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UNICROSS JOURNAL OF SCIENCE AND TECHNOLOGY, UJOST

RESEARCH ARTICLE ISSN:2814-2233

Date Accepted: 30th, May 2022 Pages 108-116

PREDICTION OF STATURE USING ARM SPAN OF YOUNG ADULT NIGERIANS IN COLLEGE OF MEDICINE UNIVERSITY OF LAGOS, NIGERIA

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Abstract

Arm span can play a crucial role in human identification and biological profiling from stature estimation, especially in situation involving disaster victims with dismembered lower extremities and bedridden individuals or those confined to wheel chairs. A total number of 450 (220 males and 230 females) Nigerian Students in College of Medicine, University of Lagos, aged between 18to 25years, stature and arm span lengths were measured. Statistical Package for Social Sciences was used to analyze descriptive statistics, Pearson correlation coefficients (r)and regression line equations were derived for both genders. These results showed strong relationship between stature and arm span with a positive confidence level of 99% ($p<0.01$), as average correlation coefficients recorded 0.87and 0.86 for the male and females respectively. Meanwhile combined sample correlation has 0.93. The regression formulas derived from this study can be applicable in prediction of stature of young adult Nigerians as a reliable determining parameter for human individualization.

Keywords: Stature, Prediction, Arm Span, Regression Equations, Young Adult Nigerians.

1. Introduction

Stature reconstruction still plays a cardinal role in identification of people, which is very essential in medico-legal investigation in particular and forensic practice at large (Gerver *et al.*, 2020). Forensic scientists are usually saddled with the responsibility of unravelling the true identity of disaster victims in scenario where dismembered body parts are seen in the crime scene and even among people with challenging health conditions affecting standing abilities like skeletal dysplasia, musculoskeletal deformity, disproportionate growth abnormalities and accidents that may affects lower limbs (Esomonu *et al*., 2015; Katara *et al*., 2016; Abay and Bereket, 2021).

Measurement of individuals height and body weight are required for assessment of growth and nutritional status of humans, determination of basic energy requirements, standardization of measures for physical capacity, for adjusting drug dosage and for identifying an unknown remains (Shah *et a*l.,2013; Alam*et al*., 2016).Length of certain long bones and appendages of the body represents a certain relationship in the form of proportion to stature (Chawla *et al*., 2013; Kranioti and Tzanakis, 2015 and Katara *et al*., 2016).

However, stature is usually affected by many factors such as genetics and ethnic descent, dietary intake, environment, gender, age, and physical activities that is widely different between different ethnic origins (Agnihotri *et al*., 2009; Srivasta and Sahai, 2010; Sarma *et al*., 2020).Various studies have been published on estimating the stature from arm span (Shah *et al*., 2013;Supare *et al*., 2015), and different ethnic, population, gender and age specific regression models have been formulated to predict stature using arm span (Mohanty *et al*., 2001; Samira *et al*., 2011; Dorjee and Sen, 2016; Abay and Bereket, 2021). But each of those previous literature contained different regression formula which implies that regression equation derived from one population might not correctly be applicable across all world populations and the whole world population.

Therefore, it has become necessary for many researches to be done across other world population, to derive population specific regression equations to avoid the application of one formula to another population that may lead to an erroneous outcome. Hence, this study is an attempt to formulate regression equations using arm span for reconstruction of stature amongst young adults Nigerian in college of Medicine of the University of Lagos, Lagos State, Nigeria.

2. Materials and Method

2.1 Study Design

The present study cohort comprised of randomly selected450 (220 males and 230 females) healthy Nigerian students in college of Medicine of the University of Lagos (Medical and Paramedical students). A study proforma was given to the students to indicate their State of origin and ethnic group, and only those that both parents are from Nigeria regardless of the ethnic descent were measured. The study subjects fall within age 18-25 years. Only were healthy students without any form of congenital standing inability or hand deformities. Participants were invited into the gross Anatomy laboratory of the Department of Anatomy, College of Medicine, University of Lagos, Nigeria for data collection. The study students were invited between the hours of 9am to 12pm each day to prevent diurnal variation for measurement of stature and arm span.

The sample size was derived from the sample size formula for infinite (unknown) population size as documented by Mohanty *et al.*, (2001).

$SS = [Z^2 p\ (1 - p)]/ C^2$

Where;

- *SS* = Sample size
- *Z* = Given *Z* value
- *p* = Percentage of population
- *C* = Confidence level
- *Pop* = Population

2.2 Stretch Stature Measurement

Measurement of the stature was taken using standard stadiometer 2017 model Germany make. The stature was measured as the vertical distance from the vertex (top of the head) to the floor of the stadiometer. The measurement protocol was taken by asking the subject to stand erect barefooted on the stadiometer having the palms of the hands turned inwards and the fingers pointing downwards, with the head at Frankfurt plane, then the subject asked to inhale and upper bar of the stadiometer is rolled across the vertex of the head and reading are taken (figure 1).

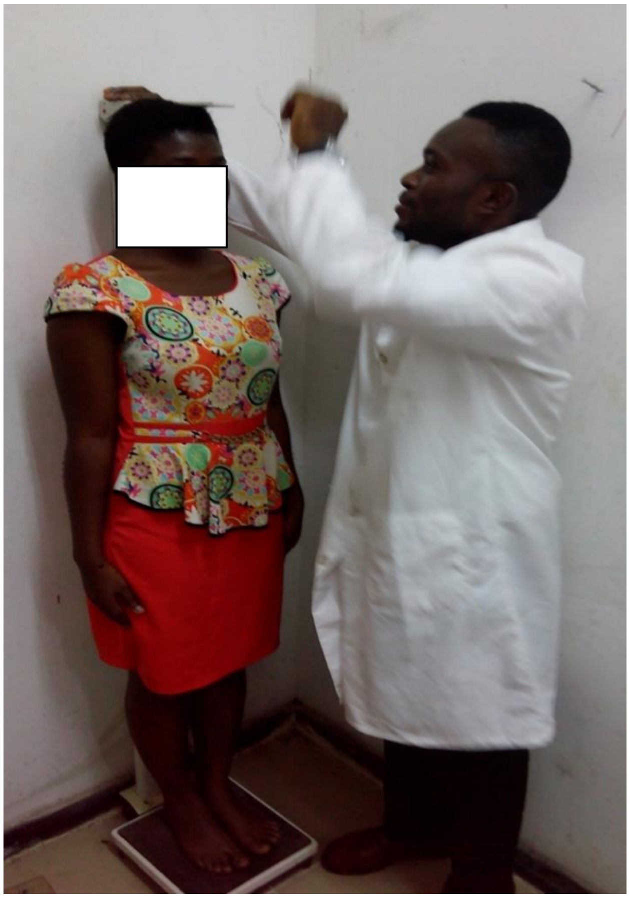

Figure.1: Measurement of stretch stature using stadiometer (cm)

2.3 Measurement of Arm Span

The arm span was measured as the horizontal distance from the left to the right dactylion when the palms are facing forward and the outstretched arms are abducted. The subject faces a wall and places one dactylion against an edge or side wall. With the aid of a non-stretchable still tape, the tip of the tape is held in contact with the dactylion of the opposing finger by a research assistant. The other dactylion is volitionally stretched along the wall for maximal span which is identified and then measured to the nearest 0.1 cm (figure 2).

Figure.2: Measurement of arm span using non-stretchable Lufkin table (cm).

2.4 Statistical Analysis

The collected data was analysed using a software called statistical package for social science (SPSS version 21 Chicago Inc.) to present outcomes of descriptive statistics, Pearson Moment correlation coefficient to assess the strength of association between the two measured variables (Stature and Arm span) regression line equations for prediction of stature using arm span as known variable from the derived equations, here both scattered plots were derived for both the males and their female counterparts for the single regression line equation.

2. Results

Table.1: Descriptive statistics of stretch Stature cm), Arm Span (cm) and Ages (years) in Males, Females and Combined Sample Population

GENDER	STATURE (cm)			ARM SPAN (cm)		
	MEAN±SD	MIN	MAX	MEAN±SD	MIN	MAX
MALES SAMPLE	**176.36±8.13****	**158.5**	**191.20**	**191.39±8.04****	**169.30**	**210.60**
FEMALES SAMPLE	**164.38±6.62****	**148.00**	**178.70**	**173.45±8.30****	**155.90**	**198.60**
COMBINED SAMPLE	**169.59±8.79**	**148.00**	**191.20**	**181.25±12.09**	**155.90**	**210.60**

Values with asterisk ** are statistically significant different at p<0.00 between the males and females.

Table.2: Pearson Correlation coefficient (r) between stretch stature and arm span in males, females and combined sample population.

PARAMETER	MALES	FEMALES	COMBINED SAMPLE
	Pearson Correlation (r)	Pearson Correlation (r)	Pearson Correlation (r)
STATURE/ARM SPAN	**0.87****	**0.86****	**0.93****

Values with asterisk ** **have strong Pearson Moment Correlation coefficient statistically significant at P<0.01**

From the result presented in table 2, which shows the outcome of the Pearson moment correlation between stature and arm span, which depicts strong relationship between the two parameters with a high confidence level of 99% (p<0.01).

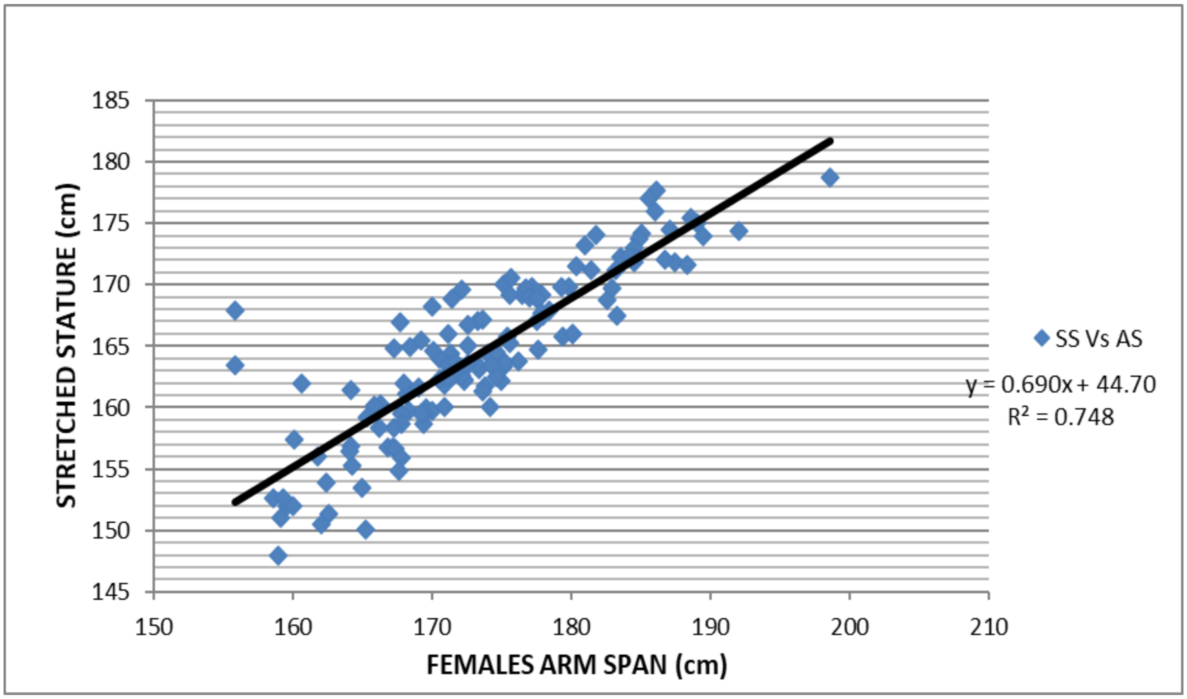

Figure 3: Scattered Plots of Stature in cm vs Arm Span in Females.

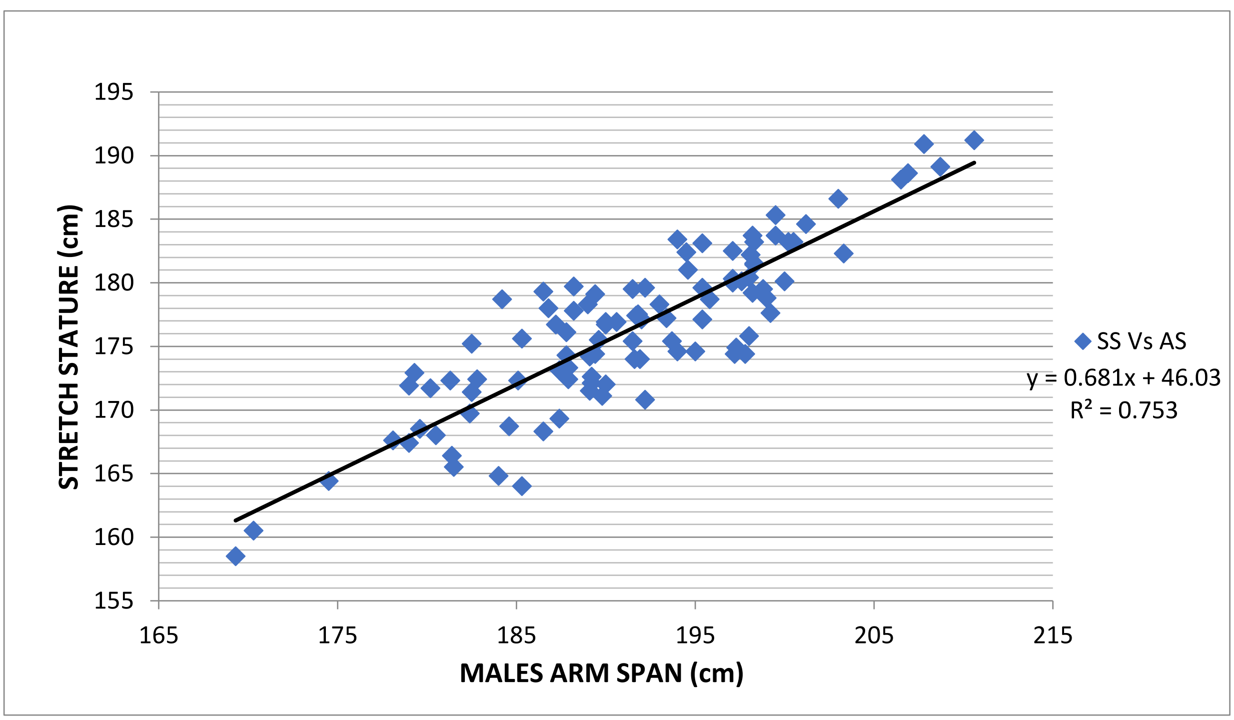

Figure. 4: Scattered Plots of Stature vs Arm Span in Males.

Figures 3 and 4- depicts the single regression line equations for the females and males respectively. The equations were derived from Y=MX+C, where Y=Stature the unknown variable, M=coefficient regression, X=known variable, C=Regression constant. R^2=Coefficient of determination

Table.3: Showing comparison of measured and predicted stature from the regression line equations in the males and females respectively.

GENDER	REGRESSION FORMULAS	PREDICTED STATURE(cm)	MEASURED STATURE(cm)	±S.E.E	R^2	t-value	p-value
Males	**SS=46.03+(0.681×AS)**	**176.36±1.01**	**176.36±8.13**	**2.148**	**0.754**	**0.42**	**0.96**
Females	**SS=44.70+(0.690×AS)**	**164.38±1.28**	**164.38±8.13**	**2.337**	**0.748**	**0.45**	**0.98**

Differences between measured stature and reconstructed stature**significant at P<0.01

Key: SS= Stretch stature, AS= Arm Span, SEE=Standard error of estimate, $R^{2=}$coefficient of determination, t-value= differences in mean between measured and predicted stature.

The results presented in table 3, showed low values for standard error of estimates (S.E.E) which connotes prediction reliability because the lower the value of S.E.E, the more reliable the regression equation. Also, it can be observed that the both the predicted and measured stature has similar data.

3. Discussion

In many situations, it is not possible to measure the stature or standing height of an individual because of possible deformities of the lower limbs that might lead to amputations and in some situations, accidents might damage the lower limbs. In such cases, stature has to be estimated from other body parameters (Shah *et al*., 2013, Supare *et al*., 2015, Esomonu *et al*., 2015).

Stature varies between the male and female of the same population which is as result of growth patterns that tend to be more rapid in males (Sharma and Dhattarwal 2016; Abey and Bereket, 2021). Their report conforms to the result of this study with statistical higher values recorded in the males than the females (table 1). Likewise, the result of the descriptive statistics for Arm span presented table 1 for the males and females showed a statistically significant different (P<0.01). The results of the presents study showed strongest positive correlation coefficient in Arm span compare to other variables, male recorded (r=0.87), female (r=0.86) and sample pool (0.93), which are higher than any other parameter as shown in (table 2).

Also, linear equation developed from arm span for the male and female (table 3 and figures 3 and 4) further explained how reliable is stature estimation from arm span as shown with small values recorded in standard of estimates (S.E.E). Comparing the present results with others from other population, Singh *et al*., (2012), reported the relationship between stature and arm span in Chandigarh sector of India and derived the following equations; y = 0.770 x + 37.73 and y' = 0.650 x' + 53.97 for the male and female respectively. Their derived formulas were totally different from that of this research documented in table 3. Although both studies showed low values for standard error of estimates. This implies that arm span can accurately predict stature irrespective of the population, even though the regression models may vary across world population, ethnic groups and even age groups.

The findings of Sharma and Dhattarwal, (2016), worked on estimation of stature from arm span in Haryana region of Indians, which published contrary values for both stature and arm span when compared with the present data (table 1). The result of Pearson moment correlation coefficient between stature and arm span derived from their study also differs from the outcome of the current study for both sexes. Higher values which indicate stronger association between the two measured variables are recorded in this study (table 3), when compared with that of the previous study.

The research done by Gupta *et al*., (2016), also found different mean values for arm span and stature with strong and correlation coefficient between the parameters. Their study published mean arm span value of 180.94±6.98 cm and 171.22±9.26cm for male and female with a positive correlation of 0.81 in male 0.83 in female with standards error of estimates (S.E.E) of 2.45 and 2.50 in male and female respectively. when compare with the current study that recorded191.39±8.04 and 173.45±8.30 (table 1) for the male and female with positive Pearson correlation coefficient of 0.87 and 0.86 (table 2) for the male and female, the recent study documented higher values with lower standard error of estimates of 2.148 and 2.337 for the male and female respectively (table 3). These differences recorded in each parameter from different studies done in different world population further buttress the fact that body segments differ with ethnicity and race. But the link between this study and previous literature is the reliability and precision of stature prediction from the derived regression models using arm span.

Many findings have recorded contrasting regression equations for stature estimation using arm span, but all of these studies have shown strong correlation coefficients and low standard error of estimates (Ter Goon *et al*., 2011; Shah *et al*., 2013; Supare *et al*., 2015; Popovic *et al*., 2015; Gerver *et al*., 2020; Abay and Bereket, 2021), which is similar to the present results. Therefore, the variation in the derived regression models between the previous works with the current shows the peculiarity and specificity of each regression formula to a race, ethnicity, population, gender and age groups, even though there could be a few exceptions where an equation derived from one population could match another, there is need for more derivation of regression models that fits each population.

4. Conclusion

Reconstruction of stature of a person from mutilated remains is still a great task despite innumerable researches done on this subject, because equations derived in a particular population might not reliably fit into another because of variation in upper limb segments. Therefore, due to variations in arm span among people of different regions, race, age groups and gender, there is need to conduct further studies among people of different regions and age groups of Nigeria and other climes to avoid erroneous application of derived formulas from population to another.

Conflict Of Interest

The author declares no conflict of interest from anyone as this is a sole authorship research. Every content of this research was done by the single author**.**

Acknowledgement

The painstaking efforts of the research subjects are duly acknowledged for their patience and cooperation during data collection exercise. Some of the students missed their lectures for the success of this research.

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