

## Estimation of stature from arm span using regression equation in Dehradun region

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### Abstract

**Background:** Stature can be easily estimated using various anthropometric parameters like arm span, facial dimensions, foot length and breadth, vertebral column length etc. Among these, arm span has been proven to be one of the most reliable predictors.

**Materials and Methods:** The study was conducted in Shridev Suman Subharti Medical College, Dehradun among a total of 100 healthy subjects (17-25 years), comprising 50 males and 50 females. Those with history of any fracture involving long bones or presence of any spinal deformity were excluded from the study. Stature and arm span was measured directly using anthropometric technique and measuring tape. The correlation between stature and arm span was determined and regression equations were calculated for stature estimation.

**Observations and Result:** There was a strong positive correlation between mean height and arm span in total subjects as well as in both sexes which showed statistical significance. ( $r=0.826$  for male,  $r=0.750$  for female;  $p<0.05$ ). Linear regression equations were obtained for total subjects as well as for both sexes for determination of stature.

**Conclusion:** Stature has a very high, positive correlation with arm span; regression equation can be easily calculated using these variables which can be used as a potential parameter in identification.

**Keywords:** Stature, Arm span, Identification.

### Introduction

Stature is one of the essential parameters of identification which is often calculated from anthropometric measurements such as long bones, facial dimensions, sternum, vertebral column length, length of scapula, limb and foot<sup>1,2</sup>. In situations when it is not feasible to measure stature due to deformities/ amputations of limbs or in unknown bodies where lower limb and / or trunk is absent; stature can be estimated using such parameters<sup>3,4</sup>.

These measurements represent certain relationship in the form of proportion to stature and once skeletal maturity is attained, they do not alter.<sup>1,5,6</sup> However, other factors such as inheritance, climate, nutrition also influence growth and development of an individual to a great extent including total height as well as length of long bones. Among the various parameters, arm span is considered to be the most reliable body indicator for predicting the body height of an individual<sup>7,8</sup>. In India, due to diversity of ethnic groups residing in varied climatic & ecological conditions, this relationship also varies from one region to another.<sup>1</sup>

### Materials and Methods

The study was conducted in Shridev Suman Subharti Medical College, Dehradun among 100 (50 males & 50 females) healthy students of the Institute, varying in age from 17-25yrs. Those having any spinal/ skeletal deformity, physical disability, past history of skeletal injuries affecting bones and those in any form of hormonal medications were excluded from the study. A written informed consent was obtained; procedure and purpose of study was explained to all the participants.

Stature was measured as the vertical distance from the vertex to the floor using a standard anthropometer. The subjects were made to stand erect on a horizontal resting plane, barefooted. Anthropometer was placed in straight vertical position behind the subject with the head oriented in the Frankfurt plane & shoulders & hips touching the vertical limb of the instrument. The movable rod of the anthropometer was brought in contact with the vertex in the midsagittal plane. Full length of both the arms, when outstretched horizontally (armspan) with both arms abducted to 90°, elbows and wrists extended and the palms facing directly forward, was noted using a measuring tape till tip of middle finger on each side. It was noted by a single observer, twice and an average was duly noted, to minimise subjective errors. Subsequently, using statistical software SPSS version 20, simple linear regression equations formulated for determining stature.

### Observation and Results

The study showed a positive correlation between mean height and arm span in total subjects as well as in both sexes. [Fig. 1-3] This correlation was found to be statistically significant as  $p < .05$  in all the parameters. ( $r=0.95$  for total,  $r=0.826$  for male,  $r=0.750$  for female) The males having stature of  $175.42 \pm 5.99$  cm had the arm span of  $179.54 \pm 6.84$  cm and females having stature of  $166.07 \pm 10.88$  cm had the arm span of  $168.66 \pm 12.51$  cm. Linear regression equation was obtained for total subjects as well as for both sexes from which stature can be calculated. [Table 1]

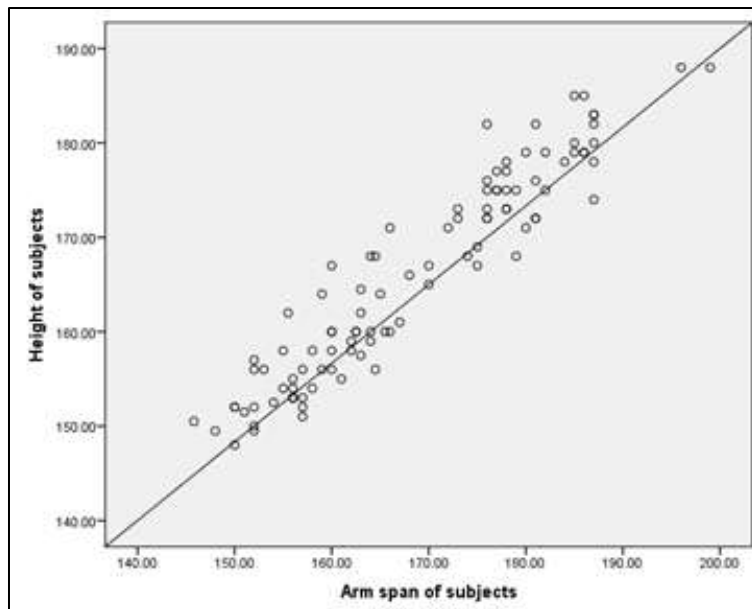


Fig. 1: Scatter diagram showing correlation in between height in total subjects and Arm span in total subjects

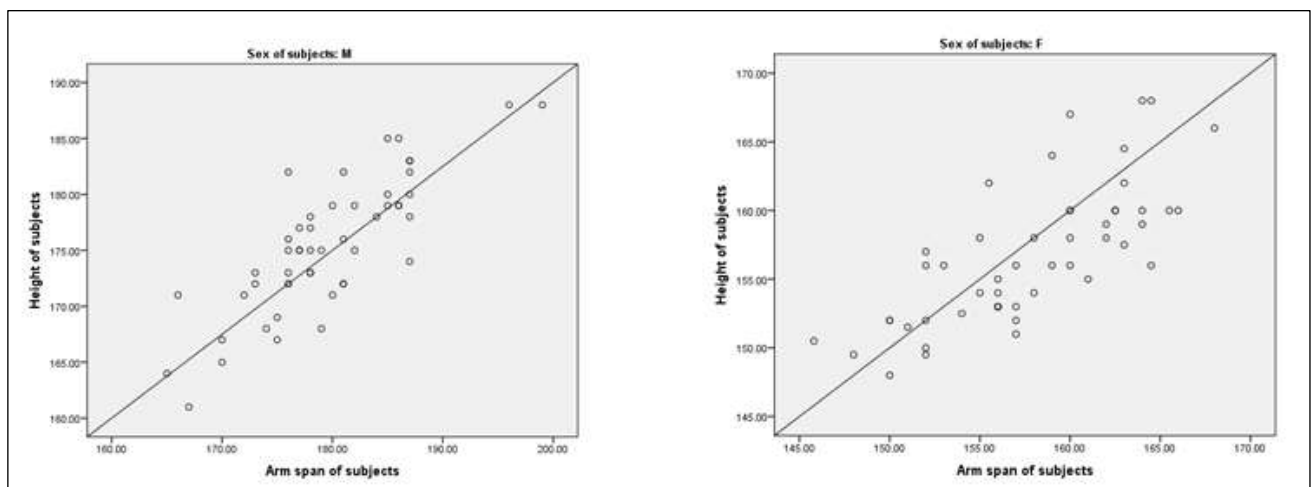


Fig. 2 & 3: scatter diagram showing correlation in between height and Arm span in male and female

Table 1: Regression analysis for predicting stature(y) of subjects (dependable variable) considering arm span as an independent variable

S. No.	parameter	mean	Std. deviation	Correlat ion value	p value	r square	Regression equation
Total subjects (n=100)	Mean height	166.07	10.88	.95	.00	.902	y=26.711+0.826 (arm span in total subjects)
	Mean arm span	168.66	12.51				
Male subjects (n=50)	Mean height	175.42	5.99	.826	.00	.683	y=153.706+6.003 (arm span in male subjects)
	Mean arm span	179.54	6.84				
Female subjects (n=50)	Mean height	156.73	5.00	.750	.00	.563	y=43.794+0.716 (arm span in female subjects)
	Mean arm span	157.78	5.24				

**Table 2:** comparison of studies by various authors

S.no.	Authors	year	Gender	Coefficient of correlation (r)	Regression equation (Y)
1	Present study	2019	Total	0.95	26.711+ 0.826 (AS)
			Male	0.826	153.706 + 6.003 (AS)
			Female	0.750	43.794+ 0.716 (AS)
2	Dongare SS et al	2017	Total	0.9187	34.752+0.7796 (AS)
			Male	0.8443	50.56+ 0.6865 (AS)
			Female	0.9187	34.752 + 0.7796 (AS)
3	Alam MT et al	2016	Total	0.798	48.91 + 0.703 (AS)
			Male	0.689	36.19 + 0.775 (AS)
			Females	0.783	60.68 + 0.630 (AS)
4	Sah RP et al	2013	Males	0.682	-
			Females	0.507	-
5	Chawla M et al	2013	Male	0.897	44.0912 + 0.9987(AS)
6	Goon TD et al	2011	Males	0.77	67.63 + 0.577(AS)
			Females	0.72	55.16 +.642(AS)
7	Zverev et al	2003	Males	0.871	-
			Females	0.815	-
8	Aggarwal et al	2000	Total	0.8226	33.837+ 0.776 (AS)
			Male	0.6473	50.818 + 0.681 (AS)
			female	0.7094	40.233 + 0.731 (AS)
9	Brown et al	2000	-	0.84	0.68 (arm span) – 3.55 (gender) – 3.81 (race) – 0.02 (age) + 55.34
10	Reeves et al	1996	Afrocaribbean male	Varying from 0.73 to 0.89	66.9 + 0.57 (AS)
			Asian male		81.0 + 0.48 (AS)

**Discussion**

A number of studies have been conducted demonstrating the positive correlation between arm span and height using regression analysis.<sup>6,10-17</sup> [Table 2] As depicted, the high values of regression coefficient signify that arm span is reliable and significantly predicts body height in all these studies; infact it is the closest physiologic measurement to standing height.

Though, most of the authors have taken only male population into consideration, our study involves both the sexes as well as the total population. Among those, who have taken both males and females into account, in studies by some authors<sup>10,14,15</sup> stature showed a better correlation in males as compared to females, which is in concordance with our study. While some authors<sup>18,19</sup> have reported that arm span is more accurate in females than in males. Still others have reported no differences between males and females.<sup>20</sup> However, only a few of the authors<sup>4</sup> failed to calculate any regression equation for estimating stature. [Table 2]

In our study, a wider age group was not considered; use of age as an additional predictor variable in the past studies shows a very small amount of variance in regression equations with no significant correlation between age and height arm ratio. There is considerable reduction in height with advancing age due to degenerative changes in the spine while the measure of arm span remains as such. Thus, age is not considered a major predictor for estimation of height from arm span.<sup>10,21,22</sup>

**Conclusion**

In situations when exact height cannot be determined directly due to deformities of lower limb, amputation or shortening as a result of fractures; arm span can be measured and stature can be easily estimated with high reliability from regression equation. This method is beneficial not only in forensic investigation but also in predicting age related loss of stature and in determining any disproportionate growth abnormalities along with calculation of basic energy requirements, standardization of measures of physical capacity and for adjusting dosages of drugs.<sup>4,6</sup>

**Ethical Clearance:** Obtained from Institutional Ethical Committee

**Conflict of Interest:** None

**Funding:** self

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