Estimation of stature using arm span length amongst Bekwara ethnic group of Cross River State, Nigeria

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Abstract

Introduction: The research was carried out to obtain the linear regression equation for the estimation of stature using arm span length amongst the Bekwara ethnic group of Cross River State. **Materials and Methods**: This study was conducted on 600 subjects (300 males and 300 females), aged 6 to 30 years, the subjects were further grouped into five sub age groups of 6-10, 11- 15, 16-20, 21-25, 26-30 years old. **Result:** The mean values of arm span length and stature for males of Bekwara ethnic group, irrespective of age group are 169.9±23cm and 158.4±19cm while females recorded 162.3±17cm and 154.0±13cm respectively. The arm span length to stature difference in males of Bekwara ethnic group is 11.5±7.2cm and 8.3±5.6cm in females, but the mean ASD value irrespective of sex was observed to be 9.9±6.6cm. Pearson correlation coefficients of stature and arm span length were recorded for both male and female as 0.977 and 0.959 respectively. Linear regression equation determined for males in Bekwara ethnic group is 25.71+ (0.781 x arm span) with a recorded estimated stature of 158.2cm, while that of females is 31.83+ (0.753x arm span) with stature estimate of 154.0cm. **Conclusion:** The arm span length of Bekwara ethnic group indigenes has proven to be an efficient anthropometric body segment parameter that can be employed in the estimation of stature among wheelchair athletes, bed ridden patients or in persons with disabilities involving amputation of the lower limb, or other deformities like scoliosis which does affect the standing ability.

Key words: Arm span length, Cross River State, height, stature

INTRODUCTION

Stature is one of the vital physical features employed in ascertaining the identification of unknown deceased bodies. Stature also serves as a basic tool in the assessment of an individual's nutritional status,[1] as well as energy requirement and evaluation of children's growth.[2] However, in certain scenarios, it may be impossible to obtain the precise stature of persons with certain abnormalities that affect full standing ability.[3] In such circumstance, an estimated height can be computed using certain body parameters since it has been established that there is a definite relationship between the height of a person and the various parts of the body like head, trunk and lengths of extremities.[4,5]

Establishment of alternative methodologies for stature estimation is important in archeological procedures or in forensic examinations for the purposes of identification after mass disasters or genocide. Moreover, evaluation of nutritional status of individuals also relies on accurate measurement of the individual's height, but it is obvious that a number of deformities affecting the vertebral column such as scoliosis and lower limb amputations might make it difficult to accurately measure standing height in many patients. Therefore, there is the need for the estimation of stature.

Arm span length correlates well with stature. Hence, it can be used to determine the height of bedridden individuals when needed in certain clinical conditions. However, the association of arm span and stature has been shown to vary from race to race.[6,7] Even though several studies on correlation on arm span length with stature are available on the Western population, very limited data is available on Nigerian subjects.[8] It is therefore important to note that the linear regression results of anthropometric estimation of stature with the use of arm span length obtained

from other countries' populations may be misleading when used on a different population. This shows the necessity for developing ethnic specific linear regression equations. Therefore, this research is carried out basically to obtain the linear regression equation for the estimation of stature using arm span length amongst the Bekwara ethnic group of Cross River State. In addition, the arm span-to-stature difference (ASD) is also determined. This parameter is a useful clinical indicator for assessing loss of height in relation to physiologic ageing or pathological processes, vertebral deformities and other associated health implications.[9] The study will also provide base line stature and arm span length data specific for the people of the Bekwara ethnic group of Cross River State. The Bekwara ethnic group of Cross River State is one of the largest ethnic groups in Northern Cross River state. They are found predominantly in Yala Local Government Area (LGA) of Cross River State.

MATERIALS AND METHODS

Sample size

The subjects were indigenes of the Bekwara ethnic group selected randomly from Yala LGA of Cross River State of Nigeria. Six hundred subjects (600), comprising of 300 each of male and female subjects with an age range from 6-30 years, were selected. The selected subjects were further subdivided into 5 subgroups within the age ranges of 6-10 years, 11-15 years, 16-20 years, 21-25 years, and 26-30 years, each subgroup comprising of 120 subjects, (60 males and 60 females). This was essential so as to statistically access the anthropometric variations pattern of each parameter with advancing age. Exclusion criteria were persons with any physically observed vertebrae column disability, amputees, and persons unable to stand upright. Inclusion criteria were persons whose parents were both confirmed to be indigenes of the Bekwara ethnic group. Some parents were consulted in cases where the subject fails to know their ethnic group.

Measurement

Full arm span measurement

The selected subjects were told to stand straight against a wall with their heels placed together and close to each other. They were further told to outstretch both hands away from their body extending the arms at shoulders length away from the torso [Figure 1]. The subjects' arms and body made a 90 degree angle and their palms were faced forward and open.

Using the measuring tape, we took the measurement from the right middle finger tip to the left middle finger tip with the tape passing in front of the clavicles. The figures obtained were then recorded in centimeter. This parameter measured is the arm span length (ASL).

Height measurement

This measurement was taken with the subject standing erect without shoes or socks, with the heels put together, and the eyes directed straight ahead. The subjects stood erect against a wall, having his/her buttocks, shoulder blades, and back of head in close contact with the wall, and the head placed in a position called the "Frankfurt plane."

In this described position, the measurement is taken with a stadiometer placed on the same leveled floor with the sole of the foot of the subject and the pointer place directly horizontal to the subject's vertex as shown in Figure 2.

Arm span-to-stature difference (ASD)

The difference in ASL relative to stature (height) is calculated as: ASD = ASL — Stature

Statistical analysis

Data obtained from ASL, height, and ASD measurements were recorded separately for male and female subjects according to their subgroups. All measurements were given in centimeters. Statistical analysis including descriptive statistics, correlation of arm span with stature and linear regression equation were performed for male and female subjects. Also, paired t-test was used to assess difference between male and female subjects amongst the Bekwara ethnic group. Statistical package used was the SPSS for Windows, Version 16.0. Chicago, SPSS Inc. Prediction equations were developed for each study group.

Figure 1: Image of a 30 years old male subject spaning for the measurement of arm span

Figure 2: Measurement of a female's height using a stadiometer

RESULT AND OBSERVATION

The mean arm span length values exceeded stature values in all age groups of both males and females. In the Bekwara ethnic group, the mean and standard deviation (S.D.) of the three parameters were statistically analyzed. The mean ASL, stature, and ASD showed an increasing value with advancing age for both male and female groups. The mean values of ASL and stature for males of Bekwara ethnic group, irrespective of age group are 169.9 ± 23 cm and 158.4 ± 19 cm, while females recorded 162.3 ± 17 cm and 154.0 ± 13 cm, respectively. However, the mean total of all the age groups irrespective of sex in the Bekwara ethnic group are 166.1 ± 20 cm for arm span length and 156.2 ± 16 cm for stature. However, the mean total irrespective of ages for arm span length and stature was higher in males when compared to the females values ($P < 0.05$). In the subgroups, only group 16-20 years showed an increased significant difference ($P < 0.05$) in arm span length of males and females (181.5 ± 9 cm and 170.2 ± 4 cm, respectively). The arm span length to stature difference in males of Bekwara ethnic group is 11.5 ± 7.2 cm and 8.3 ± 5.6 cm in females, but the mean ASD value irrespective of sex was observed to be 9.9 ± 6.6 cm. In the subgroups, a significantly ($P < 0.05$) higher value was observed in males and females only in age group 26-30. At age 6-10, 16-20, and 26-30 years, similarities were observed in the value of arm span to stature differences in both sexes [Table 1].

Pearson correlation coefficient of stature and arm span length was similar in both sex (0.977 and 0.959 respectively). Linear regression equation determined for males in Bekwara ethnic group is 25.71 + (0.781 × arm span) with a recorded estimated stature of 158.2 cm, while that of females is 31.83 + (0.753 × arm span) with a stature estimate of 154.0 cm [Table 2].

DISCUSSION

Basically, developing a linear regression equation using the arm span length in estimating the stature of indigenes of the Bekwara ethnic group of Cross Rivers State in Nigeria is necessary in conditions where measurement for stature cannot be obtained due to lower limb and spinal deformities, or any acquired physical deformity that could affect stature or in situations where the ability to stand unaided is difficult to achieve for example in bed ridden individuals. This study further analyzes the correlation between stature and arm span length since many researchers have shown that there is positive correlation between stature and arm span length.[10-13] A study carried out on adult Malawians deduced the coefficient of correlation as 0.871 while Nigerian adults from Benue State, recorded the correlation as $r = 0.83$.[8] Aggarwal *et al.*, in the year 2000, documented the coefficient of correlation as 0.971 in North Indian males,[10] while Garo population in Bangladeshi was revealed to have a significant positive correlation of $r = 0.89$ for the adult female subjects.[11]

Table 1: Anthropometric variation pattern with advancing age and comparison of arm span and height of male and female subjects of different age groups of Bekwaras

Age	Sex	ASL	Height	ASD
6-10	Male	134.3±9	129.5±2	4.7±7.0
	Female	136.5±6	133.4±6	3.1±3.3
	Total	135.4±7	131.5±4	3.9±5.2
11-15	Male	161.5±17	153.2±15	8.3±3.1
	Female	156.4±14	147.6±9	8.7±5.1
	Total	158.9±15	150.4±12	8.2±3.9
16-20	Male	181.5±9*	167.7±8	13.8±3.5
	Female	170.2±4*	161.6±3	8.6±4.3
	Total	175.9±9	164.7±6	11.2±4.6
21-25	Male	184.7±12	172.5±6	12.2±8.3
	Female	176.6±12	163.8±7	12.9±6.3
	Total	180.7±12	168.2±2	12.6±6.9
26-30	Male	187.5±13	169.0±1	18.5±5.8*
	Female	171.5±10	163.6±7	7.9±5.9*
	Total	179.5±14	166.3±11	13.2±7.8
6-30	Male	169.9±23*	158.4±19*	11.5±7.2
	Female	162.3±17*	154.0±13*	8.3±5.6
	Total	166.1±20	156.2±16	9.8±6.6

*Values are mean + SD. Values with similar superscript are significant at $P < 0.05$

Table 2: Linear regression equation, for the calculation of stature from ASL for all age group and sex in Bekwara ethnic group of Cross River State

Age	Sex	Linear regression	ASL	EST.H	OBS.H
6-10	Male	69.31+0.459 (ASL)	134.2	130.9	129.5
	Female	69.57+0.425 (ASL)	136.5	127.6	133.4
11-15	Male	23.76+0.797 (ASL)	161.5	152.5	153.2
	Female	27.47+0.788 (ASL)	156.4	150.7	147.7
16-20	Male	51.72+0.642 (ASL)	181.5	168.2	167.7
	Female	35.04+0.719 (ASL)	170.3	157.5	161.6
21-25	Male	68.93+0.549 (ASL)	184.7	171.9	172.5
	Female	88.88+0.479 (ASL)	176.7	173.5	163.8
26-30	Male	41.30+0.696 (ASL)	187.5	171.8	169.0
	Female	5.33+0.883 (ASL)	171.6	156.9	163.6
6-30	Male	25.71+0.781 (ASL)	169.6	158.2	158.4
	Female	31.83+0.753 (ASL)	162.3	154.0	154.0

EST.H = Estimated height, OBS.H = Observed height. Values are mean

There was significant correlation between arm span length and stature of the Bekwara ethnic group indigenes. The correlation coefficient of stature and arm span length in the present study were found to be 0.977 and 0.959 in males and females, respectively; this is similar to the high values noted in the works of most of the researchers.[8,10,14]

The ASD in males of Bekwara ethnic group is 11.5 ± 7.2 cm and 8.3 ± 5.6 cm in females, but the mean ASD value irrespective of sex was observed to be 9.9 ± 6.6 cm. These values are

similar to the values reported for the Malawian adults.[15] They revealed also that the arm span of Malawian adults exceeded height in all age groups of males and females and that the mean difference between the height and arm span values for females was 9.9 ± 4.9 cm and for males was 11.6 ± 4.4 cm. In this research also arm span exceeded height in both genders and in all age groups with higher values noted in males than in females, it also revealed that ASD increased with age in both sexes with higher values noted in males than females. The value reported in the present study is higher than the mean value of 3.3 cm reported for Caucasians.[7] A study on South Indian females also noted that the arm span was nearly 2.5 cm more than height, which is similar to that noted in the white population.[13] The recent study values for the ASD is higher than the value reported for the Nigerian population pulled from Benue State.[8] In this study, the mean ASD for Nigerian women of Benue state origin was 4.4 ± 4.5 cm and for men it was 5.8 ± 6.2 cm.

The linear regression equation derived for the males in Bekwara ethnic group is 25.71 + (0.781 × arm span) with a recorded mean estimated stature value of 158.2 cm, while that of females is 31.83 + (0.753 × arm span) with stature estimate value of 154.0 cm. The regression equation derived in the present study is totally different from that of Benue State indigenes of Nigeria.[8] The regression equation for the males of the Benue State indigenes of Nigeria was (stature = 67.63 + .577 (arm span); r = .77) and women (stature = 55.16 + .642 (arm span); r = .72). The present study's equation was also different from that of Malawian children which was recorded as, height of boys = 17.043 + (0.348 × age) + (0.815 × arm span) and height of girls = 18.158 + (0.265 × age) + (0.817 × arm span).[16] This, in order words, provides the necessity to derive a specific regression equation for different populations.

CONCLUSION

The present study just as in other studies revealed that positive correlation exist between arm span length and stature as such a regression equation using the arm span length can positively estimation stature. ASL was found to exceeded height in both genders and in all age groups with higher values noted in males than in females, while ASD showed increasing values with advancing age in both sexes with higher values noted in males than females. The data collated and the linear regression equation established specifically for the Bekwara Ethnic group can be useful to the clinicians, forensic scientists and in persons with disabilities that limits standing ability.

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent forms. In the form the patient(s) has/have given his/her/their consent for his/her/their images and other clinical information to be reported in the journal. The patients understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

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