

# Relationship Between Arm Span and Human Stature

Arya Ajayan<sup>1</sup>, Rahnas Abdul Azeez<sup>2</sup>, Neeraj B<sup>3</sup>, Arathy Ajayan<sup>4</sup>

<sup>1</sup>Assistant Professor, Department of Forensic Medicine, KMCT Medical College, Manassery, Kozhikode, Kerala, <sup>2</sup>Assistant Professor, Department of Forensic Medicine, Govt. Medical college, Manjeri, Malappuram, Kerala, <sup>3</sup>Assistant surgeon, FHC Parassinikkadavu, Kannur, Kerala, <sup>4</sup>Junior resident, Azeezia Medical College, Meeyannoor, Kollam, Kerala.

**How to cite this article:** Arya Ajayan, Rahnas Abdul Azeez, Neeraj B et. al. Relationship Between Arm Span and Human Stature. Indian Journal of Forensic Medicine and Toxicology/Volume 19 No. 2, April - June 2025.

## Abstract

**Background:** Incomplete human remains may be recovered from crime scenes in some cases. Stature estimation from this remains may be very important in the personal identification of the corpse or living. If the stature could be estimated it can definitely narrow down the search in missing individual data base. This study was intended to find out correlation between arm span and human stature and to derive a regression model to find out human stature from arm span.

**Materials and methods:** This cross sectional study was conducted on 100 subjects, 50 males and 50 females aged between 21 and 60 years in the department of Forensic Medicine in Govt. Medical College, Thrissur.

**Results:** In females the average arm span is  $159.91 \pm 5.61$  cm, and mean height is  $157.44 \pm 4.93$  cm, correlation coefficient (r) is 0.8388. In males the average arm span is  $173.83 \pm 6.02$  cm and mean height is  $170.85 \pm 5.2$  cm, correlation coefficient (r) is 0.8934. Thus stature is strongly correlated with arm span. The knowledge of correlation between arm span and stature is important for identification of unknown bodies when a part of body with intact upper extremities on the axial skeleton is available and from that the height of the person can be calculated in situations like mass disasters- landslide, aeroplane crash, railway occurrence, animal attack, homicides with dismembered body etc and a comparison can be made with the available missing persons data. It can also be used for identifying stature in cases like amputation of the lower limb done due to various diseases and spinal deformities.

**Key Words:** Stature, arm span, upper extremities, forensic anthropometry, identity

## Introduction

Stature estimation from various skeletal elements has been an area of vital interest among researchers.<sup>1</sup> Many varieties of mathematical techniques were developed to derive stature from both living, dead and

skeletal remains. Trotter and Gleser method is among the mostly used techniques.<sup>2-4</sup> Identification and identity establishment makes an autopsy complete.

The need of stature identification becomes necessary in mutilated fragments, shattered remains,

**Corresponding Author:** Arya Ajayan, Assistant Professor, Department of Forensic Medicine, KMCT Medical college, Manassery, Kozhikode, Kerala.

**E-mail:**

**Submission date:** September 27, 2024

**Revision date:** Nov 5, 2024

**Published date:** 28 March, 2025

This is an Open Access journal, and articles are distributed under a Creative Commons license- CC BY-NC 4.0 DEED. This license permits the use, distribution, and reproduction of the work in any medium, provided that proper citation is given to the original work and its source. It allows for attribution, non-commercial use, and the creation of derivative work.

amputated and decomposed bodies collected from mass disasters like tsunamis, bomb blast, earth quakes, road traffic or aeroplane crash, war, landslide, flood etc. The importance and significance of cephalometry, craniometry, somatometry and osteometry for the identification of human remains have been described and later on a new term 'Forensic Anthropometry' was coined.<sup>5</sup>

The foundation from which anthropology has evolved includes the big 4s Age, stature, sex and race.<sup>6</sup> The key methods used for stature estimation are Mathematical and Anatomical methods. In the mathematical method it takes advantage of higher linear correlation between stature and long bones. One can use a regression equation with long bone as the independent or dependent variable that reflects the relationship between an individual's stature and the chosen bone. In anatomical method, which is commonly known as "Folly's method", stature is reconstructed by summing the measurements of skeletal elements which contribute the height and a correction factor is added for the soft tissues.<sup>7</sup>

Stature estimation from bones is a time consuming process which involves the preparation, cleaning and washing of bones. Because of this reason Forensic anthropologists are using percutaneous measurements instead of bone measurement. The measurement of arm span for identifying human stature can be added to the arsenal and the correlation between arm span and stature was found to be most reliable.<sup>8</sup>

Arm span is the maximum distance between the tips of the longest fingers of both hands when the person extends both arms at the level of the shoulders. Stature is the distance measured from the point where the heel touches the floor to the highest point of head when the person is in erect position.<sup>9</sup> This study was done to find out the relationship between arm span and human stature. Another purpose of the study was to derive a regression equation to find out stature from arm span. Studies had been conducted by Agnihotri AK et al, Sen J et al and Saco-Ledo G et al to know the correlation between stature and foot length, stature and foot breadth, stature and tibial length.<sup>10-12</sup> Investigators like Gardasevic J et al, Arifi F et al and Supare MS et al had conducted studies to find out relationship between arm span and stature.<sup>13-15</sup> Study by Mohan Kumar S and Kamate V among farm workers of North

Karnataka region shows that there were differences in body dimensions from the anthropometric data of other part of India.<sup>16</sup> We have conducted this study among students and staff at Govt. Medical college, Thrissur, Kerala to find out correlation between arm span and stature and to find out a regression formula to detect stature from arm span.

#### **Objectives:**

1. To find out relationship between arm span and stature of an individual.
2. To formulate a regression model to predict stature of an individual from arm span.

#### **Materials and Methods**

This is a cross sectional study on 100 subjects, 50 males and 50 females aged between 21 and 60 years in the department of Forensic Medicine in Govt. Medical College, Thrissur. Sampling technique used was simple random sampling. Subjects were taken in the age group of 21-60 years as to include the persons whose ossification centres are completely fused.

#### **Inclusion criteria:**

All Staffs and post graduate students over age 21.

#### **Exclusion criteria:**

1. Subjects with apparent symptomatic diseases, deformities, fracture, amputation or history of any surgical procedures of upper limbs.
2. Who are not willing to participate in the 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 touch the rod of stadiometer (in Frankfurt plane). The arms were hung freely by the sides. Reading was taken from the stadiometer scale at the vertex point (highest point on their head) with sensitivity 0.5 cm. The reading was taken three times and their average value was taken.

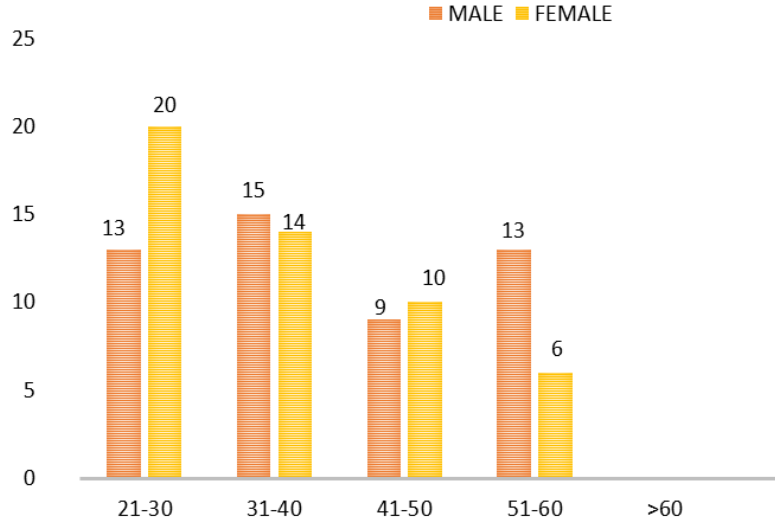
#### **Measurement of arm span.:**

It was measured using a measuring tape up to 5mm accuracy. Arm span was measured as the distance between tip of middle fingers on the stretched upper limbs.

**Results**

**Table 1. Total study population**

Individuals analysed	
No. of males	50
No. of females	50
Total	100



**Figure 1: Age wise distribution of study population.**

The age group of the female subjects ranged from 21 years to 60 years with the mean age of  $35.54 \pm 8.49$  SD. The age group of male subjects ranged from 21 years to 60 years with the mean age of  $37.39 \pm 9.58$  SD. Majority of the subjects belongs to the age group 21-30 years. Even though there are more women in the 21-30 age group and less women in the 51-60 age group this would not have impact on the finding because of the fact that in both these cases ossification centres are fused and height and arm span remain constant.

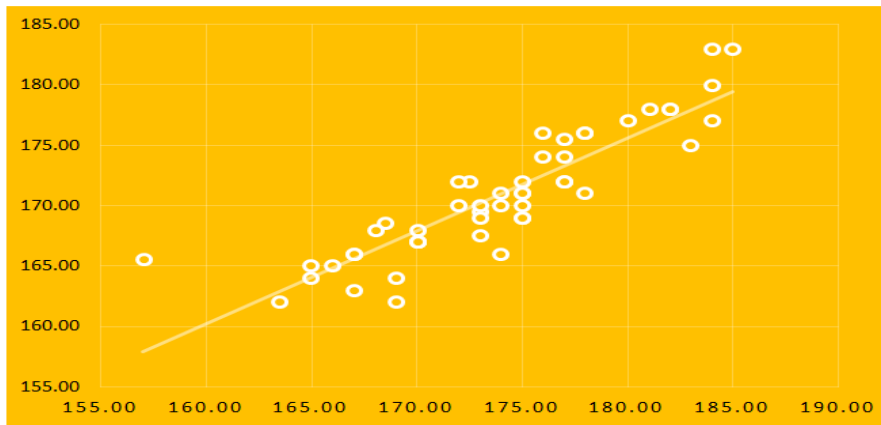
Arm span and height were calculated by standard procedure.

The height of subjects varies from 144 cm to 183cm with mean height of  $164.15 \pm 8.42$  SD

Arm span varies from 146 cm to 185 cm with mean of  $166.87 \pm 9.08$  SD.

**Correlation between arm span and stature**

In males the mean arm span is  $173.83 \pm 6.02$  cm. Correlation coefficient (r) is 0.8934



**Figure 2. Correlation between arm span and stature in males**

In females the mean arm span is 159.91 ± 5.61 cm.

Correlation coefficient (r) is 0.8388.

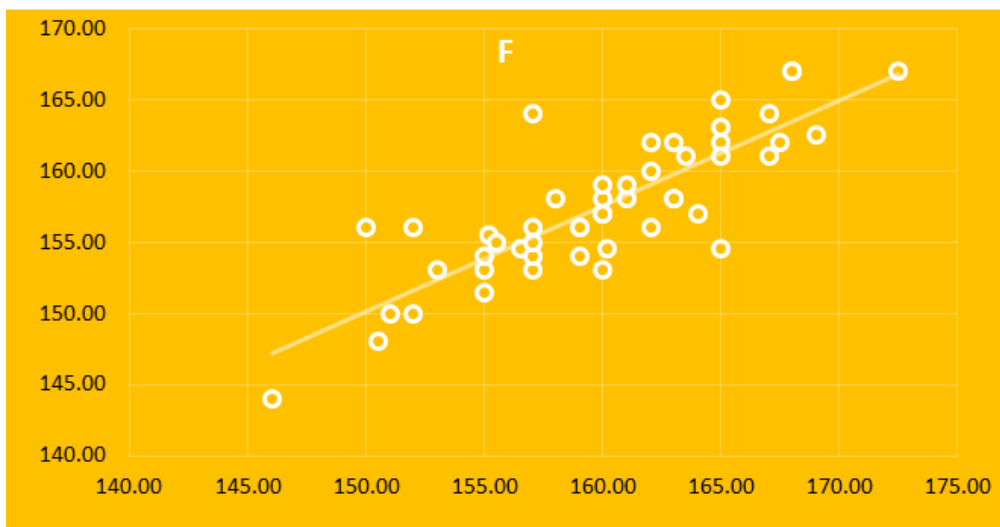


Figure 3. Correlation between arm span and stature in females

In males and females combined, the mean arm span is 166.87±9.08 SD

Correlation coefficient is (r) is 0.9483

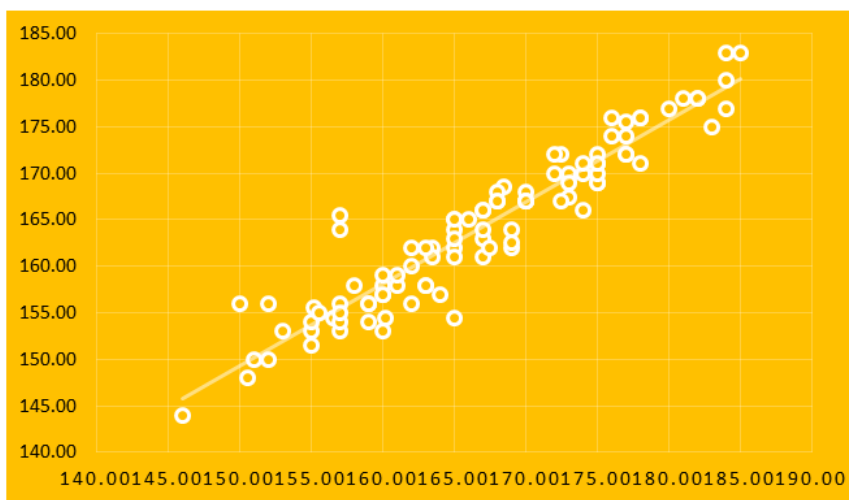


Figure 4. Correlation between arm span and stature in males and females combined

Table 2: Correlation coefficient of males and females

Correlation coefficient (r)	
Correlation coefficient (r) in males	0.8934
Correlation coefficient (r) in females	0.8388

**REGRESSION EQUATION**

- The Regression equation

Height of individual (Y) =intercept (a) + slope (b) x X,

Where, X = Arm span

Y= Height of individual

- The regression equation for individuals(including both males and females) was found to be:

$$\text{Height of individual} = 17.475 + 0.87895 \times X$$

P values, P < 0.001, SE for intercept (a) = 4.966, SE for slope (b) =0.03

**Regression equation for males**

$$Y = 36.788 + 0.771 X$$

Subject Regression coefficient Standard error-p-value

Male 0.7710.056 < 0.0001

Constant = 36.778, SE=9.735, P < 0.0001

**Regression equation for females**

$$Y = 39.393 + 0.738 X$$

Subject Regression coefficient Standard error p-value

Female 0.7380.069 < 0.0001

Constant = 39.393 SE = 11.064, P < 0.0001

**Discussion**

This study was designed to show the relationship between human stature and arm span and also to formulate a regression model to estimate stature from arm span. It was conducted among 100 subjects between 21 and 60 years of age in Govt. Medical College, Thrissur.

50 males and 50 females (total of 100 subjects) were analysed during the study period of one year. The mean age of females in the present study was  $35.54 \pm 8.49$  SD and majority belongs to the age group 21-30 years. The mean age of males in the present study was  $39.24 \pm 10.30$  SD and majority belongs to the age group 21-30 years.

Stature of males varies from 162 cm to 183 cm; the mean stature was  $170.85 \pm 5.20$  SD.

The stature of females varies from 144 cm to 167 cm; the mean stature was  $157.44 \pm 4.93$  SD.

The stature of males and females taken together varies from 144 cm to 183 cm and the mean stature of the same was  $164.15 \text{ cm} \pm 8.42 \text{ cm}$ .

The arm span ranges from 146 cm to 185 cm with mean of  $166.87 \text{ cm} \pm 9.08 \text{ SD}$ . The arm span in females ranges from 146 cm to 172.50 cm with mean of  $159.91 \pm 5.61 \text{ SD}$ .

The arm span when the males and females taken together ranges from 146 cm to 185 cm with mean of  $166.87 \text{ cm} \pm 9.08 \text{ SD}$ .

The present study showed that there is statistically significant correlation between stature and arm span in both sexes. The correlation coefficient (r) in males is 0.8934. The correlation coefficient in females were 0.8388. The correlation coefficient when males and females taken together is 0.9483.

The presence of sexual dimorphism of anthropometric parameters were considered in the study and the results in this study showed that there was statistically significant difference in mean value of the measurement. Different regression equations are necessary for estimation of stature from arm span in both sex groups. Sexual dimorphism in height and arm span measurements can be due to environmental, hereditary or other hormonal impacts. Estrogen and progesterone play a vital role in closure of growth plates in long bones. They also play a part in the secretion of growth hormones.

The findings of the present studies were in agreement with numerous previous studies. Study by Gardasevic J et al concluded by saying that relation between arm span and stature is high and significant in their study sample, and the arm span is apparently a reliable indirect anthropometric measurement used for estimating stature in males from the Federation of Bosnia and Herzegovina.<sup>13</sup> Study by Arifi et al reached conclusion that arm span reliably predicts stature and has a high value of correlation with validity of 95% in male as well as female, which have given very high value (0.776 and 0.688) of correlations between them.<sup>14</sup> Study by Supare MS et al among medical students of Maharashtra found correlation coefficient (R) of 0.89 in male and 0.90 in female and concluded that there was a strong correlation between stature and arm span.<sup>15</sup>

**Conclusions**

There was statistically significant correlation between arm span and human stature. The regression equation formulated from arm span is a best indicator of stature. There were no statistically significant difference between estimated and actual stature in female and male subjects in the study.

In conclusion, stature can be estimated when the measurement of arm span is possible. The regression equation derived can be used in cadavers with fairly

accurate results. This can be helpful in medico-legal cases as well as in anthropology studies. This study demonstrate that the stature and arm span is significantly higher in males when compared to females.

A direct relationship was observed between these measurements in both males and females. The regression equations for estimation of stature from arm span is  $Y = 36.788 + 0.771 X$  for males and  $Y = 39.393 + 0.738 X$  for females, where X is the arm span. The regression equation and slope obtained correlate with previous studies. There was difference in slope and intercept of the equation which is suggestive of ethnic and racial variations of the individuals. Similar studies should be conducted in different geographical locations and among different population groups in view of previously described variations. The possible limitation of study was that only one geographical location was used that is Govt. Medical college, Thrissur. This may affect the generalizability of the test results when applied to other geographic locations. However in future this regression equation derived could be tested on different populations to validate their accuracy across ethnic groups.

**Ethical clearance:** Institutional Ethics committee, Order No:B6-155/2019/MCTCR(28), Date:20/12/2019, Govt. Medical college, Thrissur

**Source of funding:** self

**Conflict of interest:** Nil

### References

1. Manouvrier L. Stature estimation from the measurements of the hand and the second metacarpal bone. *Rev EcAnthropol.* 1892;2:227-33.
2. Trotter M, Gleser GC. The effect of aging on stature. *Am J Physicians Anthropol* 1951;9:311-24.
3. Trotter M, Gleser GC. Estimation of stature from long bones of American whites and Negroes. *Am J Physical Anthropol* 1952;10:463-514.
4. Trotter M, Gleser GC. A re-evaluation of estimation of stature based on measurements of stature taken during life and of long bones after death. *Am J Phys Anthropol* 1958;16(1):79-123.
5. Klepinger LL. *Fundamentals of forensic anthropology.* John Wiley & Sons; 2006 Jun 23.
6. Mohanty BB, Agrawal D, Baisakh P, Samantsinghar P, Kumar S, Chinara PK. A study of different parameters of human extremities and its relationship with human height in residents of eastern India. *Tanta Medical Journal.* 2015 Jan 1;43(1):1.
7. Krishan K. Anthropometry in forensic medicine and forensic science-'Forensic Anthropometry'. *The Internet journal of forensic science.* 2007;2(1):95-7.
8. Shah RK, Nirvan AB, Patel JP, Patel B, Kanani S. Estimating Stature From Arm Span Measurement in Gujarat Region. *GCSMC J Med Sci.* 2013; 2(2):13 30-32.
9. Lohman TG, Roche AF, Mattorell R. 'Segment Length', *Anthropometric Standardization Reference Manual,* Human: Kinetics Publishers Inc, Illinois: 1988. pp18-20.
10. Agnihotri AK, Purwar B, Googoolye K, Agnihotri S, Jeebun N. Estimation of stature by foot length. *Journal of forensic and legal medicine.* 2007 Jul 1;14(5):279-83.
11. Sen J, Ghosh S. Estimation of stature from foot length and foot breadth among the Rajbanshi: an indigenous population of North Bengal. *Forensic Science International.* 2008 Oct 25;181(1-3):55-e1.
12. Saco-Ledo G, Porta J, Duyar I, Mateos A. Stature estimation based on tibial length in different stature groups of Spanish males. *Forensic science international.* 2019 Nov 1;304:109973.
13. Gardasevic J, Rasidagic F, Krivokapic D, Corluka M, Bjelica D. Stature and Its Estimation Utilizing Arm Span Measurements in Male Adolescents from Federation of Bosnia and Herzegovina Entity in Bosnia and Herzegovina. *Montenegrin Journal of Sports Science & Medicine.* 2017 Mar 1;6(1).
14. Arifi F, Sermahaj S, Gardasevic J, Alaj I, Metaj Z. Stature and its estimation utilizing arm span measurements of both gender adolescents from southern region in Kosovo. *Sport Mont.* 2018 Jun 1;16(2):51-4.
15. Supare MS, Bagul AS, Pandit SV, Jadhav JS. Estimation of stature from arm span in medical students of Maharashtra, India. *Annals of Medical and Health Sciences Research.* 2015 May 26;5(3):218-
16. Mohan Kumar S, Kamate V. Anthropometric Data of Farm Workers of North-Karnataka Region of India and its Practice for Better Design of Agricultural Tools and Implements. *J Robot Mech Eng Resr.* 2019;3(2):8-21.