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Original Research Article

Correlation of stature with arm span along with its significance in north Indian adult population

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ABSTRACT

Background: Stature is the qualitative and quantitative measurement of a personality. The purpose of this present study is to estimate the correlation of stature with arm span and to derive regression formulae for calculating the stature from arm span in adult males and Females of North Indian population.

Materials and Methods: This research was done on 400 adult human subjects, (200 males and 200 Methods: females) of North Indian Population. The total number of subjects were categorised into four groups according to the age: Category 1 - 23 - 26 years of age, Category 2 – 27- 30 years of age, Category 3 – 31-34 years of age, Category 4 – 35-39 years of age. Stature and arm span were measured and mean value, standard deviation and Pearson's correlation coefficient was calculated. Correlation between parameters with age group and gender has been estimated.

Results: Correlation of Stature and arm Span is 0.66 in males, 0.65 in females and p value is <0.001. The results of the study found that stature and arm span shows statistically significant positive correlation.

Conclusion: Stature shows a statistically significant positive correlation with arm span in adult males and females. Thus, for reconstruction surgeries of limb, it is a critical anthropologic tool. It can also be applicable in identifying an individual in mass disasters where the case is deteriorated, damaged and disfigured.

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1. Introduction

Physical anthropology deals with the study of human behaviour in time and space. Anthropometry illustrates the conventional tool of physical anthropology. It refers the study of human body and skeleton which helps in forensic science for medico legal cases. It is also categorized into social and cultural units because it deals with human and human conduct in the community. Identity is the birth-right of every individual. For recognition of a missing person, external features and body parts are very significant. If there is any mass casualty in any natural disaster, and body remnants are available for identification, they become an

important source for medico-legal investigation. Stature of an entity is a major variable that helps in the identification even after death. Correlation of height of an individual can be done with various parameters like hand length, foot length and arm span.

In the Anthropometric studies, correlation of stature with arm span in standing posture is found to be highly significant than correlation of stature in the sitting position.¹ Estimating stature and weight are helpful in evaluating growth and nutritional status of children. In children, both variables like stature and arm-span increases with age and they depends on both the variables of genders. In adults, both variables decrease with age but the rate of decendency in stature is higher than the age related to arm span. Many previous research work showed that age related

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decrease in height is lower in the white population than in black population. In bed bound patient, Arm-span helps to estimate stature of that patient. In the forensic study, arm-span has significance in estimating stature in disabled sports persons in the identification of individual. Parameters like arm-span and stature are used in normalizing pulmonary function in scoliosis patients. By measuring standing height, longitudinal growth as well as body fatness and energy requirements to adjust drug dosage can be estimated. In children who cannot stand on their feet, stature estimation becomes difficult. This study determines the precision of use of arm span in predicting stature. This study finds out the correlation of stature with arm span in North Indian population. So, the aim of this study is to determine the correlation of stature with arm span and to determine the regression equation for stature from arm span. This helps doctors, archeologists, forensic experts to approximate stature of an individual in damaged bodies especially when most of the body parts are mutilated.

2. Materials and Methods

This present study is done on 400 adult Human subjects (200 male and 200 female) of North Indian origin. This study is conducted in the department of Anatomy, S. N. Medical College, Agra. Written informed consent was obtained from the subjects prior to the study. The subjects were selected regardless of their position, socio-economic status, religion, and dietary habits and were apparently healthy & without any spinal or limb deformity.

2.1. Exclusion criteria

1. Subjects with congenital spinal deformity or limb deformity i.e scoliosis, kyphosis, Acromegaly, etc.
2. Any subject with acquired bone deformity i.e arthritis, missing extremity.

2.2. Measurements

Stature is the vertical distance from vertex to floor.² For measurement of arm span, arms were outstretched at right angles to the body, elbow and wrist extended with the palm facing forwards palms and the head was aligned in the Frankfort plane. Arm-span was measured with the subject standing adjacent to the wall, shoulder joint abducted to 90 degree, arms spread at the shoulder joint level and equivalent to floor. The measurements were taken from tip of middle finger of one hand to tip of middle finger of other hand. A non-elastic tape was used to measure arm span. A calibrated steel tape to the nearest 0.1 centimetres on a level concrete floor with their upper backs, buttocks and heels against the wall supporting. (Figure 1).

For the measurement of stature, subject was in the anatomical position, standing on their heels together, buttocks, shoulder and head touching the walls. The subjects

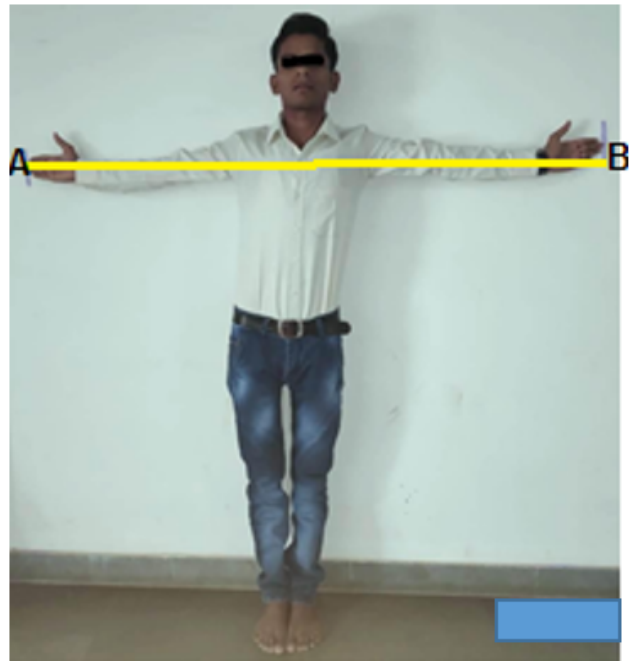


Fig. 1: A-B- Measurement of arm-span

were asked to take a deep breath and hold it. Measurement was taken from vertex to the heel. A non-elastic tape was placed against the head and wall to measure the maximum height (Figure 2)

For the purpose of study, the total number of subjects has been divided into four groups according to the age: Group I - 23 to 26 years, Group II - 27 to 30 years, Group III - 31 to 34 years, Group IV – 35-39 years.

Anthropometric measurements of stature and arm span were measured in centimeters for both males and females, by using the measuring tape. To eliminate the diurnal variation in subject's height, these measurements had been taken by the same person between 12PM to 4PM daily. Three readings were taken for all the measurements and mean of the three readings for each variable was taken into consideration, to minimize subjective errors. Data was analyzed in SPSS version 22. Mean and S.D (Standard Deviation) were noted and the difference in means were analysed. With these measurements, correlation coefficient between arm span with stature is calculated & regression equation for stature estimation with gender from arm span was derived.

3. Results

In the present study, it was calculated that the mean and standard deviation of stature in males was 167.24 ± 6.37 cm and 154.17 ± 8.35 cm in females and it was observed that the mean and standard deviation of stature in males higher than in females (Table 1).

Table 1: Comparison between male and female stature

Group	N(%)	Min-Max(cm)	Mean±SD	Mean diff	P value
I	Total -199 (50%)	131-180	161.70±8.61		
	Male -89 (23%)	153-180	167.87±5.71	11.04	<.0001
	Female -110 (27%)	131-170	156.83±7.30		
II	Total -76 (19%)	136-180	160.89±10.44	0.81	
	Male-40 (10%)	145-180	167.57±6.87	14.10	<.0001
	Female- 36(9%)	136-170	153.47±8.56		
III	Total-54 (13%)	129-182.5	159.09±12.46	1.80	
	Male-29(7%)	152-182.5	167.82±7.71	18.86	<.0001
	Female- 25(6%)	129-162	148.96±8.63		
IV	Total - 71(18%)	124-177	158.74±10.22	0.35	
	Male- 42(10%)	148-177	164.90±6.01	15.08	<.0001
	Female- 29(8%)	124-162	149.82±8.31		

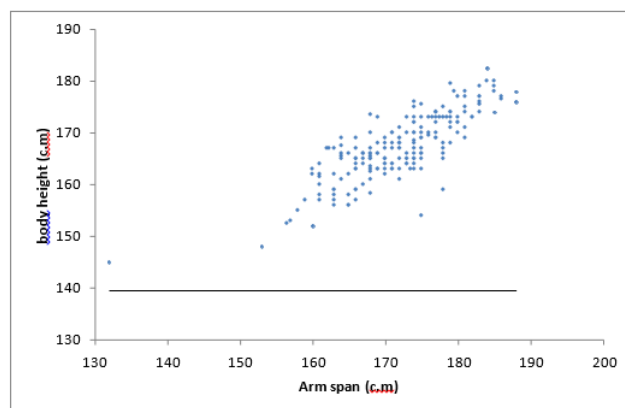
**Fig. 2:** C-D Measurement of stature

In the present study, it was calculated that the mean and standard deviation of arm-span in males 171.92 ± 7.50 cm and 153.81 ± 11.37 cm in females and it was observed that the mean and standard deviation in males higher than in females (Table 2).

Arm-span of both males and females (mean 163.11) of group I increases with increase in stature (mean 161.70) which shows a positive correlation with stature. Arm-span of both males and females (mean 163.87) of group II increases with increase in stature (mean 160.89) that

indicates arm-span has a positive correlation with stature. Arm-span of both males and females (mean 161.40) of group III increases with increase in stature (mean 159.09) that signifies arm-span has a positive correlation with stature. Arm-span of both males and females (mean 161.83) of group IV increases with increase in stature (mean 158.74) that means arm-span has a positive correlation with stature. Ratio between stature and arm-span was 0.99 in group I, 0.98 in group II, 0.98 in the group III and 0.98 in the group IV (Table 3).

In the present study, the correlation of stature and arm-span value was 0.666 in males (Figure 3), 0.654 in females (Figure 4) and p value was <0.001. The results of the study found that there was statistically significant positive correlation between stature and arm span.

**Fig. 3:** Correlation between stature and arm-span in male

Regression formulae for estimating height of a subject using arm-span

4. Discussion

Each human being relate to the one species, Homo sapiens. An individual can never be same as another in all his measurable characters, even monozygotic twins also vary

Table 2: Comparison between male and female arm span

Age group	N (%)	Min-Max	Mean± SD	Mean diff.	p- value
I	Total-199 (50%)	114-186	163.11±12.41		<.0001
	Male-89 (23%)	157-186	172.77±6.56	17.290	
	Female-110 (27%)	114-176	155.48±10.49	0.760	
II	Total-76(9%)	127-188	163.87±13.00		<.0001
	Male-40(10%)	132-188	171.73±9.55	16.600	
	Female-36(9%)	127-172	155.13±10.55	2.470	
III	Total-54(13%)	118-185	161.40±16.55		<.0001
	Male-29(7%)	160-185	173.15±7.09	25.370	
	Female 25(6%)	118-165	147.78±13.63	0.430	
IV	Total-71 (18%)	119-183	161.83±12.96		<.0001
	Male-42(10%)	153-183	169.32±7.20	18.320	
	Female-29(8%)	119-168	151±11.77		

Table 3: Comparison between male and female correlation of arm span with stature

Group	Stature(cm)		Arm-span(cm)		R-value
	N(%)	Mean± SD	Mean± SD	Ratio Stature Arm Span	
I	Total -199 (50%)	161.70±8.61	163.11±12.41	0.99	0.727
	Male -89 (23%)	167.87±5.71	172.77±6.56	0.97	
	Female - 110 (27%)	156.83±7.30	155.48±10.49	1.00	
II	Total -76 (19%)	160.89±10.44	163.87±13.00	0.98	0.827
	Male-40 (10%)	167.57±6.87	171.73±9.55	0.97	
	Female- 36(9%)	153.47±8.56	155.13±10.55	0.98	
III	Total-54 (13%)	159.09±12.46	161.40±16.55	0.98	0.880
	Male- 29(7%)	167.82±7.71	173.15±7.09	0.98	
	Female- 25(6%)	148.96±8.63	147.78±13.63	1.00	
IV	Total - 71(18%)	158.74±10.22	161.83±12.96	0.98	0.845
	Male- 42(10%)	164.90±6.01	169.32±7.20	0.97	
	Female- 29(8%)	149.82±8.31	151±11.77	0.99	

Table 4:

Male	$Y = 48.026 + 0.693x$
Female	$Y' = 62.280 + 0.598x'$

Where- x and x' is the arm-span of male and female,
And Y' is the Height of the male and female

Table 5: Correlation of arm-span with stature in different populations

S.No.	Authors	Populations	Male		Female		p-value
			Sample size	r-value	Sample size	r-value	
1	Singh et al ¹⁰	Chandigarh	272	0.875	128	0.856	<0.001
2	Shah et al ⁵	Ahmedabad	72	0.806	78	0.866	<0.001
3	Arifi et al ¹¹	Kosovo	90	0.862	100	0.794	<0.000
4	Popovic et al ¹²	Serbia	178	0.876	34	0.887	<0.000
5	Alam et al ⁷	Mau (U.P)	85	0.475	39	0.613	<0.05
6	Sharma et al ³	Moradabad	200	0.81	200	0.66	
7	Mishra et al(2017)	Odisha	774	0.94	691	0.94	<0.001
8	In present study	North Indian population	200	0.666	200	0.654	<0.001

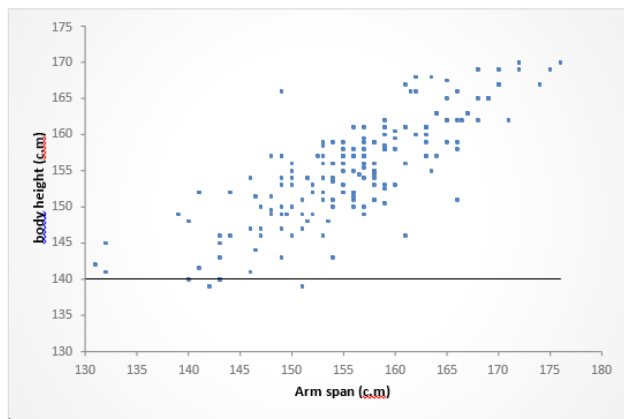


Fig. 4: Correlation between stature and arm-span in female

in few traits. This change in these characters occurs in his complete life cycle and these changes are affected by various elements causing changes in skeletal ratio in various geographical regions. The main five important deciding factors affecting the personality of an individual are genetics, climate, altitude, health, and dietary habit. The estimation of stature is a very interesting topics for researchers because of its large significance. The approximation of the, stature, build, race and identity of an individual from the Human fragments is done by Archeologists and forensic experts from time to time. It is often found that genetic factors affects a large part of grown-up stature. Females are on average shorter than males in each known populace. This difference in stature between males and females is called sexual dimorphism of stature and exists almost in each populace. In the present study, The mean stature of males was found significantly higher than the mean of stature in females in this present study. The other previous studies also found the similar results. It is seen in many studies that female skeleton is smaller than males. If the exact measurement for stature is not obtainable, it is calculated by using other methods. Different measurements were taken by different researchers for the approximation of stature. Among these measurements, measurement of Arm span is the most commonly used. Arm Span can be said to be most useful in approximating the stature. Knee height is used by Chumlea et al. (1985)³ to estimate the stature. This present work is compared with the other previous works (Table 4). This present study is done on living human beings and for estimation of the correlation of arm span with stature, a regression equation is derived. This study was done of four hundred participants, in which males and females were kept in same proportions. Similar study sample were taken by Sharma S et al⁴ in which 200 males and 200 females were studied. Shah et al.⁵ did a work on 150 MBBS students in a medical college of Ahmedabad, and he found a positive and significant correlation of 0.9313 of arm- span with stature. Patel et al⁶ did similar study on

273 subjects and studied correlation of stature with the five variables which are hand length, hand breadth, arm span, foot breadth and foot length. On doing statistical analysis, he found the greatest correlation of stature with armspan ($r=0.908$). Alam et al⁷ also found a strong and significant ($r=0.798$, $p<0.05$) correlation of arm span with stature in his cross-sectional study on 124 students in Uttar Pradesh. In this present study, like the stature, the average Arm span was lower in females than in males, which is similar with the findings of Shah⁵ and Alam.⁷ Different regression equations for different genders are derived for estimating the stature as there is significant different in the measurements of males and females. In studied males and females, the correlation R for arm span and stature is calculated as 0.66 and 0.65 respectively. Other researchers also found the similar results. In this present study, the female outstretched arm span shows a strong and statistically significant positive slightly lower coefficient correlation ($r=0.65$) with stature than the male ($r=0.66$), this correlates with the study done by Barwa J et al⁸ in Dehradun and Ter Goon D et al⁹ in Nigeria. But the work done by Alam MT et al⁷ in Uttar Pradesh showed that male outstretched arm span showed a lower correlation coefficient (r) with stature than in the female. So, for the correlation of Stature with the arm span, regression equation is derived for stature estimation.

5. Conclusion

This study was done on 400 adult human subjects (200 males and 200 females) of North Indian population. From the study, a regression equation was derived which shows a positive correlation of stature with arm span. This fact can be used by Anthropologists for estimation of stature with arm span when the identity of a person is unknown.

6. Conflicts of Interest

Nil.

7. Source of Funding


Nil.

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