ORIGINAL ARTICLE

Anthropometric Study of Arm Span Length and Standing Height of 5 - 12years Pupils in Obantoko, Ogun State, South Western Nigeria

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Abstract: Height is an essential and important anthropometric parameter for coroners and forensic anthropologists. Several studies have been performed to determine standing height (SH) using various anthropometric body parts. Arm span length (ASL) is recognized as an alternative means of measuring standing height for the disabled, adaptive, or unable to stand upright. This study was conducted to measure the height of pupils from the age 5 to the 12 years old using ASL A total of 440 pupils (220 male and 220 female) participated in the study and the study was conducted in Obantoko Ogun State in Southwestern Nigeria. The Participants' actual standing height were measured with a digital stadiometer and ASL with a tape measure to within 0.1 cm. Results showed the mean SH of 133.23 ± 9.97 cm (male participants), 123.21 ± 11.25 cm (female participants), and 128.27 ± 11.75 cm (pooled) and mean ASL of 133.66 ± 9.88 cm, 123.83 ± 11.01, and 128.75 ± 11.55 cm respectively. The correlation (r) between SH and ASL was 0.999 ($p<0.000$) with a coefficient of determination (R^2) of 99.8%. A regression models was developed to determine SH from the ASL. This study concludes that ASL is a reliable predictor of SH for both sexes and also a veritable tool for physical anthropologists and related professionals. The authors recommend conducting a larger sample study in six southwestern Nigerian states to develop a database for determining SH

Keywords: SH, ASL, Prediction, Obantoko, Anthropometric, Regression.

1.0 INTRODUCTION

Measuring the height of people with disabilities (PWD) or those who have difficulty standing upright is always very difficult. Persons with disabilities may include wheelchair users, amputees and leg deformities, paralyzed and bedridden hospitalized patients, and children with sickle cell anemia These individuals find it difficult to stop to measure their height. Several authors from different countries have used different methods to determine height based on knee length, leg length, foot length, footprint, etc. [1] [2] [3] [4] [5] [6] [7] [8] but an alternative measurement of standing height using arm span length is a useful and reliable surrogate for decisions made according to body size. Arm span length (ASL) is described as the horizontal distance between the tip of the middle finger on the one hand and the corresponding point on the other hand in the position of the cross with the arm outstretched to the side [9].

Arlappa et al., [9] investigated arm span length as an alternative for height in 400 adults over the age of 60. The authors concluded that arm span is the best alternative to measure standing height, although traditional height is not a very reliable measure. Few studies have shown a relationship between arm span length and height of children less than 15years [10]. Several researchers have

examined the relationship between arm span length and height in adults from various population groups [11], [12], [13], [14], [15], [16], [17], [18], [19], [20] but Inattentive to children.

In addition, studies have shown that the relationship between height and arm length varies by race and country [15], [17], [18], [21]. Moreover, Esomonu et al. studied height estimation from arm span in his Bekwara ethics group in Cross Rivers State, South-South Nigeria [17]. The authors reported that the arm span of his Bekwara Ethics Group of Indigenous Peoples has been shown to be a reliable anthropometric segmental parameter measure for estimating height in Indigenous peoples.

Abay and Bereket investigated how to estimate height from arm span, arm length, and tibia length in 15- to 18year olds living in Addis Ababa, Ethiopia [12]. The authors found that height predicted from arm span, arm length, and tibia length appeared to be the best predictors of height using regression analysis, thus suggesting that height and arm span are effective. The literature indicates that there is information on the relationship between arm length and height in some parts of Nigeria [15], [17]. [18], [22]. However, attempts to determine height (SH) using arm span length (ASL) are not widely available in southwestern Nigeria due to the lack of literature for this purpose. However, with the study of different models of different races, ethics and geographies, it is imperative to conduct this current research for pupils of Yoruba ethnicity in southwestern Nigeria and contribute to the body of knowledge.

2.0 MATERIALS AND METHODS

Sample selection and measurement method

A total of 440 pupils (220 male and 220 female) were randomly selected in Obantoko, Ogun State, south western Nigeria. Participants' ages ranged from 5years old to 12years old. Targeted, deterministic and selective sampling methods are used in the snowball sampling technique because they are best suited when studying a specific set of groups exhibiting traits that are rarely determined due to Nigerian uncertainties insecurity.

Snowball sampling technique is described as non-probability sampling in which the samples are rarely found. The existing participants provide referral to recruit participants required for this research study. Participants with lower extremity deformities, bedridden, or difficulty standing upright were excluded. The measured dimensions were SH and ASL. SH is determined by measuring the head at the Frankfurt level using a stadiometer while standing barefooted and recorded in centimeters while ASL is measured from the tip of one middle finger of one hand to the tip of the other middle finger on the other hand; in the "cross position" with the arm out stretched (Figure 1).

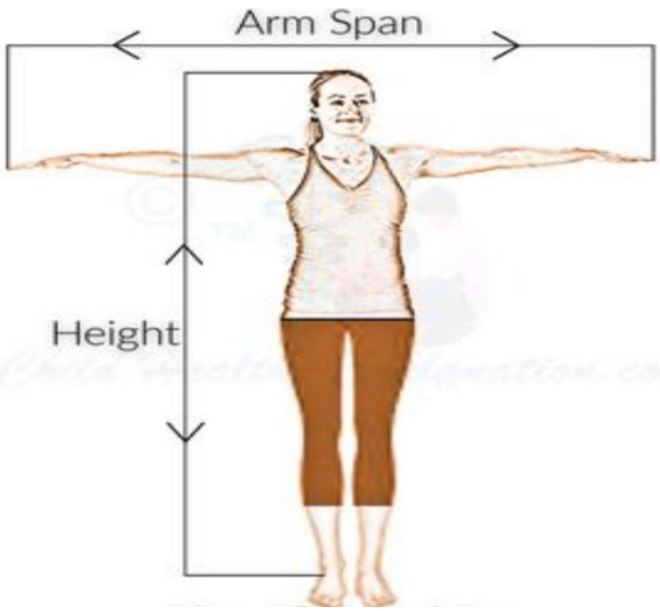

Figure 1: Survey measurements (source; Google)

Data Analysis:

Obtained data were analyzed using the Social Science Statistics Package (SPSS) version 21.0 to determine means, standard deviations and frequency-histogram plots. Coefficients of determination (R^2), adjusted correlation coefficients (R), the correlation between the coefficient (r) and the standard error of the estimate (S.E.E.) was also analyzed. Linear regression analysis was also used to set up a model formula for determining standing height (SH) from arm span length (ASL), and their relationship is shown in the scatter plot.

3.0 RESULTS

Table 1 showed the result of SH and ASL for the 3 groups.

Table 1: **Descriptive Statistics of the Respondents**

Gender	Variables	Mean	SD	Min	Max
Male n=	Age (years)	8.80	2.07	5.00	12.00
220	SH (cm)	133.23	9.97	118.00	150.00
	ASL(cm)	133.66	9.88	118.00	150.00
Female	Age (years)	8.01	2.46	5.00	12.00
n = 220	SH (cm)	123.21	11.25	109.00	138.00
	ASL(cm)	123.83	11.01	109.00	139.00
Pooled	Age (years)	8.44	2.31	5.00	12.00
n = 440	SH (cm)	128.27	11.75	109.00	150.00
	ASL(cm)	128.75	11.55	109.00	150.00

SH - standing height; **ASL** – Arm span length; **SD** – Standard deviation, **Min** – minimum; **Max** - Maximum

Male participants had an average ASL of 133.66 ± 9.88 cm with a range of 118–150 cm and an average height (SH) of 133.23 ± 9.97 cm with a range of 118–150 cm. The mean ASL for female

participants was 123.83 ± 11.01 cm, ranged from 109 to 139 cm, and the mean SH was 123.21 ± 11.25 cm, ranged from 109 to 138 cm. The pooled combined male and female data have a mean ASL of 128.75 ± 11.55 cm in the range 109-150 cm and a mean SH of 128.75 ± 11.75 cm in the range 109-150. The sex difference was statistically significant (P<0.0001), and frequency distributions were displayed in frequency-histogram plots (Figures 2 and 3)

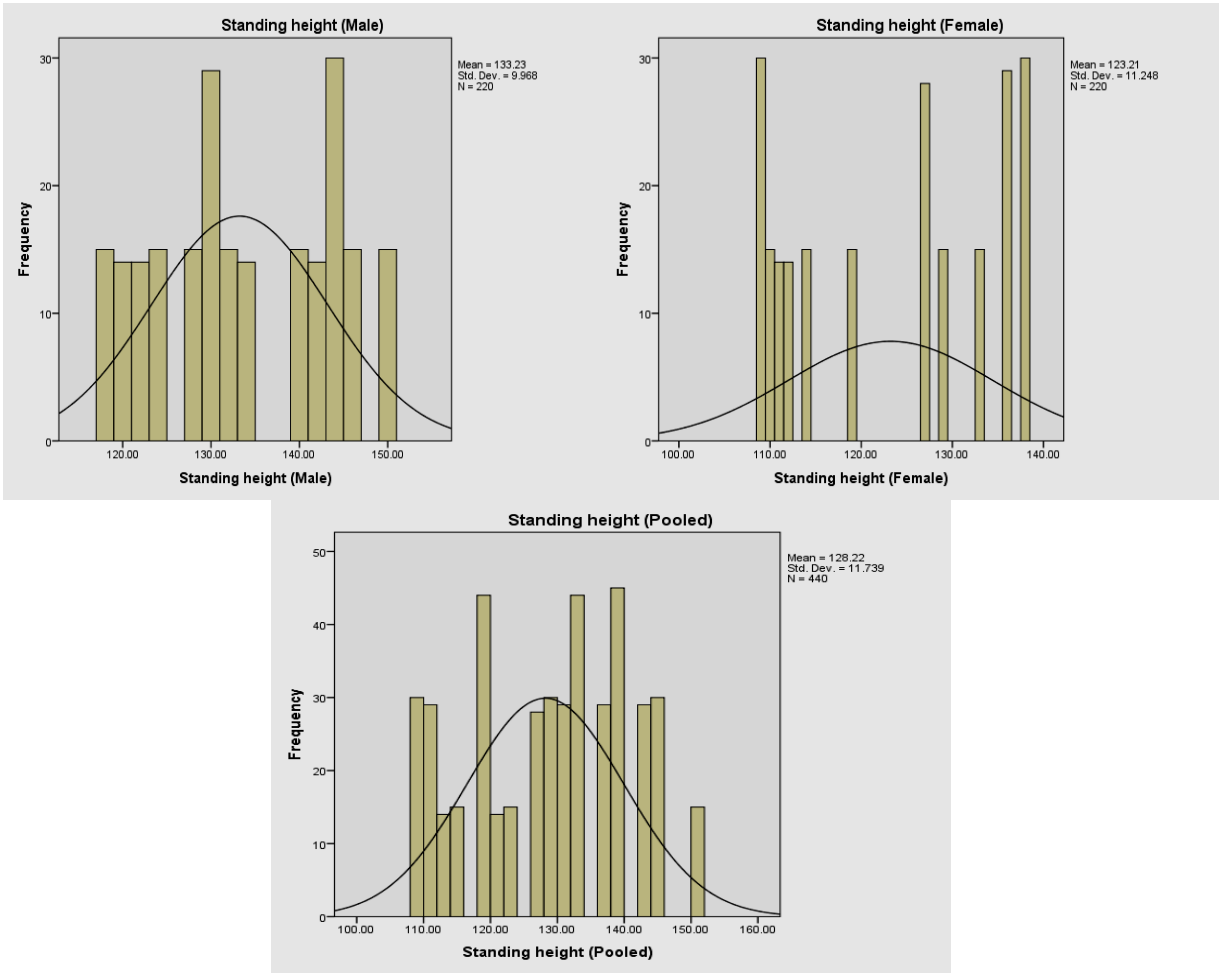

Figure 2: Frequency histogram plot of SH distribution

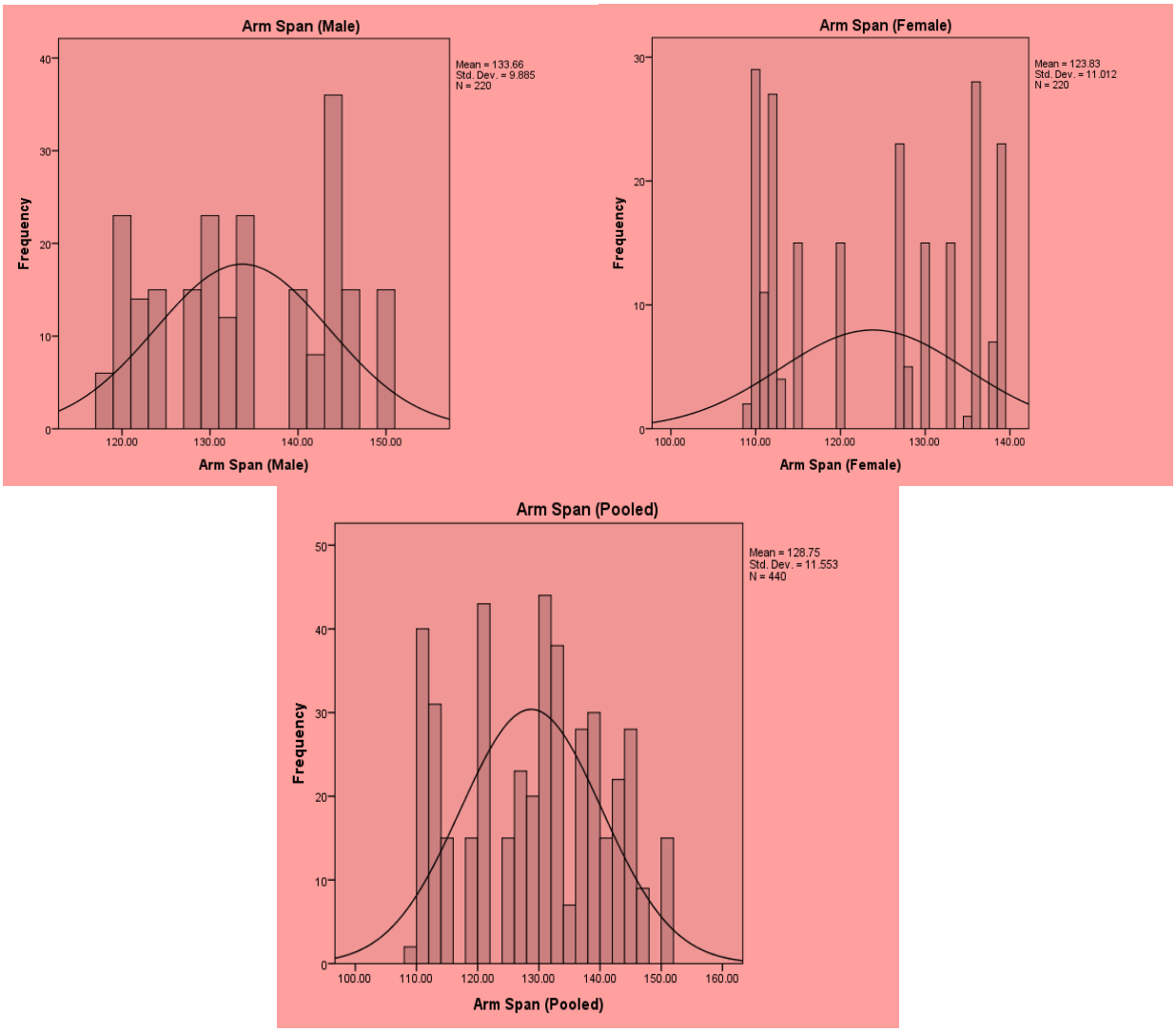

Figure 3: Frequency histogram plot of ASL distribution

Table 2: Pearson Coefficient Correlation

Variables	R	P-value	95% CI	
$\mathbf{ASL_{Male}}$	0.999	0.000	1.001	1.014
$\mathbf{ASL_{Female}}$	0.999	0.000	1.015	1.026
$\mathbf{ASL_{Pooled}}$	0.999	0.000	1.011	1.019

CI – Confidence of Interval; **r** – correlation coefficient;
P – Probability statistically significant level (p<0.005)

Table 2 shows the correlation analysis between standing height (SH) and ASL at the 95% confidence level of the participants. Correlation coefficients are statistically significant at p <. 0.000 of gendered and pooled. The correlation coefficient (r) is very high by gender and pooled. This coefficient is 0.999, indicating a good correlation. Table 2 also shows that the interval levels 1.001 to 1.014, 1.015 to 1.026, and 1.011 to 1.019 have 95% confidence for males, females, and pools, respectively.

Table 3: Regression Analysis

Variables	Regression equations	R^2 (%)	Adj. R (%)	S.E.E	P-value
$\mathbf{SH_{Male}}$	$1.01\mathbf{ASL_{Male}} - 1.39$	99.8	99.8	0.493	0.000
$\mathbf{SH_{Female}}$	$1.02\mathbf{ASL_{Female}} - 3.15$	99.8	99.0	0.483	0.000
$\mathbf{SH_{Pooled}}$	$1.02\mathbf{ASL_{Pooled}} - 2.48$	99.8	99.8	0.492	0.000

SH – Dependent variable; **ASL**- Predictor; **S.E.E** – standard error of estimation;
R^2 –Coefficient of determination; **Adj. R** – Adjusted coefficient of determination;
P – Probability statistically significant level ($p<0.005$)

Table 3 shows the linear regression analysis of the participants. The results shows that ASL significantly predict SH of the pupils in Obantoko Ogun State Southwest Nigerian populations ($p<0.000$) with the coefficient of determination (R^2) of 99.8% and adjusted Coefficient of determination (R) of 99.8%, 99.0% and 99.8% of male, female and pooled respectively. Higher the coefficient of determination (R^2), better the fit of the model and the more reliable the model.

Similarly, Table 3 also presents the regression model equations for SH_{Male}, SH_{Female} and SH_{Pooled} estimates using $ASL_{Male,}$ ASL_{Female} and ASL_{Pooled} from the survey. Results show standard errors of estimation (S.E.E.) of 0.493, 0.483, and 0.492 for male, female, and pooled participants, respectively. The relationship between the model's SH and ASL participants' measurements was shown using a scatter plot (Figure 3)

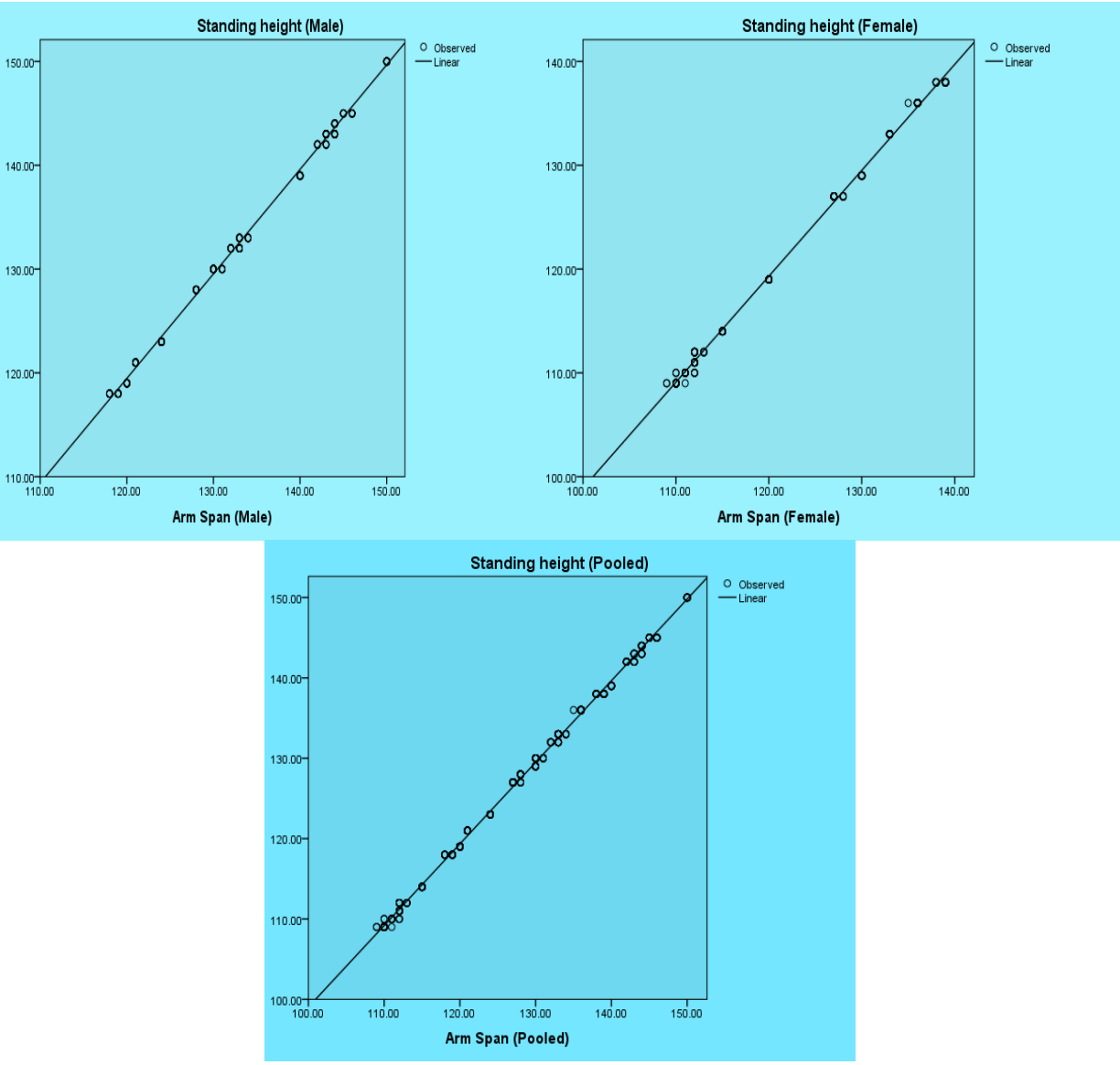

Figure 4: Linear regression scatter plot of the SH and ASL

4.0 DISCUSSION

Determinations of standing height maybe difficult for the individual who are have lost their lower limbs in disaster and accident. Paralyzed or bedridden individual or person having difficulties in standing erected could have their standing height measured difficult. But using of ASL could be alternative to standing height for deformed individuals. Several researchers have predicted the standing height or stature of adult individual using arm span measurement in other nation [20] [23] [24][25] [26] [27] and similar studies was also conducted in Nigeria[17] [18] [22] for adults population. The present study was conducted for pupils between the ages of 5 – 12years in southwest Nigeria.

Similar studies existed in other nation [29] [30] [31]. The present study shows that majority of arm span was more than standing height as well as the mean arm span in the children was higher than the mean standing height. (Table 1/ figure 1) and in accordance with the study by [10] [17] [29] [30] [31]. However, it was reported that arm span is less than standing height in South Africa [32]. The difference

could be ethnical differences as well as the sample size. Several studies conducted for adult populations shows that arm span is higher than standing height [17] [18] [22] [24] [33].

The results of the present study shows that there was a statistically significant relationship ($p<0.000$) between the standing height and arm span in the male, female and pooled participants with correlation coefficient (r) value of 0.999. The model is in strong agreement with other studies in different populations where strong association existed between arm span and standing height values [28] [34] [35] [36]. The present study shows stronger correlation than other population and this difference in sample size and sample age may contribute to the difference in the result of the studies.

A linear regression equation was set to determine SH_{Male} = 1.01 ASL - 1.39, SH_{Female} = 1.02ASL - 3.15 and 1.02ASL - 2.48 = SH_{Pooled} with adjusted R of 99.8%, 99.0% and 99.8% for males, females and pooled respectively We used this formula to estimate the child's height (SH) from age 5 to 12 and compared it to the actual measured height This linear regression equation set up in this study was quite different from other studies. Differences may be due to population differences or sample characteristics. Zverev and Chisi [10] used multiple variables of height, arm length, and age to develop regression equations for Malawian children.

These equations mentioned above are only suitable and reliable for children of the same age group of different ethnicities and not to be used for adult populations. It is worth noting that differences in height and arm span in different groups were not part of the study. Mishra et al., [28] reported that complex interaction of growth factors and hormone are relatively responsible to linear bone growth in children. Higher estradol concentrations in women contributed to pubertal growth, whereas men did not show pubertal growth due to estrogen resistance. At the age of 15years old, female arm grows more than standing height but for male, the growth will continue until the age of 25. The current study included age samples under 15years and 25years old when participants were in their growing years. Zverev and Chisi [10] reported that the lack of published literature on the relationship between arm span and height in Africa children makes it difficult to compare their studies with Malawian children. The current study was compared with other studies on children from other countries (Table 4).

Table 4: Comparison of the present study with other studies

Studies	Gender	Age (years)	N	R^2 (%)	Regression equation
Present study	Male	5-12	220	99.8	$1.01ASL_{Male}$ – 1.39
	Female		220	99.8	$1.02ASL_{Female}$ – 3.15
	Pooled		440	99.8	$1.02ASL_{Pooled}$ – 2.48
Mishra et al [28]	Male	6 – 11	774	89.0	0.788AS + 25.21
	Female		691	92.0	0.8528AS + 17.57
	Pooled		1465	91.0	0.8192AS + 21.46
Dorjee and Sen [30]	Male	3 - 11	116	96.0	8.758 + 0.929AS
	Female		124	95.0	8.882 + 0.932AS
	Pooled			95.0	9.082 + 0.928AS
Esomonu et al [17]	Male	6 -10	60	97-7	69.31+0.459ASL
	Female		60	95.9	69.57+0.425ASL
	Pooled		120		
Yousafzai et al. [31]	Male	2 – 6	83	93.0	Overall Height = 6.40 + 0.93AS
	Female		79		
	Pooled				
Zverev and Chisi [10]	Male	6-15	289	98,3	17.043+0.348age+0.815AS
	Female		337	98.6	18.158 + 0.265age + 0.817AS

Pooled	98.8	15,756+0.168age+0839AS

ASL – Arm span length; **AS** – Arm span

The results of this current study provide additional information on the state of knowledge in the Nigerian literature on estimating height from arm spans in children aged 5 to 12years. Height is very important in forensics and archaeology. If you can estimate anthropometric body parts such as knee length, leg length, and arm span, you can determine an individual's height from a regression equation that can be used for that group. The results can be used by medical professionals, including forensic experts

5.0 CONCLUSION

The present study is an additional contribution to the body of knowledge demonstrating a positive correlation between arm span and height in pupils aged 5 to 12. The results of this study can be used as a basis for future population-based studies in southwestern Nigeria and confirm the need for further development of specific models according to population and ethnicity Arm span is a valid measure of the height of an Obantoko pupils. The measurements described in this study can also be used to determine height in children with disabilities and bedridden children. Therefore, arm span can be used as a reliable predictor of height. It is also considered to be an important identification parameter useful in forensics. Further studies with larger sample sizes are recommended for adults in southwestern Nigeria. Similarly, studies that determine height from arm spans in children need to be expanded to other parts of six states in southwestern Nigeria to create a standing height determination database.

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