Estimation of Stature from Arm Span: A Prospective Study Among Medical Students of Rangpur Medical College

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Abstract:

Background:
Arm span is one of the most reliable body parameters for predicting the stature of an individual. It is useful in an age-related loss in stature and in identifying individuals with disproportionate growth abnormalities and skeletal dysplasia.

Objectives:
The present study was undertaken to determine whether there is any correlation between stature and arm span and estimate stature from arm span by using multiplication factor and assess the effectiveness of the above estimation by comparing the 'estimated' values with the measured values.

Methods:
This is a cross-sectional analytical study done in the Department of Anatomy, Rangpur Medical College, Rangpur, from January to December 2018 on purposively selected 700 medical students (350 male and 350 female). Arm span along with their stature was measured directly from the subjects by using an anthropometric technique by a measuring tape. Multiplication factors were estimated for estimating stature and comparison were made between measured and estimated stature using paired "t" test.

Results:
The mean normal value of arm span was 170.48±7.38 cm in males and 156.13±5.98 cm in females and the stature was 168.93±0.06 cm in males and 156.23±0.05 cm in females. The multiplication factor was estimated for the same hand measurements with the stature. A significant positive correlation was found in the case of arm span with stature.

Conclusion:
Arm span is a valid measure of stature for both adult males and females.
Keywords: Stature, Arm-span, Correlation, Multiplication factor

Introduction:

Stature is the maximum distance measured from the point where the heel touches the floor to the highest point of the head while the person is in an erect position.[1] It is influenced by genetic factors, nutrition, growth, and development of an individual.[2] Measurement of the stature of patients is required for determination of basic energy requirements, standardization of measures of physical capacity, and for adjusting drug dosage. However, in some situations, the exact height can't be determined directly because of deformities of the limbs or in patients who have undergone amputation. In such circumstances, an estimate of the height has to be computed based on other body parameters. These estimations are also of prime importance in predicting age-related loss in stature, identifying individuals with disproportionate growth abnor-malities, skeletal dysplasia, medico-legal cases, or height loss during surgical procedures on the spine.[3] So assessment of stature from different body parts is an area of interest to anatomists, anthropologists, and forensic experts.[4] Among all body parameters, the correlation between stature and the arm span was found to be the most reliable.[5] Arm span is the maximum distance between the tip of the longest fingers of both hands while the person extends both arms at the level of the shoulders.[1] The objectives of this study are to determine the body stature of both sexes using arm span and find the relationship between the stature and arm span.

Methods:

A cross-sectional analytical study was conducted in Rangpur Medical College from January to

December 2018 on purposively selected 700 medical students, among them, 350 were male and 350 female. Foreign students and students with any deformity of hand and stature, clinical evidence of growth disturbances, any disease condition having an effect on the growth of an individual, having sustained fracture or dislocation, or having undergone limb amputations were excluded from the study. Mean and standard deviation was calculated for arm span. Multiplication factor was calculated for estimating stature from each arm span measurement. The correlation of arm span with stature was also assessed. The effectiveness of the use of the multiplication factor in these estimations was tested by t-test whether there are significant differences. Pearson correlation coefficient (R) was calculated to assess the correlation of stature with independent variables of hand. The value of the reliability correlation coefficient ranged from 0 to 1. A correlation coefficient of below 0 indicates "no reliability", >0 to <0.2 is slight reliability, 0.2 to <0.4 is fair reliability, 0.4 to <0.6 is moderate, 0.6 to<0.8 is substantial and 0.8-1.0 is almost perfect reliability.[5] P value <0.05 was considered significant to assess the accuracy of the prediction of stature by multiplication factors. The data obtained were statistically analyzed using SPSS 16.0.

Measurement of stature:
Stature was measured using a measuring tape. The subjects were made to stand erect in an anatomical position barefoot over a flat ground with heels together and eyes directed straight ahead. Stature was measured as a distance between the vertex and the inferior surface of the heel and recorded in centimeters to the nearest one decimal place.[6]

Measurement of arm span:
Arm span was measured with a flexible steel tape from the tip of the middle finger on one hand to the tip of the middle finger on the other hand with the individual standing with her back to the wall with both arms abducted to 90 degrees, the elbows and wrists extended and the palms facing directly forward.[7]

Calculation of multiplication factor:
The multiplication factor is the ratio of the stature to the respective physical measurements (arm span). A mean multiplication factor was then calculated for arm span. This means multiplication factor was used for estimating the stature from arm span.

Multiplication factor was calculated from the following formula:

$$\text{Multiplication factor} = \frac{\text{Stature}}{\text{Length of arm span}}$$

Calculation of estimated stature:
Estimated stature was the value that found by multiplication of each hand measurement with the mean of its multiplication factor. It was estimated by the following the formula

Estimated stature = Multiplication factor × each hand measurement

The equation was formulated from the equation of multiplication factor according to Devi et al.[8]

Results:
Table-I showed that the mean stature of males and females was 168.93±0.06 cm and 156.23±0.05 cm respectively which was statistically significant.

Table-I: Distribution of stature among male and female medical students (n=350 each group)

Stature	Male	Female	p-value
Range (cm)	152-185	143-183	<0.001
Mean±SDs(cm)	168.93±0.06	156.23±0.05	

Table-II showed that the comparison of arm span between males and females were found to be significant (170.48±7.38 vs 156.13±5.98 cm respectively).

Table-II: Distribution of arm span between male and female (n=350 each group)

Arm span	Male	Female	p-value
Range (cm)	151-188	140-175	<0.001
Mean±SDs(cm)	170.48±7.38	156.13±5.98	

Comparison between the measured stature and estimated stature were shown in Table-III and Table-IV. Arm span was multiplied with multiplication factor to measure estimated stature. In males difference between estimated stature and measured stature was +0.07, R-value 0.993. In females difference between estimated stature and measured stature was -0.75, R-value 0.989.Which means arm span had strong correlation with stature in both males and females.

Table-III: Comparison between the measured stature and estimated stature (Estimated stature= Multiplication factor × arm span) in male medical students

Variables	Multiplication factor	Estimated stature (ES)	Measured stature (MS)	Difference between ES and MS	R-value
Arm span	0.99	169	168.93	+0.07	0.993

R-value obtained from correlation co-efficient test
ES-MS; calculated by subtracting measured stature from estimated stature

Table-IV: Comparison between the measured stature and estimated stature (Estimated stature = Multiplication factor × arm span) in female medical students

Variables	Multiplication factors	Estimated stature (ES)	Measured stature (MS)	Difference Between ES- MS	R-value
Arm span	1.00	155	155.75	-0.75	0.989

R-value obtained from correlation co-efficient test
ES-MS; calculated by subtracting measured stature from estimated stature

Discussion:

Arm span is the most reliable body parameter for predicting the stature of an individual.[8] The present study was undertaken to measure stature, as well as arm span, and to determine whether there is any correlation between stature and arm span. Table-V showed the comparison of arm span and stature of different groups of populations of the world. It was observed from the table that arm span was higher in males than stature but stature was higher than the arm span in females except for Nigerian females. Again it was observed that the arm span of males was higher than females like stature. The highest value of arm span was found in Bosnia, Herzegovina and Nigeria.[9,10] In the present study arm span of males was 170.48±7.38 cm and in females, it was 156.13±5.98cm which was almost similar to south Indian females[7] but not in males (males had a higher value than the present study). Again the result of the present study was higher than the Chakma tribal of Tripura.[8] Mean value of stature was 168.93±0.06 cm in males and 156.23±0.05 cm in females in the present study. These values were also close to the values of the south Indian population and lower than the Nigerian and Macedonian populations. 10,11 Arm span and stature has a strong correlation in all geographical area and in all ethnic groups. So, arm span can be used as a good predictor of the stature of an individual.

Table-V: Mean of stature and arm span in different groups of population of different parts of the world

Author	Study population	Age range (years)	Sex	Stature (cm) (mean±SD)	Arm span(cm) (mean±SD)
Popovic et al (2015)[9]	Bosnia and Herzegovina		M	183.87	184.50
			F	171.82	169.85
	Serbians		M	181.96	184.78
			F	166.82	164.67
Popovic et al (2016)[11]	Macedonia adults	18-24	M	178.10	178.78
		18-28	F	164.58	164.41
Devi et al (2014)[8]	Chakma tribal Tripuri	25-45	F	148.74	149.26
Mohanty et al (2001)[7]	South Indian		M	171.34	174.27
			F	159.41	156.47
Anibor et al (2014)[10]	Nigerian population	22-65	M	173.0	184.56
			F	164.6	173.61
Present study	Rangpur Medical College (Medical Student)	20-24	M	168.93	170.48
			F	156.23	156.13

In this study, we analyzed the correlation coefficient of stature and arm span. Multiplication factor was used for measuring estimated stature from arm span. Multiplication factor values give an easy way to understand the relative estimate of linear body dimensions for height in men and women12 but some tried regression analysis method for estimation of stature.[7,9,13] Kamal and Yadav[14] stated that there is no difference in estimated stature derived from either multiplication factor or regression analysis. Though the regression formula and multiplication factor, both are useful to determine stature from hand dimensions, the regression formula measures stature more precisely than the multiplication factor.[15] We also determined the Pearson correlation coefficient to find the correlation between stature and arm span (Table-III and table-IV). Stature was found to correlate positively with arm span both in males and females in our study (r=0.993 in males and r=0.989 in females). Similarly, observations were made by Patel et al where they found the highest correlation between stature and arm span (r=0.908).[15]

Conclusion:

Arm span measurement can serve as one of the most reliable body parameters to determine the stature of an individual. Due to multi-racial, multi-ethnic, and multicultural diversity in the world, each population group needs a separate study in this regard. The results of the present study will provide baseline information, regarding some variables of the adult Bangladeshi population (Defined for the present study as medical students of Rangpur Medical College) and will help in further research in this field.

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