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RESEACH ARTICLE

Relationship Between Arm Span Length, Height and Body Mass Index among Students of Faculty of Basic Medical Sciences, Bayero University Kano

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Abstract

Background: Anthropometry is the scientific study of human body measurements and proportions. Arm span length is defined as the distance from the tip of one middle finger to the other when the arms are outstretched horizontally. Height, on the other hand, is the measure of the distance from the floor to the top of the head. Stature or human height is an important factor in establishing the identity of a person especially in the skeletonized remains, and it varies on the basis of race, sex, and age of individuals. **Aim:** The present study is undertaken to investigate the relationship between arm span length and height among students of Faculty of Basic Medical Sciences, Bayero University Kano. **Methods:** The study is conducted on 384 students of Faculty of Basic Medical Sciences, Bayero University Kano (193 males; 191 females). **Results:** Sexual dimorphism was observed in arm span length with the males having a higher value than the females ($p=0.05$). Height and arm span length correlated strongly ($r = 0.86$; $p< 0.01$). BMI and weight correlated strongly ($r = 0.90$; $p< 0.01$). Weak positive correlation was observed between height and weight ($r = 0.28$; $p< 0.05$), arm span length and weight ($r = 0.25$; $p< 0.05$) respectively. The relationship between the arm span length and height is statistically significant ($p< 0.01$). **Conclusion:** Arm span length is a good predictor of height though the linear regression formula varies with race, age and ethnic group. Therefore, what is obtained in one population may vary with that of another population. In view of this, it is pertinent that each population should have its own formula.

Keywords: Height, Arm span length, Relationship, Basic Medical Sciences, Bayero University Kano

Introduction

Anthropometry is the scientific study of human body measurements and proportions (Armstrong *et al*., 2011). Arm span length is defined as the distance from the tip of one middle finger to the other when arms are outstretched horizontally. Height, on the other hand, is the measure of the distance from the floor to the top of the head. Both are widely used as indicators in assessing physical dimensions and in determining growth patterns (Armstrong *et al*., 2011). Stature or human height is an important factor in establishing the identity of a person especially in the skeletonized remains. It becomes a challenge when incomplete human remains or only the upper half of the body are available (Tyagi *et al*., 1999). It is difficult to measure the height of an individual that has deformed or amputated legs, or with kyphosis or scoliosis or kyphoscoliosis, in national exercises like obtaining national identification card or national population census or international passport, where height of an individual is needed. The objective of this study is to obtain the arm span length and substitute it in the linear regression equation to obtain their estimated height. The significance of this study is to establish a baseline data that could be used to obtain an estimated height for individuals that cannot stand erect for their heights to be

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measured. Before estimating stature, one must determine the race, sex, and age of the individual as stature varies with these variables (Krogman and Iscan, 1986).

Accurate stature cannot be determined directly because of deformities of the limbs or in patients who have undergone amputations or any challenging health conditions affecting their standing abilities, such as skeletal dysplasia, musculoskeletal deformity, disproportionate growth abnormalities and accidents that may affect lower limbs (Esomonu *et al*., 2015; Katara *et al.*, 2016; Abay and Bereket, 2021). Measuring stature can also be difficult in physically and mentally frail nursing home patients who are wheelchair-bound or bedridden and those with osteoporosis, sequelae after hip fracture, or stroke (Hickson and Frost, 2003). Therefore, measurements of other body segments like arm span should be used (Jalzem and Gledhill,1993; Yun *et al*., 1995; Mohanty *et al.*, 2001; Hickson and Frost, 2003).

The long bone measurement of arm span corresponds to the maximum height achieved in early adulthood and is relatively less affected by aging and does not shrink with aging, suggesting that it may offer an alternative to height in calculating BMI in other populations (Kwok and Whitelaw, 1991). Although arm span has generally been found to be slightly greater than height in most individuals, Dwyer *et al.* (1993) and Lohman (1988) advocate its use as an accurate estimate of height as well as height at maturity in older adults.

Another study conducted by Lee *et al*. (2010) in South Korean adults found a similar correlation between arm span and height, with a correlation coefficient of 0.98. The study also found that the relationship between arm span and height is stronger in men than in women.

In a study carried out by Hatton *et al.* (2012), the relationship between arm span and height was investigated in a sample of British adults aged 18 to 75 years. The results show a correlation coefficient of 0.97, indicating a strong relationship between arm span and height.

Another study conducted by Juarez-Mora *et al.* (2017) found a strong correlation (r=0.97) between height and arm span in a sample of Spanish school children. Another study conducted by Koutsimanis *et al*. (2003) reports a similar correlation (r=0.98) between height and arm span in a sample of Greek adults.

A study conducted by Oyeyemi *et al.* (2015) found a positive correlation between arm span length and height in Nigerian adults. The study involves 304 healthy adults aged 18-40 years from southwestern Nigeria. The researchers found that arm span length is a good predictor of height, with a correlation coefficient of 0.91.

Another study carried out by Akinbo *et al*. (2019) investigates the arm span-height relationship in elderly Nigerians aged 60 years and above. The study involves 215 participants from southwestern Nigeria. The researchers found that arm span length is a good predictor of height in that population, with a correlation coefficient of 0.86.

Studies conducted in Nigeria have consistently found a positive correlation between arm span length and height in different age groups. These findings can be useful in estimating an individual's height in situations where direct measurement is not possible (Daniel *et al*, 2011)

Viera *et al*. (2016) investigate the relationship between ASL and Body Mass Index (BMI), a measure of body fat based on height and weight examined the correlation between ASL, height, and BMI in a sample of 1320 adults aged 18-94 years. The study found a strong positive correlation between ASL and height ($r=0.96$, $p<0.001$)

Another study carried out by Tayyem *et al.* (2012) examines the relationship between ASL, height, and BMI in a sample of 300 Jordanian adults aged 18-65 years. The study found a strong positive correlation between ASL and height ($r=0.98$, $p<0.001$). The authors conclude that ASL could be used as a reliable proxy for height in the Jordanian population.

Materials and Methods

The Study Area

The study was conducted in the Faculty of Basic Medical Sciences, Bayero University Kano, Gwale Local Government. Kano State.

Location of the Study Area

The study was carried out in the Faculty of Basic Medical Sciences, Bayero University, in Gwale local Government area of Kano State Nigeria.

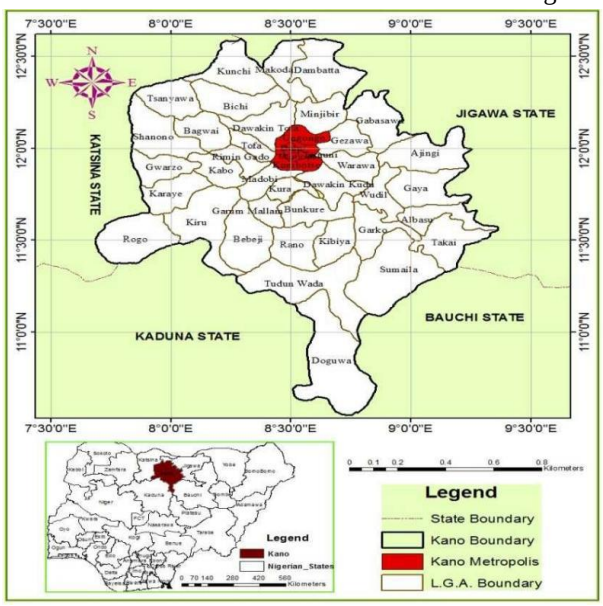

Figure 1: map showing the location of Kano state Nigeria

Inclusion Criteria

. Subjects of 17-45 years

. Subjects from the Faculty of Basic Medical Sciences, Bayero University Kano**.**

. Subjects without history of back bone or hand fracture

. Subjects apparently healthy

Exclusion Criteria

. Subjects of less than 17 and greater than 25 years

. Subjects not from the Faculty of Basic Medical Sciences, Bayero University Kano**.**

. Subjects with back bone or hand fracture or amputated hand

. Unhealthy / Ill Subjects

Sampling Technique and Sample Size Determination

A simple random sampling technique was used. A total of 384 participants comprising of 193 males and 191 females were selected as the subjects.

Sample Size Determination

The population size is determined using the formula;

$n= z^2pq/d^2$ (Lwanga and Lemeshow, 1991)

Where,

n = minimum sample size

z = standard normal deviation (±1.96, CI 95%)

p = probability value of the previous study 50% (0.5)

q = 1-p

= 1-0.5 = 0.5

d = standard error 5% (0.5)

Therefore,

$n = (1.96)^2 \times 0.5 \times 0.5 / (0.5)^2$

n=384.16

The Study Design

The study adopts a cross-sectional prospective approach

The Study Subjects

The population is made up of 384 participants in the Faculty of Basic Medical Sciences, Bayero University. Three hundred and eighty-four (384) subjects were selected from the Faculty of Basic Medical Sciences, Bayero University with their consent, comprising of 193 males and 191 females, using random sampling methods. The age range of the participants is between 17-45 years. Those participants who reported injuries to back bone or hand fracture history and subjects who

were not from the Faculty of Basic Medical Sciences, Bayero University Kano were excluded from the study.

Methodology

Anthropometry

Arm span length is the length between the tips of the middle finger of the right hand to the tip of the middle finger on the left hand. It was measured with both hands straight horizontally at 90 degrees from the body and the participants standing straight against the wall (Armstrong *et al*., 2011). Height is the distance from the vertex of the skull to the base of the foot (Figure 1). The subjects stood up perfectly upright with arms relaxed by the side, and ankles and knees placed together (Armstrong *et al*., 2011).

Figure 1: Shows measurement of arm span length (A) and height (B)

Statistical Analyses

The data were expressed as mean ± SD. Independent t-test was used for evaluation of sexual dimorphism between groups. Pearson's correlation of coefficient was carried out to determine the strength of the relationship between arm span length and height. Linear regression equation was formulated for stature estimation using the arm span length. Statistical significant difference was deemed acceptable at $p< 0.05$. The data were analyzed using Statistical Package for Service Solution (SPSS) version 20.0 (IBM corporation; Armonk, NY).

Results

Table 1 shows the descriptive statistics of the Age, ASL (m), Weight (kg), Height (m), BMI (kgm^2) with their Mean± SD, minimum and maximum values of the students. The Mean±SD age of the students was 22.003±2.333 with a minimum value of 17.00 and a maximum value of 41.00. The Mean±SD weight (kg) of the students was 59.234±11.004 with a minimum value of 38.00 and a maximum value of 96.00. The Mean±SD Height (m) of the students was 2.047±8.235 with a minimum value of 1.450 and a maximum value of 1.950(m). The Mean±SD BMI (kg/m^2) of the students was 22.39±0.208 with a minimum value of 13.655 and a maximum value of 39.958.

Table 2 shows the descriptive statistics on sexual dimorphism of Age, ASL (m), Weight (kg), Height (m), BMI (kgm^2) of the students. The Mean±SD age of the female students was 22.18±2.39, while that of the male students was 21.83±2.27. The Mean± SD ASL (m) of the female students was 1.77±0.08, while that of the male students was 1.79±0.08. Mean± SD Weight (kg) of the female students was 59.86±10.64, while that of the male students was 58.63±11.34. The Mean± SD Height(m) of the female students was 2.48±11.77, while that of the male students was 1.63±0.064. The Mean± SD BMI (kg/m^2) of the female students was 22.58±4.34, while that of the male students was 22.08±4.12.

Table 1: Descriptive Statistics for Age, Arm Span Length (ASL), Weight, Height and BMI

Variable	N	Mean± SD	Minimum	Maximum
Age(yrs)	384	22.00±2.33	17.00	41.00
ASL (m)	384	1.78±0.08	1.59	2.14
Weight (kg)	384	59.23±11.00	38.00	96.00
Height(m)	384	2.05±8.24	1.45	1.96
BMI (kg/m^2)	384	22.39±0.21	13.66	39.96

ASL= Arm Span Length, BMI= Body Mass Index

Table 2: Descriptive Statistics on Sexual Dimorphism of Age, Arm Span Length (ASL), Weight, Height and BMI

Variable	Sex	N	Mean±SD	Minimum	Maximum
Age(yrs)	Female	188	22.18±2.39	18.00	41.00
	Male	196	21.83±2.27	17.00	40.64
ASL (m)	Female	188	1.77±0.28	1.65	2.10
	Male	196	1.79±10.08	1.59	2.04
Weight (kg)	Female	188	59.86±10.64	40.70	96.00
	Male	196	61.63±0.84	41.25	97.03
Height(m)	Female	188	1.58±0.77	1.45	1.95
	Male	196	1.63±0.64	1.44	1.90
BMI (kg/m2)	Female	188	22.58±4.34	13.66	39.96
	Male	196	22.08±4.12	14.66	36.57

N= Number of Subjects, ASL= Arm Span Length, BMI= Body Mass Index

Table 3 shows sexual dimorphism in arm span length only with males having arm span length of 1.79±0.077 and with females having 1.77±0.08 (p=0.05).

Table 4 shows is a strong positive correlation between height and arm span length ($r = 0.86$; $p < 0.01$). It also shows a strong positive correlation between BMI and weight exists ($r = 0.90$; $p < 0.01$)

However, a weak positive correlation, that is also statistically significant, was observed between height and weight ($r = 0.28$; $p < 0.05$), arm span length and weight ($r = 0.25$; $p < 0.05$).

Table 5 reveals that the relationship between the arm span length and height is strongly statistically significant ($p < 0.01$). Thus, arm span length can be used as a predictor of height.

Table 3: Sexual Dimorphism in Arm Span Length, Height and BMI

Variables	Mean±SD		t-value	p-value
	Females (188)	Males (196)		
ASL (m)	1.77±0.08	1.79±0.077	-1.94	0.05
Height (m)	1.62±0.07	1.63±0.06	-0.79	0.43
BMI (Kg/m^2)	22.58±4.34	22.07±4.12	1.18	0.24

ASL= Arm Span Length, BMI= Body Mass Index

Table 4: Correlation Between Arm Span Length, Height and BMI

Variables	Age(yrs)	ASL (m)	Weight (kg)	Height(m)
ASL (m)	0.01			
Weight (kg)	0.07	0.25*		
Height(m)	0.05	0.86**	0.28*	
BMI (kg/m^2)	0.05	-0.13	0.90**	-0.17

*p<0.05; ** p<0.01, ASL= Arm Span Length, BMI= Body Mass Index

Table 5: Regression model between arm span length and height.

Y = a + bx	R^2	SEE	t-value	p-value
HT (m)=(0.9+0.5ASL)	0.71	1.55	-0.37	<0.02

ASL= Arm Span Length, HT= Height

Discussions

This study shows a statistical significant correlation between arm span length and height (r=0.86). This is in line with study carried out by Akinbo *et al*. (2019) who investigates the arm span-height relationship in elderly Nigerians aged 60 years and above and found arm span length to be a good predictor of height in this population, with a significant positive correlation (r=0.86). A study conducted by Micheal, (2022) conforms to the result of this study with a strong positive correlation of (r=0.93) between arm span length and height. Similarly, several studies have explored the association between arm span length and height in diverse populations, including adults, athletes, and specific occupational groups (Kim *et al*, 2019; Silva *et al*., 2019). However, a study conducted by Aggarwal *et al*. (2019) among Indian adults reports non-significant associations between arm span length and height. This finding disagrees with the present study which shows a significant association between arm span length and height.

Another study carried out by Hauspie and De Meyer (1987) evaluates the relationship between arm span length and height in a sample of 2,000 children and adolescents. They found a strong positive correlation between arm span length and height, with a correlation coefficient of 0.9. This conforms with the present study, showing that in cases of challenging measurement of standing height, arm span length can be used to predict individual's height.

Arm span length and height are correlated, and studies have shown that the arm span length of most people is roughly equal to their height. One such study conducted by Juarez-Mora *et al.* (2017) found a strong correlation (r=0.97) between height and arm span in a sample of Spanish school children. Another study carried out by Koutsimanis *et al.* (2003) reports a similar correlation (r=0.98) between height and arm span in a sample of Greek adults.

The present study investigates the relationship between arm span length and height among students in the Faculty of Basic Medical Science at Bayero University Kano. The obtained results reveal that the relationship between arm span length and height ias statistically significant with a strong positive correlation (r=0.86). A study carried out by Moon *et al*. (2017) investigates the association between arm span length and height among elderly Korean individuals and reports significant results.

A study conducted by Hwang and Lee (2007) investigates the relationship between arm span length and height in a sample of Korean adults. It found a strong positive correlation between arm span length and height, with a correlation coefficient of 0.91. Furthermore, it found that arm span length is a better predictor of height in Korean adults than other measures, such as foot length and hand length. This supports the findings of the present study that show a strong positive correlation of 0.86 between arm span length and height. This indicates that arm span length can be used to predict height especially in individuals that cannot stand erect for their height measurement. A study conducted by Dong *et al*. (2017) investigates the relationship between arm span, height, and BMI among Chinese adults. The findings reveal a weak positive correlation between arm span and height. This result is consistent with the present study, suggesting that the relationship between these variables is significant in this studied population of students of Basic Medical Sciences, Bayero University Kano.

Conclusion

The relationship between arm span length and height is established. The correlation between the variables is very strong, indicating a high level of accuracy and reliability. Also, a weak positive correlation that is statistically significant is observed between height, arm span length and weight, and also between weight and BMI, indicating that variation occurs intra- and inter-

ethnically. Therefore, the relationship between arm span and stature in a group of students of Faculty of Basic Medical Sciences Bayero University Kano, Nigeria is found to be strongly positive. Consequently, it can be concluded that arm span length can reliably be used as a predictor of height in this specific students' population. Though, the linear regression equation into which the arm span length value is substituted is age, race and population specific. Therefore, there is the need to conduct studies on different populations so as to have formulae for different populations.

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