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Use of Arm Span as Proxy Indicator of Stature- An Anthropometric Study in Western U.P.

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ABSTRACT

Background: Arm span is the most reliable anthropometric parameter to predict the body height of an individual. It is useful in predicting the age related loss in stature and in identifying individuals with disproportionate growth abnormalities and skeletal dysplasia. Previous studies show that stature can be measured effectively from various body parameters and length of long bones also. However, the relation between arm span and height was found to vary from race to race. The present study was undertaken to measure the stature as well as arm span and to determine whether there is any correlation between the stature and the arm span. **Methods:** This study was carried out with a total number of 400 subjects of Teerthanker Mahaveer University, 200 male and female each, age range (18-25). Stature was measured with the Stadiometer and arm span was measured using steel tape. The relationships between body height and arm span were determined using correlation coefficients. Then a linear regression analysis was evaluated to examine the extent to which arm span can reliably predict body height. **Results:** The results have shown the mean of arm span for the male subjects was 175.03± 7.00cm and the height 168.13±5.89 cm, while female arm span 159.01±6.32 cm and height 156.00±5.61cm. The arm span was consistently more than height. The arm span exceeded stature in 87.5% of the participants.**Conclusion:** There is a good correlation between body height and arm span.

Keywords: Anthropometric, Arm span, Stature.

INTRODUCTION

Identity is the birth-right and identification is the basic need of an every individual in every sphere of life. Identity may be defined as the distinctive characteristic belonging to any given individual, or shared by all members of a particular social category or group. Many characteristics can be used to identify a person. Age, sex and stature are the most important criteria for establishing the identification of an unknown person or dead bodies.[1]

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Anthropometry presents the way of production of knowledge about humans and their health care systems. Height is a major indicator of body size and of bone length and it is a composite measurement including head, neck, trunk and extremities.

However, direct measurement of stature is not possible in the bed ridden patients with spinal deformities or who are on wheelchairs bound due to some accidental cases, unable to stand straight due to physical deformities, or structural defect such as kyphoscoliosis and neuromuscular weakness.[2,3] In such circumstances, an estimate of body height has to be derived from other reliable anthropometric indicators, such as hand and foot lengths, leg length, length of the sternum, vertebral column length, sitting height , arm span , and facial measurements etc.[3,4] Therefore, all these anthropometric indicators that are used as an alternative to estimate body height are very important in predicting age-related loss in body

height. Several studies have reported the effectiveness of using various body parameters in predicting standing height,[5] and the arm-span is found to be one of the most reliable anthropometric parameter, However, the relationship between arm-span and stature was found to vary from race to race.[6]

Standing height can be estimated from the arm-span measurements, particularly in the elderly, since arm-span does not vary significantly with age, [6] it is less influenced by aging. Reduction of arm-span on elderly people is slower than reduction of height, so that arm-span is recommended as a parameter for stature prediction.[7]

Several studies of this nature are available in the literature; very limited data are available on Indian particularly in Uttar Pradesh region (India). Taking into consideration all above authors and co-authors of the present study believed it would be reasonable to find the effectiveness of using arm span in estimating the stature of an individual in a particular geographic area.

MATERIALS AND METHODS

This study was conducted in the department of Anatomy, TMMC & RC, Moradabad, India. After obtaining institutional ethical clearance of TMMC & RC and informed consent a total no. of 400 students (200 males and 200 females) were examined for this study. The participant who volunteered in the study were healthy and without any abnormality like kyphosis, scoliosis and any spinal disease. The sampling technique used for collection of data was by Simple random sampling. The study subjects were male and female subjects 200 each, age range (18-25 yrs). The inclusion criteria was the Healthy adult males and females of western U.P with the ability of stand erect for measurement of standing height, absence of any spinal and skeletal deformity of the limbs, and the exclusion criteria was the Individuals of Physical deformities that can effect body height or arm span and the students not of western UP region. The equipments used in the study were Stadiometer, Flexible steel tape, and Digital camera. Stature and arm span were measured for all the participants according to the standard anthropometric methods of the International Society for the Advancement of Kin anthropometry.[9] Stature was measured to the nearest .1 centimeters (cm) in bare feet with the participants standing upright against a stadiometer. The respondent's head had to be in the Frankfort horizontal plan. The subjects were said to stand erect with heel together and backs straight as possible so that his heels, buttocks, shoulders and the head touched the rod of stadiometer. The arms were hung freely by the sides. And asking the subject to take a deep breath and holding it, and take a reading from the stadiometer scale at his vertex point. The arm span was measured using a calibrated steel tape to the nearest (0.1 centimeters) [Figure 1]. The participants head was also in the Frankfort horizontal plane and the arms were outstretched at right angles to the body with palms facing forwards. The measurement were taken from one middle fingertip to the other middle fingertip, with the tape passing in front of the clavicles while two field workers supported the elbows.

Statistical Analysis- Mean and standard deviations were obtained for both anthropometric variables. The relationships between body height and arm span were determined using simple correlation coefficients. Then a linear regression analysis was evaluated to examine the extent to which arm span can reliably predict body height. Finally, these relationships were plotted as scatter diagram. Statistical significance was set at $p<0.05$.

Figure 1: Procedure of measuring the arm span.

RESULTS

Measurement of stature and arm span was taken using direct physical procedure in 400 subjects (200 males and 200 females). Mean and Standard Deviation were calculated for each variable. Gender wise distribution of arm span and height was studied. Correlation of arm span with stature was also assessed. The arm span was consistently more than height. The arm span exceeded stature in 87.5% of the participants. A summary of the anthropometric measurements in both genders is shown in [Table 1 & 2]. [Table 3] and [Table 4] showed the regression statistic of male and female. The Multiple R and their 95% confidence interval analysis between the anthropometric measurements are presented in [Table 5]. It shows that the relationship between body height and arm span are high in male but not so good in females. The results of the linear regression analysis are shown in [Table 6] and in [Table 7] for male and female respectively. The high value of the regression coefficient shows that the arm span may clearly predict the body height in both sexes. Scatter diagram also showing the relationship between the stature and arm span in male and female in [Figure 2 & 3]. We have used computer based programmed 2007 for our calculations and have considered a

linear relationship between X and Y and as such have calculated a linear regression equation of the form Y =A+BX. The linear regression equation derived from arm span for estimating height showed statically non significant relationship [p<0.05] in both genders.

Table 1: Descriptive statistics for Male

Male	N	Range (c.m.)	Minimum (c.m.)	Maximum (c.m.)	Mean± SD
Stature	200	31	152	183	168.13± 5.89
Arm Span	200	50.2	149.3	199.5	175.03± 7.01

Table 2: Descriptive statistics for Female

Female	N	Range (c.m.)	Minimum (c.m.)	Maximum (c.m.)	Mean±SD
Stature	200	40.5	143.5	184	156.00±5.61
Arm Span	200	38	143	181	159.01±6.32

Table 3: Regression Statistics of Male

Regression Statistics	
Multiple R	0.80
R Square (%)	0.66
Adjusted R Square	0.65
Standard Error	0.65
Observations	200

Table 4: Regression Statistic of Female

Regression Statistics	
Multiple R	0.66
R Square %	0.43
Adjusted R Square	0.43
Standard Error	4.77
Observations	200

Table 5: Correlation between body height and arm span of the subjects

Sex	Multiple R	Lower 95% confidence Interval	Upper 95% Confidence Interval
Male (n=200)	0.81	0.86	1.06
Female (n=200)	0.66	0.62	0.86

Table 6: Equation for estimating stature from arm span in male.

Male	Coefficients	Standard Error	t Stat
Intercept	13.36	8.40	1.59
	0.96	0.04	19.25

The Regression formulae for Male:-

[Y=A+BX]

[Y=13.35+0.96(168.13)]

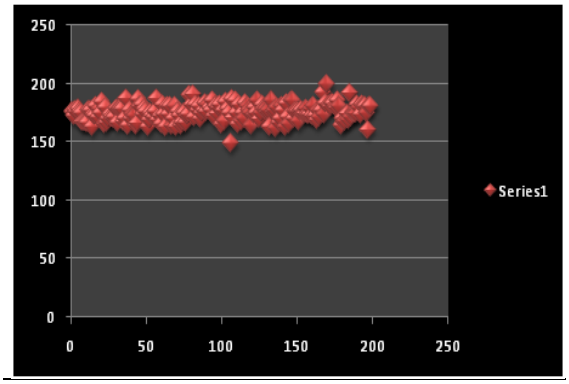

Figure 2: Scatter diagram showing the relationship between the stature and arm span in Male.

Table 7: Equation for estimating stature from arm span in female.

Female	Coefficients	Standard Error	t Stat
Intercept	43.08	9.42	4.57
	0.74	0.06	12.31

The Regression formulae for Female:-

[Y=A+BX]

[Y=43.08+0.74(156.00)]

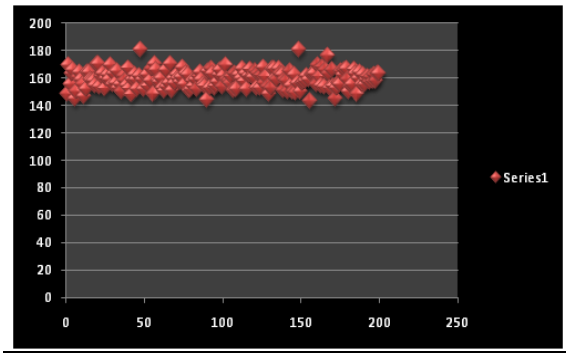

Figure 3: Scatter diagram showing the relationship between the stature and arm span in Female.

DISCUSSION

The population of Western Uttar Pradesh is composed of a varied set of communities and tribe's ahirs, jats, jatavs, rajputs rohilla. Western Uttar Pradesh shares borders with the state of Uttarakhand, Haryana, Delhi, Rajasthan and Madhya Pradesh, as well as a brief international border with Nepal in Pilibhit district.

The present observation were carried out on the students of Teerthanker Mahaveer University, which is located in Moradabad, the students belong to various regions of U.P.

The prediction of stature utilizing arm span measurement has been attempted by many researchers using smaller samples.[9-12] additionally, this study provided us with the data which aided our understanding of the relationship between arm span and stature in adults living in western U.P region; information which is currently lacking. The large difference between the measures of arm span and stature found in this study, which was observed by Zevrev (2003)[10] among the Malawians too, might be explained in the light of a relatively short stature of the participants. The results of this study showed that the mean arm span measure exceeded stature measure in western U.P. population, consistent with other studies.[13-15] Standard procedures were applied in the measurement of arm span and stature in these samples as such the larger differences between the arm span and stature values are unlikely ascribable either to systematic error in measurement or nor the likelihood that the arm span of a comparatively large sample of Nigerian participants was affected by a pathological condition such as marfan's syndrome, which is portrayed by disproportional elongation of extremities. Estimation of stature using various physical measurements has been attempted by many researchers. Chumlea (1985)[16] estimated stature from knee height, while Mitchel (1982)[17] correlated arm length with stature. In a similar study of blacks of both sexes in the age group 22–49, a correlation of 0.87 was observed between arm span and stature. In the present study, the multiple R is 0.80 in male and 0.65 in female, which is less then male. Multiple R is the coefficient of multiple correlations it is a scalar that is defined as Pearson Coefficient between predicted and actual value of dependent variable in a linear regression model that include an intercept. This value show correlation of stature and arm span in male and female respectively, but in male, it is highly correlated. In other research, the studies were showing strong correlation between body stature and arm span, which is reliable body parameter for predicting body stature. For example, Bjelica Dusko[18] reported that the correlation was r=0.86 in male and 0.81 in female, while in shah K Ritesh[19] study correlation was r=0.80 in male and 0.86 in female; in Fatmah[20] study, the correlation was r=0.86 in male and 0.75 in female. In above-mentioned research, these studies were showing strong correlation between body stature and arm span, which is reliable body parameter for predicting body stature. The estimation of body height using various anthropometric measurements has attempted by many researchers in many studies over the centuries. As already mentioned, all of them estimated body height from various anthropometric measurements, but it is important to emphasize that the arm span has been derived the most reliable body indicator for predicting the body height of an individual.

In the present study, we also found that the arm span is more than height, which is similar to that found in the white population. The linear regression equation derived from arm span for estimating height showed statically non-significant relationship [$p>0.05$] in both genders.

In the present study the arm span exceeded stature in 87.5% of the participants; measurement in 12.5% participants indicated a contrary result. Since these subjects had no any deformity or apparent medical disorder, they represent the healthy general population. These subjects were drawn from several regions of western U.P India, and the relationship derived between height and arm span can, therefore, be extrapolated to and used for the general population residing in Western U.P. region. However, such prediction estimates might vary across races thus warranting the need for similar studies in different ethnicities and regions.

CONCLUSION

The most consistent body parameter for foreseeing the height of an individual is Arm span. It is helpful in envisaging age-related loss in stature and identifying individuals with uneven growth oddity and skeletal dysplasia. Alterations in the height of an individual that may occur due to progressive deformities of the spine and surgical correction of spinal deformities has become very easy as arm spam plays very crucial role in this regard. This should persuade others in taking up advance research in the area. Outcome of the present study provides baseline information, concerning some variables of a particular residents (defined for the present study as subjects of Western U.P. population) though the sample size was medium and the convenience sampling had to be applied due to time constraints. This study suggests to study more precisely on different ethnic groups as many people from various parts have migrated to West U.P. in search of better lives and infrastructures. Therefore, it is necessary to develop separate models for each population, on account of ethnic differences, using bigger samples for the

prediction of body height utilizing arm span measurement. The body height and arm span correlates well in males but not in females. This confirms the necessity for developing separate height models for each population and different sex. A more precise estimation of the average body height and its prediction utilizing arm span measurements in West U.P. adults would require a larger sample with sufficient geographical and social heterogeneity or a national survey that measures the whole population. Thus, the obvious limitation of this research study was the composition of the measured sample that consisted of population from different societies.

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