

Correlation between Stature and Arm Span: A Prospective Regional Study in Eastern Uttar Pradesh.

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ABSTRACT

Background: When actual measurement of stature cannot be done, other surrogate parameters can be used to predict stature. Stature in clinical medicine and in the field of scientific research can be easily estimated using various anthropometric parameters like arm span, knee height, foot length and breadth etc. Arm span has been proven to be one of the most reliable predictors. Thus this study was undertaken to estimate the stature from arm span using regression equation and to determine correlation between stature and arm span. **Methods:** The present study was carried out in the Department of Anatomy, Hind Institute of Medical Sciences, Ataria, UP. Our study consisted of 124 MBBS students (85 boys and 39 girls). The stature and arm span was measured directly using anthropometric technique and measuring tape. The data collected were recorded and analysed with SPSS 16. Regression equations were derived for stature estimation and the relationship between stature and arm span was determined by Pearson correlation coefficient. **Results:** We found that the males with stature 171.34 ± 9.71 cm had the arm span of 174.27 ± 8.63 cm and the females with stature 159.41 ± 6.33 cm had the arm span of 156.47 ± 7.85 cm. The stature calculated using regression equation was 171.25 ± 6.69 cm in male and 159.25 ± 4.95 cm in females. The correlation between stature and arm span was positive and significant ($r=0.689$ for male, $r=0.783$ for female, $p<0.05$). **Conclusion:** Body height correlates well with the arm span so it can be used as a reliable marker for stature estimation using regression equation.

Keywords: Stature, arm span, anthropometry, regression, correlation.

INTRODUCTION

It is well known in scientific literature that the measurement of body height is important in many settings. It is an important measure of body size and gives an assessment of nutritional status.^[1] 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 erect position.^[2] Stature is one of the most important elements of identification of an individual. Establishment of the identity of an individual is essential in cases when only fragmentary remains of a human body found.^[3] Such need may arise from mass disasters i.e. bomb blasts, airplane crash, stampede, tsunami, earthquake, flood, cyclones, Terrorist attack, close compartment fire, wars, public vehicle (train, bus, ship, plane etc) accidents etc. Mutilation of the body could also be possible by humans, animals or by a natural process of decomposition. Even, from hand print and foot print left at the crime scene, identification and exclusion of a person involved in a crime can be made.^[4]

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Measurement of height and weight are required for assessment of growth and nutritional status of person, determination of basic energy requirements, standardization of measures for physical capacity,

for adjusting drug dosage and for identifying an unknown cadaver.^[5] Length of certain long bones and appendages of the body represents a certain relationship in the form of proportion to height.^[6] Once the skeletal maturity is complete, the proportions do not alter with age. Height is a quantitative or qualitative measurement of personality.^[1] However, in some situations it is not possible to measure the stature of a person because of deformities of the limbs, in person who have undergone amputations or in unknown cadavers where lower limb (s) and / or trunk is mutated / absent. In such cases, stature has to be estimated using other body parameter^[5] like hand and foot lengths sitting height and knee height, length of the sternum, vertebral column length, length of scapula, arm span as well as cranial sutures.^[7] These estimations are also of prime importance in predicting the age-related loss in stature, identifying individuals with disproportionate growth abnormalities, skeletal dysplasia, medico-legal cases or height loss during surgical procedures on the spine. These measurements also have found application in normalizing pulmonary function in scoliosis.^[8]

Among all body parameters, 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.^[2]

The associations of arm span and body height vary in different ethnic and racial groups.^[9] Torres et al. and Hickson and Frost, applying the Bland Altman analysis, observed a poor agreement between the

arm span and height even though these correlate well. This suggests that arm-span measurements may be an inappropriate proxy for height in certain populations. The measurements of height and arm span and relationship between them have applied significance in forensic medicine, plastic and cosmetic surgery and other allied clinical sciences.^[10]

Thus, 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.

MATERIALS AND METHODS

This study was carried out in the Department of Anatomy, Hind Institute of Medical Science, Ataria, Sitapur, UP. After obtaining an institutional ethical clearance from the institute, a total no. of 125 students (86 males and 39 females) were included for this study.

Measurement of stature:

The subjects were asked to stand erect with their heel together and backs straight as possible so that the heels, buttocks, shoulders and the head touched the rod of stadiometer. The arms were hung freely by the sides. Reading was taken from the stadiometer scale at the vertex point (highest point on their head).

Measurement of arm span:

It was measured using a calibrated steel tape to the nearest 0.1 centimeters in bare feet on a level concrete floor with the upper backs, buttocks and heels against the wall providing support. The participant’s head was also in the Frankfort horizontal plane and the arms are outstretched at right angles to the body with palms facing forwards. The measurement was taken from one middle fingertip to the other middle fingertip, with the measuring tape passing. The measurements were taken twice, and an average of the two readings was calculated.

The measurements obtained were statistically analyzed using SPSS 16.0. Mean and standard deviation of the parameters were calculated. Regression coefficient and constants were calculated

for estimating the stature from regression equation ($Y = a + bX$).

Stature = value of constant + regression coefficient X Arm span

$Y = a + bX$, where Y = Stature (in centimeter), a = constant, b = regression coefficient and X = Arm span (in centimeter).

The effectiveness of using regression equation in stature calculation was tested by t test. Correlation of arm span with stature was also determined. Scatter diagram was plotted from the data. p value < 0.05 was considered statistically significant.



Figure 1: Measurement of stature.



Figure 2: Measurement of arm span.

RESULTS

Table 1: Distribution of study groups on the basis of height and arm span.

Group	Male (N/%)	Female (N/%)	Total (N/%)
Height=Arm span	11 (13%)	4 (10.3%)	15 (12.1%)
Height>Arm span	17 (20%)	27 (69.2%)	44 (35.5%)
Height < arm span	57 (67%)	8 (20.5%)	65 (52.4%)
Total	85 (100%)	39 (100%)	124 (100%)

Table 2: Stature and arm span in both genders.

Group	No.	Stature cm (mean±sd)	Arm span cm	Stature :Arm span(mean±sd)
Male	85	171.34±9.71	174.27±8.63	0.983
Female	39	159.41±6.33	156.47±7.85	1.019
Total	124	167.59±10.38	168.67±11.78	0.995

Table 3: Comparison of stature and arm span in male and female.

Group	Stature	Arm span
Male	171.34±9.71	174.27±8.63
Female	159.41±6.33	156.47±7.85
p	<0.001	<0.001

Table 5: Comparison between calculated and measured stature using 't' test.

Group	Measured stature	Calculated stature	p
Male	171.34±9.71	171.25±6.69	>0.05
Female	159.41±6.33	159.25±4.95	>0.05
Total	167.59±10.38	167.49±8.28	>0.05

Table 4: Calculated stature using regression equation.

Group	a (intercept)	b (regression coefficient)	Measured stature (mean±sd)	Calculated stature (mean±sd)
Male	36.19	0.775	171.34±9.71	171.25±6.69
Female	60.68	0.630	159.41±6.33	159.25±4.95
Total	48.91	0.703	167.59±10.38	167.49±8.28

Table 6: Correlation (r) of stature with arm span.

Group	Arm span (r)	p	r ² (coefficient of determination)	% r ²
Male	0.689	<0.05	0.475	47.5
Female	0.783	<0.05	0.613	61
Total	0.798	<0.05	0.638	64

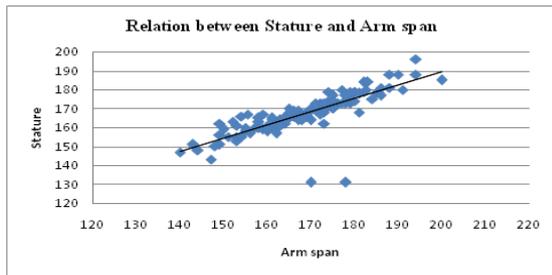


Figure 3: Scatter diagram showing relation between Stature and Arm span.

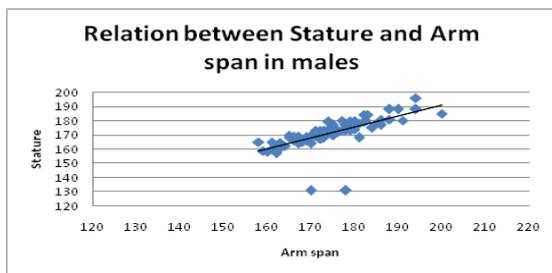


Figure 4: Scatter diagram showing relation between Stature and Arm span in males.

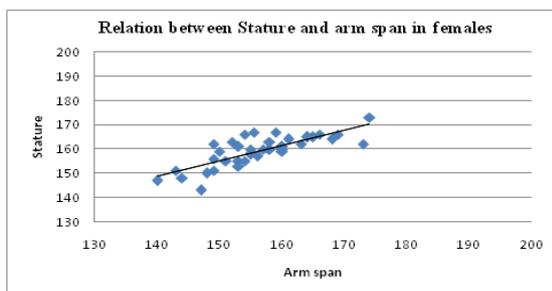


Figure 5: Scatter diagram showing relation between Stature and Arm span in females.

DISCUSSION

When the accurate measurement for stature is unobtainable, it is computed using other surrogates. Arm span is the most widely used one. In this study, we analysed the correlation coefficients of stature and arm span. Regression equations were then developed to predict stature.

Arm span is considered a useful alternative to height, particularly in the elderly, since arm span does not vary significantly with age. Several studies demonstrated that arm span measurements exceeded height measurements in all the ethnic groups and in both sexes.^[11]

In our study, we divided the subjects into three groups on the basis of height and arm span. 52.4% of the participants had an arm span more than height. Out of this, 67% were males and 20.5% were females. Maximum number of females (69.2%) showed less arm span in comparison to stature. Equal measurement of height and arm span was found in 12.1% of the subjects (13% male and 10.3% female). Mean height to arm span ratio obtained were 0.983 in males and 1.0196 in females. According to Ashutosh N, et al, arm span exceeded height in 82.6% subjects. Mean height to arm span ratio was 0.9711 and 0.9816 in males and females respectively ^[12]. Datta SB in his study found that males were taller and had longer arms spans than females. The height-arm span ratio was 0.98–0.99, indicating height to be slightly less than an arm span in both sexes ^[1]. Normally the arm span is less than the height in boys up to 10 years of age and in girls up to 11 years of age. The arm span is approximately

5 cm greater than the height in adult males and 1.2 cm in adult females.

The arm span was nearly 8.3 centimeters more than the body height for the black population (105.36% body height), whereas for the white population this difference was only 3.3 centimeters (102.04% body height) [13]. The arm span was nearly 2.5 centimeters more than the body height in South Indian females (101.4% body height), which is similar to that noted in the white population [8]. Similarly the arm span was 5.8 centimeters more than body height for Nigerian males (103.3% body height), whereas for Nigerian females this difference was only 4 centimeters (102.5% body height) which is similar to that noted in the white population.[14]

The mean measured stature and arm span for males were 171.34±9.71 and 174.27±8.63 whereas for females they were 159.41±6.33 and 156.47±7.85 respectively. Mean arm span and stature in male were more than female and it was statistically significant ($P < 0.001$). So, the same regression equation can't be used in both sexes to estimate stature. We formulated a regression equation for estimation of stature depending upon the sex. The calculated stature obtained from a regression equation using arm span were 171.25±6.9, 159.25±4.95 and 167.49±8.28 for male, female and all the participants in total. We also compared the measured stature with calculated stature using 't' test but could not find any significant difference among mean measured stature and mean calculated stature ($p > 0.05$). This shows that arm span can be used to calculate stature of the individual. The coefficient of determination for the regression equations obtained were 47.5% for male and 61% for females. According to Mahanty SP et al the coefficient of determination for regression equation models obtained from arm span was 66.6% for standing height (similar to our finding) and 31.5% for sitting height in the case of south Indian women.[8]

The study of Stevo Popovic et al, showed that male Serbians are 181.96±6.74 cm tall and have an arm span of 184.78±8.41 cm, while female Serbians are 166.82±5.88 cm tall and have an arm span of 164.67±8.09 cm.[15]

Stevo Popović et al in 2015 have also shown that the male Bosnian and Herzegovinians are 183.87±7.11 cm tall and have an arm span of 184.50±8.28 cm, while female Bosnian and Herzegovinians are 171.82±6.56 cm tall and have an arm span of 169.85±8.01 cm.[16]

We also determined Pearson correlation coefficient to find the correlation between stature and arm span. Stature was found to correlate positively with the arm span ($r = 0.689$ for male, $r = 0.783$ for female and $r = 0.798$ for all participants) and the correlation was statistically significant ($p < 0.05$). Correlation of arm-span and height for black subjects was 0.776 and for white subjects was 0.894.[17]

A study by Mohanty et al showed significant correlation between arm span and height of individual [8]. Similarly, observations were made by Patel et al where they found highest correlation between stature and arm span ($r = 0.908$).[3]

A study by Goon TD et al concluded that the arm span is a good predictor of the stature of men (stature=67.63+5.77 (Arm span); $r = .77$) and women (stature=55.16+6.42 (Arm span); $r = .72$), accounting for 59.3% and 51.8% of variance in the subjects' stature, respectively. The correlation between arm span and stature ($r = .82$; $p < .01$) was high and significant in all the age groups. The findings could be of practical significance in sports, ergonomics, growth and development, monitoring, and in physical anthropology.[17]

CONCLUSION

Arm span measurement can serve as one of the most reliable body parameter to determine stature of an individual. It is useful in determining related loss in stature and in identifying individuals with disproportionate growth abnormalities. It also important in medico-legal cases, where stature becomes a prime factor in identification of a deceased subject when only parts of the body are available.

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