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Swimmers, Boys, Aged 11 Years**

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Abstract:

The aim of this study is to examine the morphological characteristics of the longitudinal body segments of young, pre-pubescent swimmers (11 years old) undergoing growth. It also seeks to provide potential answers to certain questions concerning the health and growth status of Algerian child athletes and to present their profile in relation to existing international literature. Understanding the rate of morphological development of longitudinal segments and their homogeneity within overall body growth is also of particular importance for epidemiological studies in Algeria.

We investigated Algerian male athletes, specializing in swimming, aged 11 years, from the regions of the Wilaya of Sétif and Algiers. The anthropometric measurements taken included: stature, sitting height, trunk length, upper limb length, arm length, forearm length, and hand length. The tests also encompassed the lower limb and its components: thigh, leg, and foot. Statistical analysis was performed using multivariate analysis, also known as Principal Component Analysis. This method was employed to extract redundancies and correlations between these segments, which explain the state of homogeneity and the representativeness of longitudinal development in relation to stature during this age period.

The results indicate that the development and bodily growth of the segments during this age period are characterized by harmony and significant redundancy among body parts. This

observation confirms the similar growth pattern to that mentioned and described in scientific literature.

Keywords: Morphology; longitudinal segments; growth; child; sport.

1-Introduction:

A review of the epidemiological literature reveals numerous studies concerning the physical development and growth of children during the pre-pubertal and pubertal stages. This growth primarily involves stature and longitudinal development, an aspect of significant importance for establishing the principles of growth at this age. The most widely recognized principle is that growth is generally homogeneous, exhibiting some variability in accordance with stature development. However, studies on the development of Algerian children indicate early, late, and typical physical development, leaving the question open for further investigation.

While many authors have focused on various biological and physical aspects during childhood and the pre-pubertal period, researcher Toivo Jûrimâe (2001) presented a study on the characteristics of growth and motor development in pre-pubertal children, identifying specific anthropometric and motor properties associated with this age range. Bailey, DA&Kay, MC. (1999) demonstrated the influence of physical exercise on the growth of different body segments and the body composition of children and adolescents.

Detailed analysis of growth and development is primarily based on longitudinal data, meaning serial data from the same subjects, which allows for the establishment of individual growth curves.

To illustrate, consider three main types of body dimension growth curves: the typical stature growth curve for lengths (e.g., leg length) and certain widths (such as shoulder and hip width); the weight growth curve; and the head circumference growth curve. In the latter case, at birth, the child has already attained a significant portion of the final dimension; this curve is similar for all cranial dimensions as well as facial dimensions.

Koziel et al. (1995) demonstrated that the rate of stature growth is characterized by a period of rapid, yet decelerating, increase during the first two years of postnatal growth. This is followed by a period of a more or less constant rate of stature growth, occasionally interrupted by one or more small pre-pubertal growth spurts (Butler et al., 1989; Hauspie&Chrzastek-Spruch, 1993). This period is succeeded by puberty or adolescence, marked by a significant pubertal growth spurt.

Weight growth differs from height growth in that the onset of pubertal growth is not marked by an age at which the rate is minimal. On the contrary, a minimum rate of weight growth is generally observed around 12-13 years of age (Tanner et al., 1986), after which the rate gradually increases. The growth rate curve for head circumference is characterized by a rapid but sharply decelerating rate during the first postnatal year.

Around the age of 2 years, the growth rate drops below 1 cm/year and remains so for the rest of the growth period. The dimensions of the head and face do not exhibit a pubertal growth spurt. During childhood, growth is sometimes characterized by one or more small pre-pubertal growth spurts. The duration of this childhood period varies depending on sex and the child's rate of maturation. This period is followed by puberty or adolescence, characterized by an acceleration of stature growth and a pubertal growth spurt. After this peak, the rate of stature growth rapidly

decreases, and growth ceases in adulthood, currently reached around 18-19 years of age in boys. Sexual dimorphism in anthropometric characteristics is primarily established during puberty. In terms of the average height growth curve, body dimensions are slightly greater in boys during childhood; however, at the time of their puberty, boys become taller than girls for almost all body dimensions. Again, longitudinal data allow for a better understanding of how this sexual dimorphism is established during the growth process (Tanner et al., 1976; Hauspie, 1997). Indeed, by comparing the average constant curves of boys and girls, obtained after fitting a mathematical model to the individual subjects of the sample, the sexual dimorphism of adult height can be decomposed into three parts:

At birth, secular trends are negligible (Rothenbuhler et al., 2006). However, they emerge in the early years of life, but the secular trend in height is often more pronounced during puberty, which accounts for 15 to 20% of the height attained in adulthood; Tanner (1986) estimated

changes for the period 1880-1980 at 1.5 cm per decade during childhood, 2.5 cm per decade during puberty, and 1 cm per decade in adulthood.

Currently, the secular trend in adult height is slowing down or even ceasing in some European countries. Two reasons can explain this deceleration: either mesological conditions have become optimal for the full expression of the genotype, or mesological conditions have ceased to improve in recent decades. The secular trend in height is primarily linked to that of lower limb length (Tanner, 1986).

Some authors (Eveleth & Tanner, 1990) mention greater plasticity in boys, meaning that boys are more adaptable to mesological changes, being more affected by unfavorable conditions and growing more rapidly when conditions are favorable.

In a longitudinal study of pre-pubertal Canadian children in a sport-study program, Léone and Larivière (1994) defined morphological characteristics, noting a very large number of strong correlations between anthropometric variables during the age of less than 13.25 years.

The incidence of gynecomastia varies according to Tanner's genital stages: 20% at stage 1, 50% at stage 2, 20% at stage 3, and 10% at stage 4. The peak occurs at 14 years of chronological age. The cause of pubertal gynecomastia is unclear. Some authors believe that the plasma testosterone/estradiol and adrenal androgen/estrone ratios are lower in boys with pubertal gynecomastia. In obese adolescents, gynecomastia may be caused by the conversion of testosterone and androstenedione to estradiol and estrone in adipose tissue.

Concerning the sexual dimorphism of anthropometric characteristics, it is primarily established during puberty. Regarding the average height growth curve, body dimensions are slightly greater in boys during childhood; however, at the time of their puberty, boys become taller than girls for almost all body dimensions. Again, longitudinal data allow for a better understanding of how this sexual dimorphism is established during the growth process (Tanner et al., 1976; Hauspie, 1986). Part I is due to the difference in pubertal growth spurt, Part II to the difference in pre-pubertal growth, and Part III to the difference due to the delayed onset of the pubertal growth spurt in boys. The results of the dimorphism concern height and sitting height in boys.

Secular trends are not naturally limited to height but involve all body dimensions and proportions. Compared to height, biacromial diameter, arm length, and thoracic dimensions would

decrease, while concerning pelvic diameters, the literature is contradictory (Susanne et al., 2001) but often indicates a more linear body type, as in Belgium (Susanne, 1993), Sweden (Lindgren, 1996), and Germany (Jaeger, 1998). Regarding cephalic dimensions, secular changes are also observed, such as a narrower face, a reduction in head width combined with an increase in head length, a phenomenon known as debrachycephalization (Demoulin, 1998).

The secular trend in height is essentially linked to that of lower limb length (Tanner et al., Tanner, 1990). Some authors (Eveleth&Tanner, 1990) mention greater plasticity in boys, meaning that boys are more adaptable to mesological changes, being more affected by unfavorable conditions and growing more rapidly when conditions are favorable.

Secular trends are not naturally limited to height but involve all body dimensions and proportions. Compared to height, biacromial diameter, arm length, and thoracic dimensions would decrease, while concerning pelvic diameters, the literature is contradictory (Susanne&Bodzsar, 2001) but often indicates a more linear body type, as in Belgium (Susanne, 1993; Vercauteren et al., 1998), Sweden (Lindgren, 1996), and Germany. Regarding cephalic dimensions, secular changes are also observed, such as a narrower face, a reduction in head width combined with an increase in head length, a phenomenon known as debrachycephalization.

Based on the research conducted on this topic and according to the advanced literature review, our primary concern is to determine the physical development relationship of longitudinal body segments in Algerian children who practice swimming. This leads to the research question: What is the relationship between the growth of longitudinal body segments compared to all other parts of the body in 11-year-old swimmers?

The objective of this study is to examine the morphological dimensions of longitudinal body segments in growing children during the pre-pubertal period and to provide potential answers to certain questions related to the health and growth status of Algerian athlete children, and to present its perspective in relation to foreign literature. Understanding the rate of morphological development of longitudinal segments and their homogeneity within overall body growth is also of particular importance for epidemiological studies in Algeria.

Concomitantly, our hypothesis is to verify the existence of a statistically significant difference, using the multivariate analysis method (Principal Component Analysis, PCA), between the different longitudinal body segments in 11-year-old Algerian athlete children.

2-Tools and Methods:

2.1. Subjects: The subjects of our study were Algerian children from the swimming clubs of Sétif and Algiers. Their mean age was 11.03 years. They were enrolled in various schools in the municipality of Sétif. The total number of subjects included in the study was 53. Our study population was characterized by the following longitudinal anthropometric segments:

Stature = 146.2 ± 4 cm; Sitting height = 67.59 ± 0.9 cm; Trunk length = 58.1 ± 3.14 cm; Upper limb length = 65.62 ± 6.5 cm; Arm length = 27.4 ± 0.1 cm; Forearm length = 21.22 ± 2 cm; Hand length = 17 ± 0.3 cm; Lower limb length = 78.84 ± 6.24 cm; Thigh length = 44.05 ± 3.73 cm; Leg length = 37.06 ± 4 cm; Foot length = 21.09 ± 0.7 cm.

2.2. Method: The method used was anthropometric measurement, employing a Harpenden portable anthropometer for measuring morphological body segments. Measurements were taken on-site at the swimming pools during training sessions between March 10th and 18th, 2025.

2.3. Statistical Method: We utilized Principal Component Analysis (PCA) via XLSTAT 23 software. Principal Component Analysis (PCA), also known as the Karhunen-Loève Transform (KLT), is a data analysis technique used to transform interrelated variables (statistically "correlated") into a new set of uncorrelated variables. These new variables are termed "principal components" or principal axes. PCA serves to summarize information by reducing the number of variables.

3-Results

3.1. Principal Component Analysis of the Ten Lengths:

Statistical Conditions for Conducting the PCA Test:

The first condition is verified and favorable, as the majority of the correlation coefficients between the treated variables, presented in a bivariate correlation matrix, are >0.05 for our study sample of this age group.

The second condition, related to the Kaiser-Meyer-Olkin (KMO) index for measuring sampling adequacy, is 0.800 for the overall group. Specifically for the 11.03-year-old subgroup, the KMO index is estimated at 0.518.

A preliminary analysis of the raw lengths highlights a very high correlation between the lengths and stature. This is evidenced by the fact that all lengths show significant positive correlations with the first principal component; Table 01 presents the correlation coefficient values calculated for our population.

The characteristics of the first principal component in the PCA of the 10 observed lengths show significant variability and high correlation coefficients with the six variables (size effect).

The principal component analysis conducted on the ten lengths measured on the 53 subjects aged 11.03 years identifies the two most representative components. The first component accounts for a high total variability, estimated at 63.61%, while the second component represents a lower variability of 13.47%.

Table 01: Eigenvalues

	Eigenvalues	Variability (%)	Cumulative %
Component 1	121.750	63.615	63.615
Component 2	25.783	13.472	77.087

Table 2: Correlation coefficients of lengths with the principal components

Variables	Component 1	Component 2
Sitting Height	0.760	0.116
Trunk Length	0.662	0.098
Upper Limb Length	0.945	0.062
Forearm	0.284	-0.812
Arm	0.260	-0.810

Hand	0.847	-0.346
Lower Limb Length	0.320	-0.917
Thigh	0.892	0.000
Leg	0.859	0.036
Foot	0.501	0.336

Table 02 illustrates the impact of stature, revealing the existence of positive correlations between almost all lengths. This is logical and typical for children in this age range, who are biologically characterized by a greater increase in length and specific body proportions. The first principal component demonstrates significant positive correlations with five characteristics:

Upper limb length, positive correlation: Upper limb length, $r = 0.945$. Thigh length, $r = 0.892$. Leg length, $r = 0.859$. Hand length, $r = 0.874$. Sitting height, $r = 0.760$. Trunk length, $r = 0.662$. Foot length, $r = 0.501$.

The second component illustrates significant negative correlations: Lower limb length, $r = -0.917$. Forearm length, $r = -0.810$. Arm length, $r = -0.810$.

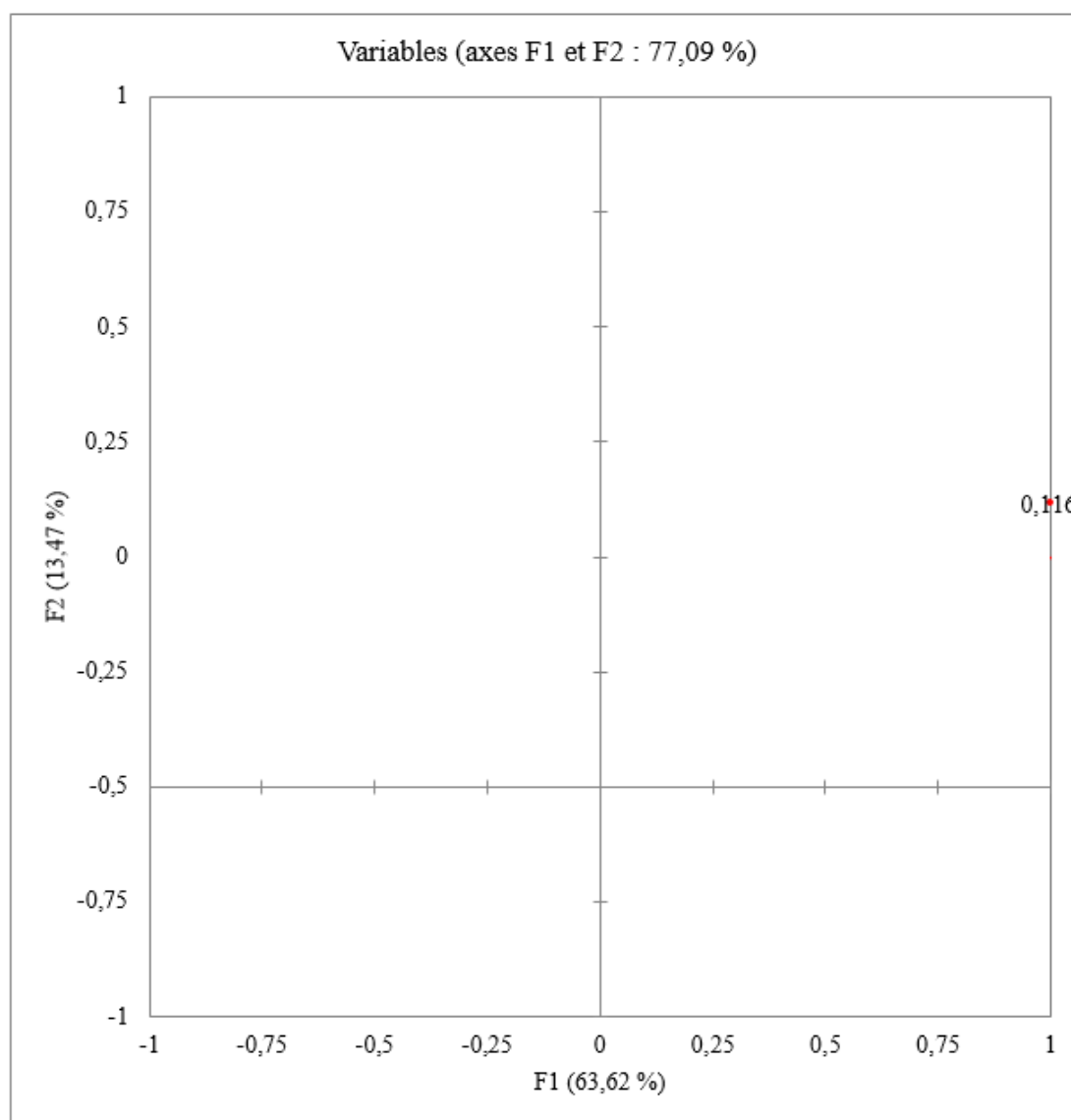


Figure 1: Representation of correlations of body lengths in subjects aged 11.03 years.

Figure 1 illustrates the clustering of each variable within the correlation circle constructed using the first two principal components or factors. We observe that sitting height and trunk length, leg length, upper limb length, and thigh length cluster together, indicating redundancy with respect to the first factor. Each of these variables represents the others with a similar inertia or shared information, referred to as a size effect. However, hand length is strongly correlated with the first factor and is considered significant. Foot length also shows a moderate correlation with the first principal component.

Conversely, the longitudinal segments of the arm, forearm, and lower limb length are negatively correlated with the second principal component. This indicates a complex correlation, explained in PCA by redundancy in terms of shape effect. This implies that if hand length increases, arm or forearm length tends to decrease, and vice versa. A similar interpretation applies to trunk length and lower limb length.

The determined ratio of sitting height growth, which is relative to trunk length and lower limb length, is noteworthy. This biological phenomenon of the ratio of standing height to body segments is maximal during childhood at this age, gradually decreasing until adolescence (when the lower limbs grow faster than the trunk), reaching its minimum during the peak growth spurt. Similarly, the growth rate of the hand is followed by the forearm and then the arm. The same pattern of enlargement is described for the lower limb: foot, leg, then thigh (Tanner et al., Tanner, 1990).

4-Conclusion and Recommendations:

The growing morphological segments, selected and subjected to Principal Component Analysis (PCA), allowed us to highlight the linear redundancies between the different characteristics. This enabled us to select and retain the most important characteristics for the morphological profile during this period of rapid development. This confirms our previously stated hypothesis that a correlation exists between these segments, where one represents the others in terms of inertia or information. This redundancy in correlation explains that the body undergoes remarkable longitudinal growth during this age period.

Based on the findings of this study, we present the following recommendations:

- 1-To give greater importance to the study of the factors and characteristics of growth in Algerian children at all age periods.
- 2-To attempt to determine the morphological profile of Algerian children of both sexes.
- 3-To establish databases concerning the study of growth in our children.
- 4-To broaden the scope and development of morphology and biometrics and their application in public health.

5- List of References:

1. Bailey, D. A., & Kay, M. C. (1999). A six-year longitudinal study of the relationship of physical activity to bone mineral accretion in growing children: The University of Saskatchewan Bone Mineral Accrual Study. *Journal of Bone and Mineral Research*, 14(10), 1672-1679.

2. Bailey, D. A., Martin, A. D., McKay, H. A., Whiting, S., & Mirwald, R. L. (2000). Calcium accretion in girls and boys during puberty: A longitudinal analysis. *Journal of Bone and Mineral Research*, 15, 2245–2250.
3. Butler, G. E., McKie, M., & Ratcliffe, S. G. (1988). An analysis of the phases of mid-childhood growth by development synchronization of growth spurts. In J. M. Tanner (Ed.), *Auxology 88, Perspectives in the Science of Growth* (p. 77-84). Smith-Gordon et Comp. Ltd., London.
4. Eveleth, P. B., & Tanner, J. M. (1990). *Worldwide variation in human growth* (2nd ed.). Cambridge University Press.
5. Hauspie, R., Vercautere, N. M., & Susanne, C. (1997). Secular changes in growth. *Hormone Research*, 45, 8-17.
6. Hauspie, R. C., & Chrzastek-Spruch, H. (1993). The analysis of individual and average growth curves: Some methodological aspects. In W. Duquet & J. Day (Eds.), *Kinanthropometry IV* (pp. 68-83). E&FN Spon, London.
7. Jurimaë, T. (2001). Influence of anthropometric variables on whole-body resistance in pre-adolescent children. In *Body composition assessment in children and adolescents* (pp. 107-120). Karger.
8. Koziel, S. K., Hauspie, R. C., & Susanne, C. (1995). Sex differences in height and sitting height in the Belgian population. *International Journal of Anthropology*, 10(3-4), 241-247.
9. Léone, M., & Larivière, G. (1998). Anthropometric and biomotor characteristics of elite adolescent male athletes competing in four different sports. *Sport & Sciences*, 13(1), 26-33.
10. Lindgren, G. (1996). Pubertal stages 1980 of Stockholm schoolchildren. *Acta Paediatrica*, 85(11), 1365-1367.
11. Rothenbuhler, A., Fradin, D., Heath, S., Lefevre, H., & Bouvattier, C. (2006). Weight-adjusted genome scan analysis for mapping quantitative trait loci for menarcheal age. *The Journal of Clinical Endocrinology & Metabolism*, 91(9), 3534-3537.
12. Susanne, C., Bodzsar, E., Bielicki, T., Hauspie, R., & Hulanicka, B. (2001). Changements séculaires de la croissance et du développement en Europe. Retrieved from [Insert actual URL if available]
13. Susanne, C., Rebato, E., & Chiarelli, B. (2003). *Anthropologie biologique. Évolution et biologie humaine*. De Boeck Université.
14. Tanner, J. M., Whitehouse, R. H., Marubini, E., & Resele, L. F. (1976). The adolescent growth spurt of boys and girls of the Harpenden study. *Annals of Human Biology*, 3(2), 109-126.
15. Tanner, J. M. (1986). Growth as a target-seeking function - catch-up and catch-down growth in man, Vol 1. In F. Falkner & J. M. Tanner (Eds.), *Developmental biology, prenatal growth* (pp. 167-179). Plenum Press.