
Correlation between arm span and stature in different age groups- An anthropometric study in population of Rajasthan

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Abstract

Background: The estimation of inter-relationship between arm span and stature has been an important tool in anthropometric measurements. It is found to be of great importance in such cases where direct measurement of stature is not possible.

Objective: To find the correlation between the arm-span and standing height of both males and females in the population of Rajasthan and to use the results for medico-legal and anthropometric purposes.

Materials and Methods: The study involved 600 participants (300 males and 300 females) grouped in 3 different age groups to find inter-relationship between arm-span and standing height among these age groups. The groups were divided as Group A (26-35 yr), Group B (36-45 yr), Group C (46-55). The data for study collected from different regions of Rajasthan by means of community visits. The standing height and arm-span were measured for each individual and analyzed.

Result: A positive correlation was found to exist between the arm-span and stature. The correlation coefficient 'r' was found to be 0.921, 0.956 and 0.956 for group A, B and C respectively.

Conclusion: It can be concluded that arm-span can be used in estimation of the height of both males and females. Arm span is one of the most reliable body parameter for obtaining the stature of an individual, also useful in obtaining age-related loss in stature and in identifying individuals with disproportionate growth abnormalities and in medico-legal cases.

Keywords: Arm-span, Stature, Anthropometry

1. Introduction

Anthropometry is the science dealing with measurement of size, weight and proportions of human body. It is being very popular nowadays in medical science for formulating correlations in relation to nutritional assessment and inter-relationship of various body parameters. Identity is the birth-right of every individual. 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 [8]. Physical identity of a person is assessed by person's height, weight, body build etc. So a person can be identified by stature and correlation with various body parts like arm span, hand length, foot length, demi-span etc. Relationships that exist between different parts of body and height have been of great interest to anthropologists, forensic and medical scientists for many years. This is because of the increase in the

number of destructive events causing mass death from natural and man-made errors. Such disasters like flooding, tsunamis, earthquakes, plane crashes, train crashes and terrorist attacks usually requires the identification of victims from fragmentary and dismembered human remains. These estimations are also of prime importance in predicting age-related loss in stature, identifying individuals with disproportionate growth abnormalities and skeletal dysplasia or height loss during surgical procedures on the spine. These measurements also have found application in normalizing pulmonary function in scoliosis. [6] Stature is an important anthropometric tool in different clinical and non-clinical settings.

Arm span has been suggested as an alternative method for predicting stature in situations where direct measurement is not possible [17]. 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. [16]. In such cases, stature has to be estimated using other body parameters. Among all body parameters, correlation between stature and the arm span was found to be most reliable. However the relation between arm span and stature is found to vary among race to race. Arm span is considered a useful alternative to stature, particularly in the elderly, since arm span does not vary significantly with age. [12]

2. Materials and methods

2.1 Study population and sample size

The study involved 600 participants (300 males and 300 females) which are grouped in 3 different age groups to find inter-relationship among these age groups. The data for study to be collected from different regions of Rajasthan. The various areas selected for collecting population sample included Ajmer (centre), Jaipur (East), Mount Abu (south), Shriganganagar (north) and Jaisalmer (west).

These regions are selected randomly to get data from all directions. Age groups are classified as follows:

- a.) Group A -: 26 yr – 35 yr
- b.) Group B -: 36 yr – 45 yr
- c.) Group C -: 46 yr – 55yr

Each group includes a total number of 200 participants with 100 males and 100 females. Where further division in group was settled to get mixture of population of various regions of Rajasthan. Again each 100 of the every group (say male or female) include 20 samples from each of the above said five different areas (Ajmer, Jaipur, Mount Abu, Jaisalmer and Shri Ganganagar) of Rajasthan. The data to be collected through community-visits to the above said regions of Rajasthan.

3. Results

The observations were done on 600 subjects and the analysis of data concludes following results:

Table I: Descriptive Statistics for total samples of Group A (26-35) year

Parameter	N	Minimum	Maximum	Mean	Standard Deviation
Stature	200	143	184	161.30	10.08057
Arm span	200	142	187	164.70	10.713425

Table II: Descriptive Statistics for Males and Females of Group A (26-35) year

Parameter	N	Minimum	Maximum	Mean	Standard Deviation
Stature (male)	100	154	184	169.58	6.20123
Arm span(male)	100	153	187	173.26	6.72169
Stature(female)	100	143	164	153.01	4.93823
Arm span (female)	100	142	169	156.15	6.00147

Table III: Correlation between Stature and arm span of Group A (26-35) yr

Subject	Correlation coefficient (r)	Significant p-value
Total	0.921	0.0001
Male	0.715	0.0001
Female	0.862	0.0001

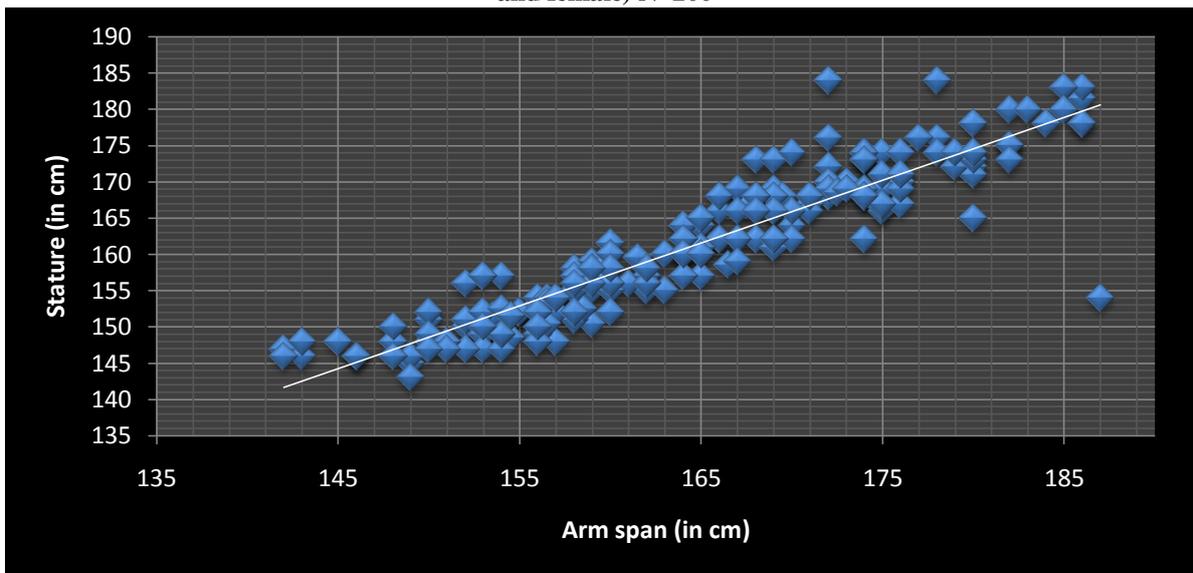
2.2 Measurement of stature

Stature was measured with the subject standing on their heels together and back as straight as possible so that heels, buttocks, shoulders and the head touched the wall. The arms were by the sides of trunk with the palms facing the thighs. Students were asked to take a deep breath and hold it, a measuring steel scale was placed against the head and wall to determine maximum height on the wall, and this was marked. The participants were then told to breathe out and to step away from the wall. The subject's head had to be in the Frankfort horizontal plane. This was achieved when the lower edge of the eye socket (the orbitale) is horizontal with the tragion. The vertex was the highest point on their head, otherwise the respondents had to raise or lower their chin until it was in the Frankfort horizontal plane to align their head properly. The stature was then measured from the floor to the mark on the wall with flexible steel tape which represents the stature in centimetres to the nearest 0.1 centimetres.

2.3 Measurement of arm span

Arm span was measured with a flexible steel tape from the tip of the middle finger of one hand to the tip of the middle finger of the other hand with the individual standing with their back to the wall with both arms abducted to 90 deg., elbows and wrists extended and the palms facing directly forward. Readings were taken to the nearest 0.1 cm. Measurements was taken twice in each subject. When the two measurements for each parameter fell within 0.4 cm, their average was taken as the best estimate for the true value. When the two initial measures did not satisfy the 0.4 cm. Criterion, two additional determinations were made and the mean of the closest records was used as the best estimate. The mean values of arm span and height were calculated separately for boys and girls.

Figure 1: Correlation & Regression analysis of arm span and height of Group A (26-35) year (Both male and female) N=200



$y = 0.865x + 18.72$; $r = 0.9217$; $r^2 = 0.849$
 [y= regression equation where 'x' is standing height of the person]

Table IV: Descriptive Statistics for total sample of Group B (36-45) year

Parameter	N	Minimum	Maximum	Mean	Standard Deviation
Stature	200	140	180	160.32	9.85574
Arm span	200	140	188	164.84	10.44588

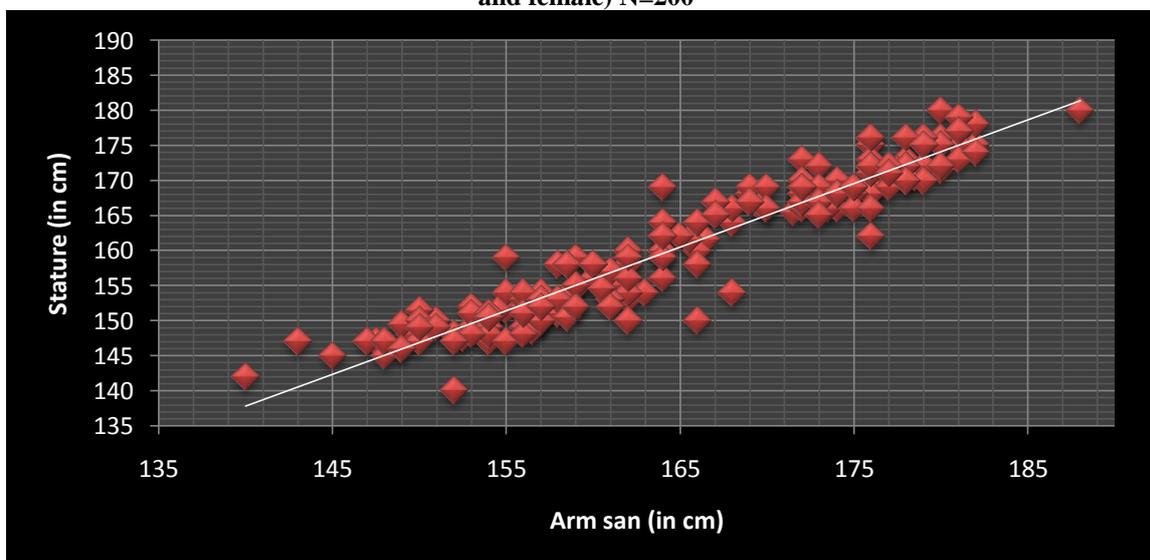
Table V: Descriptive Statistics for both Males and Females of Group B (36-45) yr

Parameter	N	Minimum	Maximum	Mean	Standard Deviation
Stature (male)	100	150	180	168.71	6.03229
Arm span(male)	100	155	188	173.41	6.43255
Stature(female)	100	140	168	152.03	4.51498
Arm span(female)	100	140	169	156.27	5.62434

Table VI: Correlation between Stature and arm span of Group B (36-45) year

Subject	Correlation coefficient (r)	Significant p-value
Total	0.956	0.0001
Male	0.862	0.0001
Female	0.857	0.0001

Figure 2: Correlation & Regression analysis of arm span and height of Group B (36-45) year (Both male and female) N=200



$y = 0.902x + 11.66$; $r = 0.9561$; $r^2 = 0.914$
 [y= regression equation where 'x' is standing height of the person]

Table VII: Descriptive Statistics for total sample of Group C (46-55) year

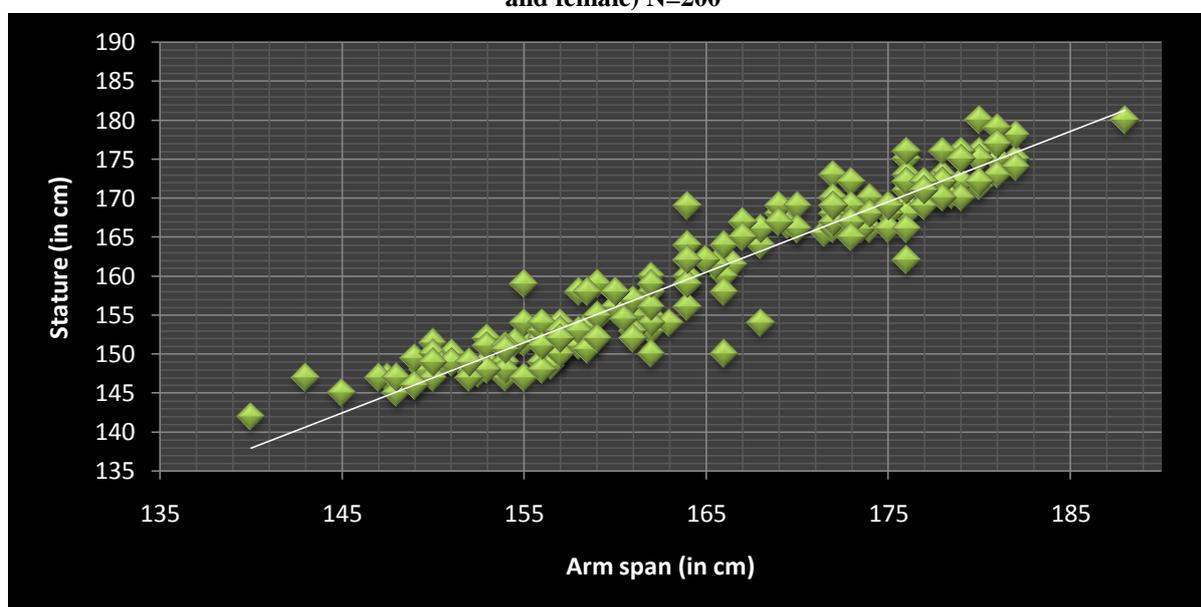
Parameter	N	Minimum	Maximum	Mean	Standard Deviation
Stature	200	142	189	160	9.85574
Arm span	200	140	188	164	10.44588

Table VIII: Descriptive Statistics for Males and Females of Group C (46-55) year

Parameter	N	Minimum	Maximum	Mean	Standard Deviation
Stature (male)	100	150	180	168.71	6.03229
Arm span (male)	100	155	188	173.41	6.43255
Stature (female)	100	142	168	152.03	4.51498
Arm span (female)	100	140	169	156.27	5.62434

Table IX: Correlation between Stature and arm span of Group C (46-55) year

Subject	Correlation coefficient (r)	Significant p-value
Total	0.956	0.0001
Male	0.886	0.0001
Female	0.872	0.0001

Figure 3: Correlation & Regression analysis of arm span and height of Group C (46-55) year (Both male and female) N=200

$$y=0.9021x=11.66; R^2=0.912; r=0.956$$

[y= regression equation where 'x' is standing height of the person]

Table X: Comparison between the result of three groups A, B and C

Subject	Correlation coefficient (r)	R ²	P-value
Group A	0.921	0.849	0.0001
Group B	0.956	0.914	0.0001
Group C	0.956	0.912	0.0001

Table XI: The value of correlation coefficient (r) individually for males and females

	Group A	Group B	Group C
Male	0.715	0.862	0.886
Female	0.862	0.857	0.872

4. Discussion

The present study deals with the observations on correlation of Total Standing Height with arm span in various age groups. Total 600 living subjects taken for study from different regions of Rajasthan. The age groups of 26-35 year (Group A), 36-45 year (Group B), 46-55 year (Group C) were selected and in present study, approximate stature has

been estimated from arm span. The stature of an individual mainly being genetically predetermined is an inherent characteristic, the estimate of which is considered to be an important assessment in the identification of unknown human remains. Height-estimation formulae based on arm span show similar levels of accuracy to the calculations based on the length of other body parameters. This is supported by

the standard errors of the estimations reported in several studies. The value of “r” implied that there was a positive correlation. The simple linear regression equation which has so far been derived can be used for the estimation of the height. The Height is more if the arm span is more. This holds true for the sample size taken. ‘t’ test for regression coefficient was found to be statistically significant. It suggests that a significant contribution of arm span towards height. Two separate formulae were derived. The average height of adult males within a population is significantly higher than that of adult females. The results obtained in this study also show the similar results as that of previous studies.

In present study we have selected both sexes of 3 different age groups and the results a found to be correlation coefficient for group A (26-35), group B and Group C were 0.921, 0.956 and 0.956 respectively.

The result shows that there is Positive Correlation between stature and arm span. However the estimation of height using various physical measurements has been attempted by many authors. Chumlea in 1985, estimated stature from knee height [5], while Mitchel in 1982, correlated arm length with height [15]. The one variable that proved to be consistently reliable in estimating height was the arm span. Steele and Chenier in a study on black and white women in the age group 35–89 reported correlations of arm span and height of 0.852 and 0.903 for black and white women, respectively [24].

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 height. These results are almost similar to the correlation obtained in the present study. Simple linear regression equation so far derived by present study can be used for estimation of height. These are $y=0.666x+54.27$ for males and $y'=0.709x'+42.243$ of age group 26-35 year, $y=0.807x+28.68$ for males and $y'=0.688x'+44.50$ for females of age 36-45 year and $y=0.814x+24.88$ for males and $y'=0.7101x'+39.46$ for females of age 46-55 year, where y and y' are height and x and x' are arm span of males and females respectively.

Even though these relations are similar, the estimation equations which we obtained are clearly different from those of other populations. This emphasizes the need for developing separate models for each population group based on the racial and ethnic differences in anthropometric measurements.

5. Conclusion

It can be concluded that arm-span can be used in estimation of the height of both males and

females. Arm span is one of the most reliable body parameter for obtaining the stature of an individual.

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Conflict of interest – None

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