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Use of Arm-Span length for Estimation of Height of The Person in Khatri Population of Delhi

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Abstract:

Identification of an individual has many characteristics which are taken into account. Age, sex and stature are one of the major characteristics for identifying the individual. However, in cases where the dead body is highly decomposed, fragmented or mutilated/ attacked by animals; mass disasters, etc., where only part(s) of body is/are available, anthropometry becomes an important tool for identification of such corpse. A central position in the anthropometric research is preoccupied by the stature as every body part bears more or less a constant relationship with height of an individual. The objective of the study is to estimate the stature from Arm span length and predict the regression equation in the males Khatris of India. The study was carried out on 100 healthy male individuals aged 18 to 45 years. Arm span length was taken by using measuring tape and stature by anthropometric Rod. The data was statistical analysis using SPSSv23 software. During analysis it was found that the males with stature 167.7±8.73cm had the arm span of 172.2±8.61cm. The correlation between stature and arm span was positive and significant (r=0.967 p & lt; 0.01). The predicted regression equation for stature was 0.981X arm span length+ (-1.112). The stature calculated using regression equation was 167.8±8.44cm. It can be concluded through this study that estimation of stature forms an important parameter to reach to the partial identification of an unidentified body and dismembered remains. The study indicates that the Arm span length can be efficiently used for estimation of stature. Most authors' findings have underlined the need for population- specific stature estimation formulae. In this study we derived a separate regression equation to estimate stature from arm span length for population which are helpful to those who are working in the field of medical disciplines, ergonomics anthropologists and security experts.

Keywords: *Stature, Arm Span length, Anthropometry, Identification, Regression Equation*

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Introduction

Body size is the important measure which helps in an assessment of nutritional status **(Datta Banik, 2011).** Scientific literature is studied with reference to measuring of body height which is of great importance in field Anthropometry.

Stature can be defined as the maximum distance from the point where the heel touches the floor to the maximum point of the head in erect position **(Lohman *et al.*, 1988)** and it is one of the most essential elements of identification of an individual. Establishing the individual identity is very essential in cases when only fragmentary remains of a human body are found (**Darji and Tanna, 2018)** and in mass disasters i.e. Earthquake, airplane crash, bomb blasts, stampede, tsunami, flood, cyclones, Terrorist attack, close compartment fire, wars, public vehicle (train, bus, ship, plane etc.) accidents etc. Body Mutilation could also be possible by humans, animals or by a natural process of decomposition. Identification and exclusion of an individual involved in a crime can be made from the evidences traced from hand print and foot print left. Stature and weight are required for assessing the growth and nutritional status of person, which help in determination of basic energy requirements, standardization of measures for physical capacity, for adjusting drug dosage and for identifying an unknown cadaver **(Shah *et al.*, 2017).**

Length of appendages and long bones of the body represents a certain relationship in the form of proportion to height /stature **(Chawla *et al.*, 2013).** The skeletal maturity is accomplished when bones are properly ossified, the proportions of the body doesn't alter with age. Therefore, it can be said that the individual stature is a quantitative or qualitative measurement of personality. However, in some worse conditions it is not possible to measure the stature of a person due to 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 some cases, predicting stature using other body parameter 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 **(Sah *et al.*, 2014).**

Estimating stature are of prime importance in, identifying individuals with disproportionate growth abnormalities, predicting loss in stature in the age-related problems, skeletal dysplasia, medico-legal cases or height loss during surgical events on the spine. These body measurement parameters are well utilised for the application in normalizing pulmonary function in scoliosis **(Mohanty *et al.*, 2001).**

Correlating between stature and the arm span, it was found to be the most consistent paramter in relation to other body parts. Arm span is the maximum distance covered between the tips of the longest fingers of both hands when the person extends both arms at the level of the shoulders (**Lohman *et al.*, 1988).**

There is great variation between the associations of stature and arm span in different ethnic and racial groups **(Brown *et al.*, 2002)**.

The study of **Hickson and Frost (2004)**, while applying the Bland Altman analysis, it was observed that there was wrong agreement between the arm span and height even though these correlates well. So, it suggests that arm-span measurements may be an inappropriate proxy for the stature in certain populations. The relationship between arm span length and stature is of great importance in forensic medicine, plastic and cosmetic surgery and other allied clinical sciences.

Method and Methodology

A. Subject:

The study was carried on a sample of healthy 100 male individuals within the age group of 18-45 years belonging to Khatri community of Delhi. Subjects with any deformity in hand were not taken in this study. All the subjects were informed about the study design, measurements and privacy of data collected. Consent about the study was taken from each subject before obtaining measurements. According to **Lohmann *et al.* (1988)**, all measurements were taken at a fixed time of day to eliminate diurnal variation and were each measurement was repeated three times and a mean value was taken into consideration. The measurement was accurate to ± 0.5 cm.

Measuring tape for the measurement of Arm span length and Anthropometric rod for the measurement of stature. All of the data were analysed using SPSS v23.

B. Anthropometric Measurements

Stature: It is the vertical distance between the highest point on the vertex and platform of surface where the subject stand erect, bare foot on a level platform, the feet were close to each other and the heals touching the each other, arms hanging by the side. The head of the subject was resting without any straining the Frankfurt's plane i.e., trigone and the infraorbital margin of both the sides lie in the same plane.

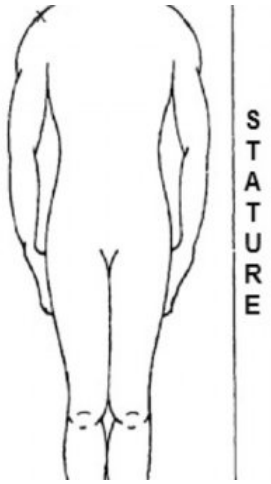

Figure No. 1: Stature Representation

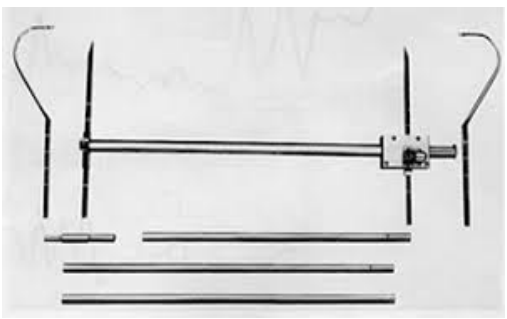

Figure No. 2: Anthropometric Rod

Arm Span Length: It was measured using a calibrated measuring tape to the nearest 0.1 centimetres 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 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.

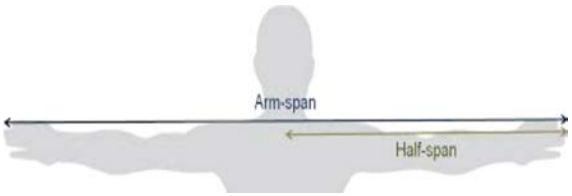

Figure No. 3: Arm Span Length

Figure No. 4: Measuring Tape

Aims and Objectives

To obtain population specific equation for estimation of stature from Arm Span length in the Khatri population of Delhi.

- Obtaining anthropometric measurements i.e stature and arm span length of population of males
- To find out the correlation between Arm Span length with stature of the individuals.
- To devise linear regression equation to estimate stature from Arm Span length.

Observation and Results

The data was computed and analysed using SPSS (Statistical Package for Social Sciences, version 23.0) computer software.

Table 1: Descriptive Statistics of Stature and Arm Span Length Measurements

Parameter	Mean (cm)	Standard deviation	Minimum(cm)	Maximum(cm)
Stature	167.7	8.7	148.10	183.50
Arm Span length	172.2	8.6	150.10	189.10

It shows that there is a widely distribution of stature among study population, ranging from 148.10 – 183.50 cm in males and the mean stature among males is 167.7 cm with the standard deviation of ± 8.7 cm. The distribution of Arm Span length ranging from 148.10cm to 150.10cm and the mean and standard deviation of Arm Span length among this population is 172.2cm and ±8.6 respectively.

Table 2: Correlation between the Stature of an Individual and Arm Span Length in Males of Khatri Population of Delhi

Correlations			
		STATURE	SPAN LENGTH
STATURE	Pearson Correlation	1	.967**
	Sig. (2-tailed)		.000
	N	100	100
SPANLENGTH	Pearson Correlation	.967**	1
	Sig. (2-tailed)	.000	
	N	100	100

**. Correlation is significant at the 0.01 level (2-tailed).

The table shows that stature is positive correlated and significantly at 0.001 level with length of Arm span of Khatri population of Delhi.

Table 3: Regression Equation for determining the stature from Arm span length in Khatri Population of Delhi

Model Summary[b]				
Model	R	R Square	Adjusted R Square	Std. Error of Estimate
1	.967[a]	.935	.935	2.23131

a. Predictors: (Constant), SPANLENGTH

b. Dependent Variable: STATURE

Coefficients[a]						
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	-1.112	4.491		-.248	.805
	SPAN LENGTH	.981	.026	.967	37.658	.000

a. Dependent Variable: STATURE

Y= ax+b where Y is Stature and x is mean of middle finger length

=0.981X Arm Span length + (-1.112)

= 0.981x172.2-1.112

= 167.81cm

Therefore, the estimated stature from the middle finger length is 167.69cm.

Table 4: Shows the Maximum, Minimum, and Mean of the observed value of Stature and Values predicted by Regression Equation from Arm Span Length in Males.

	Khatris Males		
	Minimum(cm)	Maximum (cm)	Mean (cm)
Observed Value (Actual Stature)	148.10	183.50	167.7
Arm Span Length	150	189.10	167.81

The table depicts that observed value of stature ranges from 148.10cm to 183.50cm with mean 167.7cm and the predicted stature from the Arm Span length ranges from 146.10 to 184.35 with mean 167.81 of Khatri population of Delhi.

Discussion

During the natural situations or the mass disaster when the accurate measurement for stature is unobtainable, it is computed using other substitutes. The most widely used is arm span length. In this study, we have analysed and inferred the correlation coefficients of stature and arm span length and which are highly correlated. On analysing, the correlation between the Stature and arm span length is 0.967 ($p<0.01$). On being correlated the regression equations were then developed for predicting the stature. In old people, arm span length is considered as the most useful assessing parameter for predicting stature, as arm span length does not vary significantly with age.

Several studies have been carried out that arm span length measurements exceeded body height in all the ethnic groups and in both sexes.

In one of the findings carried out by **Aggarwal *et al*., (1999)** arm span exceeded body height in 82.6% subjects and the arm span ratio and mean height was 0.9711 and 0.9816 in males and females respectively. The study undertaken by **Datta Banik (2011)**, it was

found that males were taller and had longer arms spans than females and due to this the height-arm span ratio was 0.98–0.99, indicating height to be slightly less than an arm span in both sexes.

In general, the arm span length is less than the body height in boys up to 10 years of age. The arm span length is approximately 5 cm greater than the stature in adult males and 1.2cm in adult females.

In Black population the arm span length was nearly 8.3 cm more than the body stature. (105.36%body height), whereas in the white people population the difference was only 3.3cm between the arm span and stature (102.04% body height) **(Steele and Chenier, 1990).**

Similarly study were also carried out on the South India population, where the arm span length of females was around 2.5 cm more than the body height (101.4% body height), which is similar to that of white population. In the Nigerians males, the arm span was 5.8 cm more than body height (103.3% body height), whereas for Nigerian females this difference was only 4 cem (102.5% body height).

On statistically analysing the data it was found that the mean measured stature and arm span length for males were 167.7±8.7 and 172.2±8.6. The Arm span length is derived a regression equation for estimation of stature depending upon the arm span length of the population under study. . The calculated stature obtained from a regression equation using arm span were 167.71± 8.44. The coefficient of determination for the regression equations in this study obtained was 93.5%. There were many other study findings, accordingly study of female South Indian by **Mohanty *et al.*, (2001)** where the coefficient of determination for regression equation models obtained from arm span was 66.6% for standing height and 31.5% for sitting height. In the study of **Popovic et al. (2013)**, showed that male Serbians are 181.96±6.74cm were taller and have an arm span of 184.78±8.41 cm, while female Serbians are 166.82±5.88 cm are taller and have an arm span of 164.67±8.09 cm.

The male Bosnian and Herzegovinians population stature was 183.87±7.11 cm are tall and with arm span of 184.50±8.28 cm, while female Bosnian and Herzegovinians have body height of 171.82±6.56 cm tall and have an arm span of 169.85±8.01 cm study carried out by **Popović *et al.*, (2016).**

Similarly, study were carried out by **Sah *et al.* (2014)** where they found highest correlation between stature and arm span (r=0. 908).

A study by **Ter Goon *et al.* (2011)** concluded that the arm span length is a good predictor of the stature of men (stature=67. 63+.577 (Arm span); r=. 77) and women (stature=55. 16+.642 (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 of all the above mentioned study can be of practical significance in sports where stature is key important parameter, ergonomics (desigining products for individual population), evolution and expansion of the individuals, monitoring, and in physical anthropology.

Conclusion

Arm span length measurement can serve as the most steadfast body parameter to determine stature of an individual. This study helps in determining loss in stature due to age related factor and in identifying individuals with disproportionate growth abnormalities. This study can serve important pillar in medico-legal cases, where stature becomes prime facie in identification process of a deceased subject when only parts of the body are available.

The study results indicate that the arm span length can be Arm span length is proficiently used for estimation of stature. Most authors have emphasised on the need for population-specific stature estimation formulae. In this study we derived a separate regression equation to estimate stature from arm span length length for males Khatri population of Delhi. The obtained regression equations for male stature is S = -1.112+ 0.981 x Arm span length length) of Khatri population.

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