ORIGINAL ARTICLE

Relationship between Arm Span and Body Height in Preschool Children of the Urhobo Ethnic Group in Abraka, Delta State, Nigeria

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ABSTRACT

Background*:** Among various anthropometric measures, arm span and height stand out as primary indicators of growth and physical development in children. ***Objective: To determine the correlation between the height and arm span in preschool children of the Urhobo ethnic group in Abraka in Delta State, Nigeria. It also aims to establish a formula for estimation of height using the arm span in this population. ***Methods*:** This descriptive cross-sectional study was carried out among two hundred children (99 male and 101 female) aged 3 and 5 years belonging to the Urhobo ethnic group, who were randomly selected from nursery schools. Standard anthropometric techniques were used to measure height and arm span. Pearson's coefficients of correlation and regression equations were calculated. ***Results*:** The mean and standard deviation of the height of males and females were 107.43±8.98cm and 105.59±8.83cm respectively and that of arm span of males and females were 108.58±9.95cm and 106.39±9.44cm respectively. The differences were not statistically significant ($p>0.05$). However, a positive correlation was observed between the height and the arm span parameters ($R^2=0.936$). A regression formula of height was provided (H=14.22+0.86 AS), as per our data analysis. ***Conclusion*:** In Conclusion arm span was found to be a valid measure of the height. Hence, arm span can be used as a reliable predictor of height in children with disabilities. These findings could be of practical significance in monitoring growth and development in children.

Keywords: Anthropometry, arm span, body height, preschool children, Nigeria

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INTRODUCTION

Anthropometry is the science of measurement that underlies physical/biological anthropology.[1] In general, the variations measured in anthropology are driven by multiple genetic factors. Thus, some of, the easiest anthropometric parameters to measure include height and weight, which on average vary across communities and tribes. Average height is essential for assessing the health and well-being (standard of living and quality of life) of a population, and like other phenotypic traits, is determined by a combination of genetic and environmental factors.[2] Arm span (also known as 'stretch' or 'wing span') is the length of a person's arm from one end (measured from the fingertips) to the other, and varies with height. Sometimes, this variation can be an indicator of health problems.[2] Arm span is the closest physiological measurement to standing height.[3] Human height is an essential characteristic, and its assessment is important for identifying unknown human remains.[4] The length of some long bones and appendages of the body has a specific relationship in the form of a proportion to height. Once skeletal maturation is complete,

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the proportion does not change with age.[4]

In the field of assessing child health and development, the interaction between various anthropometric measures is of great importance.[5] Among these measures, arm span and height stand out as primary indicators of child growth and physical development. Understanding the relationship between these two indices can provide insight into the overall health, and developmental pathways of children in educational and healthcare settings.[6] During the developing years of early childhood, spanning from 3 to 5 years of age, children undergo rapid physical changes and growth spurts. This period marks a critical junction characterized by profound transformation in body proportions and dimensions.[7] Explaining how arm correlates with height during the crucial developmental phase not only contributes to our understanding of normal growth patterns, but also adds in the detection of aberrations that may warrant further clinical evaluations.[8,9]

This study seeks to address this gap by conducting a comprehensive examination of the relationship between arm span and height in children aged 3 to 5 years. By employing rigorous anthropometric techniques and statistical analysis, we aim to uncover the dynamics of this relationship within this distinct age group. We also aim to explore potential moderating factors of this relationship, including gender differences, nutritional status, and environmental influences.

METHODS

This study cross-sectional, descriptive study was conducted in nursery schools in Abraka, Delta state, Nigeria. The study population consisted of all male and female children belonging to the Urhobo ethnic group of Delta State, Nigeria within the ages of 3 to 5 years. A total of 200 samples were utilized and were selected using a simple random sampling technique. Subjects between the ages of 3 to 5 years and subjects whose parents are of Urhobo descent (up to two generations) were selected for this study. The study excluded male and female children above or below the required age range and subjects with physical deformities involving the spine and either upper or lower limbs. Stadiometer, measuring tape and data collection form were used to gather data for this study. The following parameters were measured:

Measurement of height: Height was measured with the subject standing on the stadiometer platform with their heels together and toes apart. The toes are pointed slightly outward, and the back as straight as possible so that heels, buttocks, shoulders and the head make contact with the back board. The arms were by the sides of trunk with the palms facing the thighs. The subject's head had to be in the Frankfort horizontal plane. This was achieved when the lower edge of the eye socket (the orbitale) is horizontal with the tragion. The vertex is the highest point on their head, hence, the respondents had to raise or lower their chin until it is in the Frankfort horizontal plane. Participant were asked to take a deep breath and hold it, the stadiometer head piece is lowered so that it rests firmly on top of the participant's head with sufficient pressure to comment the hair. The height was the measured and the participant was told to breathe out and step away from the stadiometer platform. The measurements was taken twice, and an average of the two readings was calculated and recorded.

Measurement of arm span: It was measured using a calibrated steel tape to the nearest 0.1 centimetres, with the participant in bare feet on a level concrete floor with the upper backs, buttocks and heels against the wall providing support. The participant's head was also in the Frankfort horizontal plane and the arms outstretched at right angles to the body with palms facing forwards. The measurement was taken from one middle fingertip to the other middle fingertip, with the measuring tape passing the arms. The measurements were taken twice, and an average of the two readings was calculated and recorded.

Data obtained was statistically analyzed using Statistical Package for Social Sciences (SPSS) version 27.0 for Windows. The data was summarized using mean and standard deviation (SD). Comparison among male and female was made statistically by independent 't' test. Correlation of arm span with height was determined using Pearson correlation coefficient and regression analysis was used to set up a model formula to predict height from arm span. A p-value of 0.05 or less was considered statistically significant.

RESULTS

A total of 200 children (99 males and 101 females) participated in this study. The mean

age was 4.00±0.81 years, with a mean height of 106.50±8.93 cm, and a mean arm span of 107.48±9.73 cm (Table 1). Our male participants had an average height of 107.43±8.98cm and an average arm span of 108.58±9.95cm, while female participants had an average height of 105.59±8.83cm and an average arm span of 106.39±9.43cm. When gender comparison was done, there was no statistical significant difference in height and arm span between male and female ($p>0.05$) (table 2). Pearson correlation coefficients between parameters measured was performed and it showed that there was a strong positive correlation between parameters measured ($p<0.001$) (Table 3).

Table 4 showed the results of a linear regression analysis, where arm span was used to predict height. The regression equation provided (H=14.22+0.86 times AS), where (H) is height and (AS) is arm span. This therefore suggests that for every unit increase in arm span, height increases by 0.86 units, starting from a base height of 14.22 cm. Coefficient of Determination (R^2) value is 0.88, meaning that 88% of the variability in height can be explained by the arm span. Standard Error of Estimate (SEE) value is 3.16, which indicates that the equation is accurate, and can be used to predict height, which is statistically significant ($p<0.001$).

Table 1: Descriptive statistics of the parameters measured

Variables	N	Minimum	Maximum	Mean±SD
Age (years)	200	3	5	4.00±0.81
Height (cm)	200	89.20	130.30	106.50±8.93
Arm span (cm)	200	89.70	131.10	107.48±9.73

Table 2: Gender comparison of body height and arm span

Variables	Sex	N	Mean±SD	p-value
Body height (cm)	Male	99	107.43±8.98	0.146^{NS}
	Female	101	105.59±8.83	
Arm span (cm)	Male	99	108.58±9.95	0.111^{NS}
	Female	101	106.39±9.43	

NS=not significant.

Table 3: Correlation between parameters measured

Variables		Age	Height	Arm span
Age	Pearson Correlation	1	0.714**	0.685**
	Sig. (2-tailed)		0.000*	0.000*
	N	200	200	200
Height	Pearson Correlation	0.714**	1	0.936**
	Sig. (2-tailed)	0.000*		0.000*
	N	200	200	200
Arm span	Pearson Correlation	0.685**	0.936**	1
	Sig. (2-tailed)	0.000*	0.000*	
	N	200	200	200

*=significant.

Table 4: Linear regression analysis for height estimation using arm span

Variable	Predictive equations	R	R^2	SEE	p-value
Arm span (cm)	H=14.22+0.86AS	0.94	0.88	3.16	<0.001*

H=Height, AS=Arm span; R=regression coefficient, R2= Coefficient of determination, SEE=Standard error of estimate; *=significant.

DISCUSSION

When the accurate measurement for height is unobtainable, it is computed using other surrogates. Determinations of standing height may be difficult for children who have lost their lower limbs in disaster and accident. Paralyzed or bedridden children having difficulties in standing erected could have their standing height measured difficult. But the use of arm span could be an alternative to standing height.[9,10]

In this study, the mean height and arm span for males were higher compared to that of the females. Also, the average height and arm span of male subjects were found to be higher than those of the female subjects, but no significant difference was found between males and females in either parameter. This suggests that at young age, gender does not play a significant role in the development of height and arm span. This is due to the fact that growth patterns in young children are primarily influenced by general

developmental processes rather than gender-specific differences.[10] The hormonal changes that drive significant differences in growth between genders typically begin during puberty. Preschool-aged children have not yet undergone these hormonal changes, so their growth patterns remain similar.[9] In contrast, a study conducted by Mishra et al.[11], on 1465 school children between the age of 6 to 11 years, reported that mean height and arm span in males was significantly higher than mean height and arm span in females. Similarly, Rahmayani et al. [12] who carried out a study on 1,114 children between the age of 7 to 12 years, reported that the mean height and arm span in males was significantly higher than mean height and arm span in females. These studies suggest that males start to exhibit greater height and arm span increase at age between 6 and 12 years. However, children of 6-12 years are known as the preadolescent phase, and as children approach these phase, males begin to experience increases in growth hormone and androgens, such as testosterone, which contribute to their overall body size and muscle mass. These hormones help promote bone growth and elongation, impacting both height and arm span.[13] The difference between the aforementioned studies and this present study can be attributed to age differences.

In the present study, there was a statistically significant relationship ($p<0.001$) between the standing height and arm span in the children, with correlation coefficient (r) value of 0.936. The strong correlation between height and arm span which suggests a very close relationship between these two measurements in preschool-aged children. This means that children with greater height also tend to have a greater arm span, that is, as height increases, arm span tends to increase as well. The results of this study are in line with the study by Forman et al.[14] which reported a strong correlation between height and arm span (r=0.97), as well as the study by Maziciougluet al.[15] which also reported a strong correlation between height and arm span (r=0.95). Similarly, observations were made by Mishra et al.,[16] where they found strong correlation between stature and arm span (r=0. 95). The strong correlation between arm span and height is due to their shared growth patterns, mechanical advantage, and allometric scaling.[17] The correlation can be attributed to the similarities in the developmental patterns of the upper limb and the axial skeleton. According to the "axis of growth" theory, the upper limb and the axial skeleton share a common growth axis, which determines their proportional growth and development.[18] This theory suggests that the arm span and height are correlated due to their shared growth patterns. Another theoretical perspective is the "mechanical advantage" hypothesis, which proposes that the arm span is adapted to optimize the mechanical advantage of the upper limb for locomotion and manipulation.[19] According to this hypothesis, the arm span is proportional to height to maintain an optimal mechanical advantage for movement. Furthermore, the "allometric scaling" theory suggests that the arm span and height are related due to their shared scaling patterns during growth and development.[20]

Strong correlations were found between age and height (r=0.714) and between age and arm span (r=0.685). This suggests that as age increases, height and arm span tends to increase as well. This is due to the fact that human growth follows predictable patterns from infancy through adolescence. These patterns are characterized by specific growth spurts, particularly during early childhood and puberty, resulting in steady increases in height and arm span with age.[10]

In this study, although the mean height and arm span in male were more than female, it was not statistically significant. So, the same regression equation can be used in both sexes to estimate height. Contrary to this, Rahmayaniet al.[12] who reported that the difference between the mean height and arm span in males and female was statistically significant provided two regression equations used to predict height through measurement of arm span in male subjects and in female subjects. In this study, the regression equation provided is (H=14.22+0.86 times AS), where (H) is height and (AS) is arm span. This equation suggests that for every unit increase in arm span, height increases by 0.86 units, starting from a base height of 14.22 cm. The coefficient of determination (R^2) for the regression equations obtained was 0.88, meaning that 88% of the variability in height can be explained by arm span. This is a high proportion, indicating a strong predictive power of the model. The equation shows a low Standard Error of Estimate (SEE) value of 3.16. This indicates that the equation is accurate and can be used to predict height. This equation is only suitable and reliable for preschool-aged children of the Urhobo ethnic group and not to

be used for adolescent or adult populations. Similarly, Rahmayani et al. [12] provided a regression equation for male and female subjects where R^2=94%; SEE: 2.66 and R^2=95.4%; SEE: 2.29 respectively. This corresponds with the study findings of Banik et al.[21] and Chen et al.[22] as they reported correlation values of R^2=0.90 and R^2=0.978 respectively. The aforementioned studies showed a strong correlation between height and arm span, as well as a low SEE value. These findings reinforce the use of arm span as an indicator for height of preschool-aged children.

CONCLUSION

Our data suggests that there was no significant difference between the mean height and arm span of the male and female participants. Strong correlations were observed between age, height, and arm span. To conclude, arm span was found to be a valid measure of the height. Therefore, arm span can be used as a reliable predictor of height in children with disabilities.

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Authors' contribution: All of the authors were equally involved in the study design, data collection, compilation and analysis as well as manuscript writing, editing and final submission.

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