

## ORIGINAL ARTICLE

# Determination of Multiplication Factor to know the Height using the Combined Length of Forearm and hand in Dead Bodies at Indore Central India

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## Abstract:

Like other phenotypic traits, stature is ascertained through the integration of genetic, environmental, and demographic factors. It has been underscored that the associations between various bodily parameters manifest variances across populations due to dissimilarities in nutrition, levels of physical activity, and environmental influences, which serve as modulatory factors. Moreover, racial and ethnic disparities exert a noteworthy influence on genetic expressions. The intricate relationship between genetic potential and environment is multifaceted and is the fundamental determinant of stature. Stature exhibits sexual dimorphism and adheres to a relatively normal statistical distribution. Stature prediction occupies a central position in anthropological research and the identification procedures mandated by medical jurisprudence or necessitated by medico-legal experts. Hence, it assumes significance for both medico-legal and humanitarian purposes. The present study was conducted to know the multiplication factor for estimating stature. The anthropometric measurements of the combined length of the forearm plus hand and height were taken using “standard anthropometric measuring instruments” in centimetres<sup>1</sup>. The data were recorded carefully up to mm for accuracy and then analysed with associated factors, and appropriate tests were applied to test the statistical significance. The value of  $<0.05$  was considered statistically significant to interpret the findings. In the present study, the M/F ratio was 1:1. The mean stature was  $163.45 \pm 5.38$  cm in male subjects, whereas, in female subjects, the mean stature was  $142.27 \pm 5.34$  cm. The males were found to be taller than females, with the bisexual differences being statistically significant ( $p < 0.001$ ). This study helps to know the multiplication factor that may be used for stature estimation in the population of Indore. Definite proportion exists between all individuals' stature and the combined length of the forearm and hand. These multiplication factors are derived for males 3.58 and females 3.78. statistical analysis.

**Keywords:** Identification; Anthropometry; Stature; Forearm and hand; Multiplication factor.

## Introduction:

Estimation of stature from the incomplete skeletal remains or the mutilated or amputated limbs or parts of limbs or highly decomposed, fragmented human remains has obvious importance in personal identification of the individual in the events of murders, accidents or natural disasters considered as one of the most significant aspects of forensic science.<sup>1</sup> It is the single most portable, universally applicable inexpensive and non-invasive technique for measuring the length of the forearm and hand. Stature is one of the most essential and primary elements in formulating the biological profile during the process of personal identification of an individual. Stature is one of the key parameters established in the course of identification of unknown skeletal remains.<sup>2</sup> As all individuals differ in their measurable traits, therefore stature estimation by anthropometry

is paramount for giving quantitative expression to variations of such traits. Ascertaining sex and estimating stature from incomplete skeletal remains and decomposing bodies is a recurring theme in physical anthropology and forensic science.<sup>3,4</sup> In most advanced countries, documented skeletal remains are available to forensic experts. In India, recorded skeletal remains are not available for establishing the norms of stature reconstruction. In the absence of documented skeletal material, the researchers have focused their attention towards living population groups of India and have taken relevant bone length over the skin and correlated them with the stature to find out the degree of relationship between them and subsequently formulated multiplication factor for long bones and their fragments for the reconstruction of stature.<sup>5</sup> Thus, the studies conducted by researchers.<sup>5-8</sup> in India pertains to the use of percutaneous measurement of long bones and their fragments for the reconstruction of stature. Some of the studies<sup>6,9,10</sup> have reported a significant difference in the proportion of the limb bone dimensions due to the population's environmental, hereditary and dietary factors, and have influenced a person's stature. In a vast country like India, the climatic condition and nutritional habits of different regions vary considerably, in

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**Table 1. Multiplication factor.**

The ratio of height and average of combined length of forearm and hand	Male	Female
Minimum	3.42	3.67
Maximum	3.73	3.77
Average	3.58	3.72

**Table 2. Study of comparison of multiplication factor of combined length of forearm and hand for both male and female with other studies.**

S. No.	Authors	Multiplication factor male	Multiplication factor female
1.	Kumar Amit et al. (2010)	3.67	3.73
2.	Kumar Sushil et al. (2010)	3.899	--
3.	Choudhary et al. (2014)	3.665	3.664
4.	Jain et al. (2015)	3.68	3.73
5.	Banik et al. (2016)	3.89	3.79
6.	Present study	3.58	3.72

addition to the racial and ethnic variation. It is opined that the study of residents of one state is not necessarily applicable to residents of another state.<sup>11</sup> Due to improved socioeconomic conditions, the population, especially in India, is getting taller, and the relationship between height and length of long bones is changed. Hence, fresh formulae are needed for generation.<sup>12,13</sup>

The lack of anthropometric data concerning the local population of Indore was felt as the city is prone to mass disasters like bomb blasts, and accident. Hence the present study was aimed at & concentrated on the Indian population of Indore of known stature, of which anthropometric measurements of the combined length of forearm and hand were calculated & correlated with stature to find the multiplication factor.

#### Material and methods:

The present Cross-Sectional study was carried out on a sample of 400 deceased individuals in the Department of Forensic Medicine mortuary, Mahatma Gandhi Memorial Medical College and M.Y. Hospital, Indore (M.P.). In the present study, a convenient sampling procedure was done. We examined 200 deceased males and 200 deceased females. The study included individuals who were 21 years of age or older. Exclusion criteria were skeletal abnormalities, deformities, amputated lower limbs, and mutilated and decomposed bodies. Written informed consent was taken before the research after giving detailed information to the relatives of the deceased regarding the study. Detailed individual demographic data, including the height, sex, age etc., were also recorded on the pre-structured proforma. Anthropometric measurements of the combined length of the forearm and hand on the left and right side of each consented individually down height were also recorded. All the measurements were taken in daylight. The measurements were taken twice for accuracy.

Stature is measured as the vertical distance between the vertex and the heel in the mid-sagittal plane, where the vertex is the highest point on the head when the head is held in Frankfurt Horizontal (FH) plane using Standard measuring tape.

The length of the Forearm and hand was measured between the tip of the olecranon process of the ulna and the tip of the middle finger of the hand of the subjects using a sliding calliper as well as

a standard measuring tape. The measurements were taken where the pronated and forearm were placed on flat, hard, and horizontal surfaces with extended and abducted fingers but without any abduction adduction, flexion or extension of wrist joint so that the forearm was directly in longitudinal axis with the middle finger.

Multiplication factors were calculated to evaluate ratio of the average height of the individual and the average combined length of the forearm and hand.

#### Observation & results:

Distribution of anthropometric parameters for age, the mean age of the male and female subjects was  $43.25 \pm 13.85$  years and  $38.57 \pm 14.70$  years, respectively. The range of the age in male subjects was 21 to 80 years. The range of the age in female subjects was 21 to 90 years. The maximum sample came in the age group 21-30 years in females and 51-60 years in Males.

Furthermore, multiplication factor calculation and comparison with other studies were done in Table No. 01 and 02, respectively. These multiplication factors are derived for males 3.58 and females 3.78. statistical analysis is used to know the relation between height and the combined length of the forearm and hand.

#### Discussion:

The male subjects' mean height was  $163.45 \pm 5.38$  cm, with the maximum reported height being 179.50 cm and the minimum reported height being 153.6 cm. Therefore, the height range for male subjects in this study was 153.6 to 179.5 cm. It is important to note that the study conducted by M.R. Shende population of Maharashtra state of India.<sup>14</sup> The height range for male subjects in that study was reported to be 153.4 to 189.2 cm, with a mean height of 170.12 cm and a standard deviation of 6.99 cm. The observed subjects in that study were between 18 and 22 years old. While the minimum reported height was the same in both studies, it is worth noting that the maximum reported height in the study conducted by M.R. Shende was approximately 10 cm greater. This difference could potentially be attributed to the narrower age range of subjects in the current study compared to the age range in the study conducted by M.R. Shende.<sup>14</sup>

Moving on to the female subjects, the mean height observed in this study was  $142.27 \pm 5.34$  cm. The range in height for the female subjects was reported to be from 145.0 to 167.3 cm. Comparatively, in the study conducted in Maharashtra, Indian female subjects had a height range of 140.8 to 174.0 cm, with a mean height of 156.15 cm and a standard deviation of 11.10 cm, which were higher than the findings in our study.<sup>14</sup> Furthermore, another study conducted in Jammu, India, found slightly higher heights for both males and females, with observed heights of  $169.76 \pm 6.23$  cm for males and  $155.21 \pm 5.32$  cm for females.<sup>15</sup> These findings suggest that there is height variation in different parts of India. It is worth noting that males were found to be, on average,  $21.18 \pm 5.38$  cm taller and had more extended hands than females. These differences between sexes were statistically significant ( $p < 0.001$ )(14–17). Various studies have consistently shown that males tend to be taller than females.

In the present study, the mean age of male subjects was 43.25 years, while the mean age of female subjects was 38.57 years.

Thus, the mean age of males was higher than that of females. The multiplication factor, which represents the stature ratio to the combined length of the forearm and hand, has been calculated and observed in males and females. In males, the range of the multiplication factor was found to be between 3.42 and 3.73, with an average of 3.58. In females, the range was between 3.67 and 3.77, with an average of 3.72. The multiplication factor serves as a convenient tool, particularly in situations where forensic investigators may not be well-versed in complex mathematical equations or when dealing with many cases, such as mass disasters or incidents involving victims of terrorist attacks. The table reveals that previous studies conducted by Kumar Amit et al. (2010),<sup>16</sup> Jain et al. (2014),<sup>18</sup> and Choudhary et al. (2014)<sup>15</sup> have reported similar multiplication factors of 3.67, 3.68, and 3.66, respectively, in males. However, Kumar Sushil et al. (2010)<sup>16</sup> and Banik et al. (2016)<sup>19</sup> found a higher multiplication factor (3.89) in males, which contrasts with the findings of the present study. Regarding females, our study demonstrated a similar multiplication factor (3.72) for the combined length of the forearm and hand compared to other studies, such as Kumar Amit et al. (2010).<sup>16</sup> Jain et al (2015),<sup>18</sup> Banik et al (2016)<sup>18</sup> (Table-02).

Full form of mnemonic used in study-

HT- Height.

RCLF & H- Right combined length of forearm and hand.

LCLF & H- Left combined length of forearm and hand.

Avg CLF & H- Average combined length of forearm and hand.

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