant influence of these indices on the swimming speed in the 400 m event. The percentage of influence reached values of 41% and 24%.

4. Discussion

The results of our study clearly show speed differences recorded in the 50 m and 400 m freestyle events, as well as significant morphological differences in terms of height and body mass (weight), between young female swimmers from North-Eastern and those from the South-Eastern Algeria. This difference has a significant impact on the performance in the 50 m and 400 m events. However, no significant difference was observed in muscle mass, body fat mass and body mass index (BMI).

4.1 Stature

North-Eastern female swimmers exhibit greater stature compared to their South-Eastern counterparts, correlating with superior performance in the 50 and 400m freestyle event.

This difference in body size is related to the growth process and its completion, which does not occur in the same way for everyone. It is influenced by various factors:

4.1.1. Genetic and Racial Factors

Height is a highly hereditary attribute determined by multiple genes. Studying the height of various family members and the ethnic group provides an indication of the child's future height (Pottinger, 1969).

4.1.2. Psycho-affective Factors

Studies show that the height of people in more privileged societies is higher than that of individuals from lower socio-economic backgrounds

(Silventoinen et al., 2003; Pawlowsky et al., 2000). These differences can be explained by better access to nutrition, healthcare, and environments conducive to optimal growth. According to Côté and Fraser-Thomas (2007), reaching a high level of performance depends not only on years of practice but also on environmental factors.

4.1.3. Nutrition

Various studies have shown the fundamental role of nutritional factors on the average height of a population across several generations (Kenntner, 1983). This is truly a genetic adaptation to environmental conditions, particularly nutrition. The training of young athletes must be associated with a positive caloric balance. Studies by Manfield and Emans (1993) confirm that it is necessary to optimize the nutrition of athletes during childhood and early adolescence, especially during the growth spurt at puberty.

Lätt et al. (2010) studied the influence of height and other morphological characteristics on the performance of adolescent swimmers. They found that height was strongly correlated with swimming performance in both sprint and endurance events. Costa et al. (2015) also noted that taller young female swimmers tended to perform better in competitions due to the biomechanical advantages conferred by their height.

According to Dufour et al. (1988), the difference in performance among young swimmers is mainly related to differences in height rather than swimming technique.

Jagomägi et al. (2005)**,** in their study on morphology and swimming performance, Jagomägi et al. demonstrated that taller swimmers benefit significantly in sprint events due to a greater range of motion and better glide in the water. This study highlights that height allows for better utilization of the force and power generated by the muscles, which is crucial for performance in the 50-meter events. Thus, Zuniga et al. (2011), examined body composition and swimming performance in youth. They found that taller swimmers generally have better swimming efficiency, allowing them to maintain higher speeds over long distances such as the 400 meters with relatively lower energy expenditure. This increased efficiency is due to reduced drag and better arm reach.

4.2. Body Mass

Weight follows a pattern relatively similar to height, with body mass being higher in swimmers from the North-East. This difference in weight can be attributed to several factors, including hereditary aspects (Bouchard et al., 1990), nutritional factors (Ebbeling et al., 2002; Lobstein et al., 2004),

physical factors (Dietz, 1998), environmental factors (Story et al., 2008), and psychological factors (Neumark-Sztainer et al., 2006). However, the influence of body mass on 50m and 400m freestyle performance can largely be explained by an increase in muscle mass associated with improved power and speed.

4.2.1. Performance on 50 m Freestyle

The results of Geladas et al. (2005) suggest that performance in sprint swimming, such as the 100 meter freestyle, can be influenced by the increase in the size of propulsive segments, as well as by weight.

A higher body weight due to muscle mass can improve propulsion power, which allows for the development of a stronger push-off (Pyne & Sharp, 2014) and faster acceleration at the start and in the water (Hawley et al., 1994), which is crucial for sprint events. This muscle strength is necessary to improve explosiveness during quick starts and turns, which is essential to maximize speed from the beginning of the race (Keskinen et al., 2003).

4.2.2. Performance on 400 m Freestyle

Swimmers with balanced muscle mass can better utilize their energy, which is beneficial for longer-duration events like the 400 meter freestyle. Better swimming economy means that energy is used more efficiently, thus delaying the onset of fatigue (Toussaint et Hollander, 1994). Well-developed muscle mass can improve muscular endurance, allowing young swimmers to maintain a steady speed over longer distances. Enhanced aerobic capacity helps maintain high performance without excessive fatigue (Pyne et Sharp, 2014). However, excessively high body weight can affect the swimmer's buoyancy in the water, leading to increased muscle fatigue and additional energy expenditure.

Moreover, a certain amount of body fat can improve buoyancy, allowing swimmers to better maintain their horizontal position in the water. This can reduce drag and increase swimming efficiency over long distances (Clarys et al., 1983).

5. Conclusion

Swimming is a complex and multidimensional sport, and swimmers' performances are influenced by a combination of genetic and environmental factors. Therefore, it is difficult to generalize the morphological characteristics and performance levels of swimmers from various regions of Algeria without a specific and detailed study.

Our comparative study focused on the morphological characterization and its influence on the performance of young competitive female swimmers from two different geographical areas, revealing important data on the existing morphological differences between swimmers from the Southeast and Northeast of Algeria. The results indicate significant differences in terms of height and body weight, favoring northern swimmers over their southern counterparts in the 50 and 400-meter freestyle events.

Numerous studies have highlighted the significant impact of the growth process on swimming performance (Avlonitou, 1994; Salazar-Lioggiodice et al., 2006; Zuniga et al., 2011), particularly during puberty, where growth speed and pubertal age vary from one child to another. In this context, it appears that northern swimmers reach their pubertal peaks earlier than their southern counterparts.

Furthermore, studies on twins have shown that height is inherited at about 80-90%, compared to 10-20% attributed to environmental factors (Jelenkovic et al., 2016). More than 400 genetic variants have been identified as influencing human height (Wood et al., 2014), and more than 97 associated with body weight regulation (Locke et al., 2015).

In conclusion, our study highlights the importance of considering interindividual morphological variations resulting from environmental and genetic factors to optimize the performance of young swimmers. Therefore, it would be interesting to examine other morphological profiles of young female swimmers from different regions of the country, in order to provide our selection institutions with representative data necessary for the detection and monitoring of young talent.

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