

## Anthropometric Measurements of Hand Length and Breadth for Estimation of Stature in South Indians

Perugu Vanishri<sup>1</sup>, Nishat Ahmed Sheikh<sup>2</sup>

### Abstract

**Background:** Anthropology is the study of humans, subdivisions are the cultural anthropology and biological anthropology, and stature estimation is an important parameter in forensic examination for identification of skeletal remains. **Objective:** To evolve a regression equation to calculate stature from hand lengths and breadths using statistical methods in the south Indian region. **Study Design:** Cross Sectional Study. **Place of study:** Study was conducted in the department of Forensic Medicine, Government Medical College Mahbubnagar State Telangana. **Methods:** The present study consists of a cross-sectional sample of 192 subjects (96 males and 96 females) aged from 19 to 26 years. **Observation and Discussion:** Stature in male was  $169.98 \pm 1.99$  and in female was  $156.07 \pm 2.09$ . It is observed that males have greater stature than females, and it was statistically significant. In our study the stature estimated in male was  $169.98 \pm 1.99$  cm and in female was  $156.07 \pm 2.09$  cm. It is concluded that males have greater stature than females. This phenomenon can be explained by the genetic constitution of male's age of puberty being 2 years later in males as compared to females give them additional time for growth. **Conclusion:** In this study we have derived regression equations and multiplication factors to estimate stature from hand length and breadth for south Indian population from Mahbubnagar region.

**Keywords:** Hand Length; Hand Breadth; Regression equations; Stature.

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### Introduction

Anthropology is the study of humans, subdivisions are the cultural anthropology and

biological anthropology, and stature estimation is an important parameter in forensic examination for identification of skeletal remains. In dead unknown bodies and mass disaster scenario where few parts of bodies might be available the objective of post-mortem examination that is Identification becomes more important [1]. Stature measurement is required for assessment of child growth, calculation of nutritional indices [2] for prediction and standardization of physiological parameters such as lung volumes, muscle strength, glomerular filtration rate and resting metabolic rate and for adjustment of drug dosage as apart from Identification. However, in few cases it is being observed that stature measurement is too difficult as well in certain situation it is almost impossible, reasons may be due to deformities of the trunk or legs, lower limb amputation and in few patients who are not able to stand [3-8].

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The comparison of different population, it is essential to have stature measurements, stature represents the length of the body from the head to foot when standing. Usually it is done by measuring the length of long bones. It can also be done by measuring short bones of the hands and feet. A point of focus for various researchers, anthropologist and anatomist is the dimensional relationship between various body segments and stature for several years [9]. In this regards many sets of regression equation have been developed and the better known are Karl Pearson from Western countries and Singh and Sohal (1952) from India [10]. Earlier researchers had reported the effectiveness of using hand length and hand breadth in estimating stature [9,10]. Earlier studies on stature estimation which are available are applicable to only specific population group and hence cannot be considered generalized to other populations, it is because of variations in genetic and environmental factors, hence it becomes necessary to have stature estimation methods to the different ethnic groups.

So there is the diversity and difference in anthropometric measurements in various different geographical areas racial, ethnic variations are well-known and prominent in India, hence region wise study seems to be necessary. Various studies are done to measure the stature from foot length, limb length, and long bones but only few studies are available on hand lengths and breadth. The hand length and breadth reflects significant correlation with the stature, so in this present study we made an effort to evolve a regression equation to calculate stature from hand lengths and breadths using statistical methods in the south Indian region as there are very few studies and such data available. This study will surely be of a great value in conditions where only a hand or a part of hand is available for identification of a person.

## Materials and Methods

*Place of Study:* Study was conducted in the department of Forensic Medicine, Government Medical College, Mahbubnagar, State Telangana.

*Study Design:* Cross Sectional Study

*Procedure:* The present study consists of a cross-sectional sample of 192 subjects (96 males and 96 females) aged from 19 to 26 years. Subjects were selected irrespective of their caste, religion, dietary habits and socio-economic status. Sufficient permissions and consents are procured before the measurements of the subjects are taken and

clearance from the Institutional Ethical committee is obtained in advance. Stature; using the stadiometer, the subject was made to stand barefoot in the standard standing position on its baseboard. Both feet are in close contact with each other and head oriented in Frankfurt's plane. The height was then recorded in centimetre from the standing surface to the vertex in the weight bearing position of foot.

### *Hand length*

Subject placed their hand in supine position on a flat hard table and the measurements were taken using digital vernier callipers. The hand length is measured from distal transverse crease of wrist to tip of middle finger [11].

### *Hand breadth*

Subject placed their hand in prone position on the flat hard table, and the measurements were taken using digital vernier callipers. The hand was placed on a flat table with the fingers together and the thumb out to the side, with a sliding digital vernier calliper the breadth of the hand was measured at the level of the knuckles. The hand breadth was measured as a distance between the radial side of 2<sup>nd</sup> metacarpophalangeal joint to the ulnar side of 5<sup>th</sup> metacarpophalangeal joint [11]. The measurement of height and hand length, breadth was carried out at a particular period of time 10 am to 1 pm to avoid diurnal variations.

### *Inclusion criterion*

Only those subjects who were born & brought up in south India were included in the study.

### *Exclusion criteria*

Subject morphologically showing the congenital malformations, Dwarfism/Achondroplasia, features of nutritional deficiencies and injuries to extremities were not included in the present study. Subjects from other regions, NRI, those with poorly defined wrist creases, deformities of vertebral column & limbs, and history of trauma were excluded from the study.

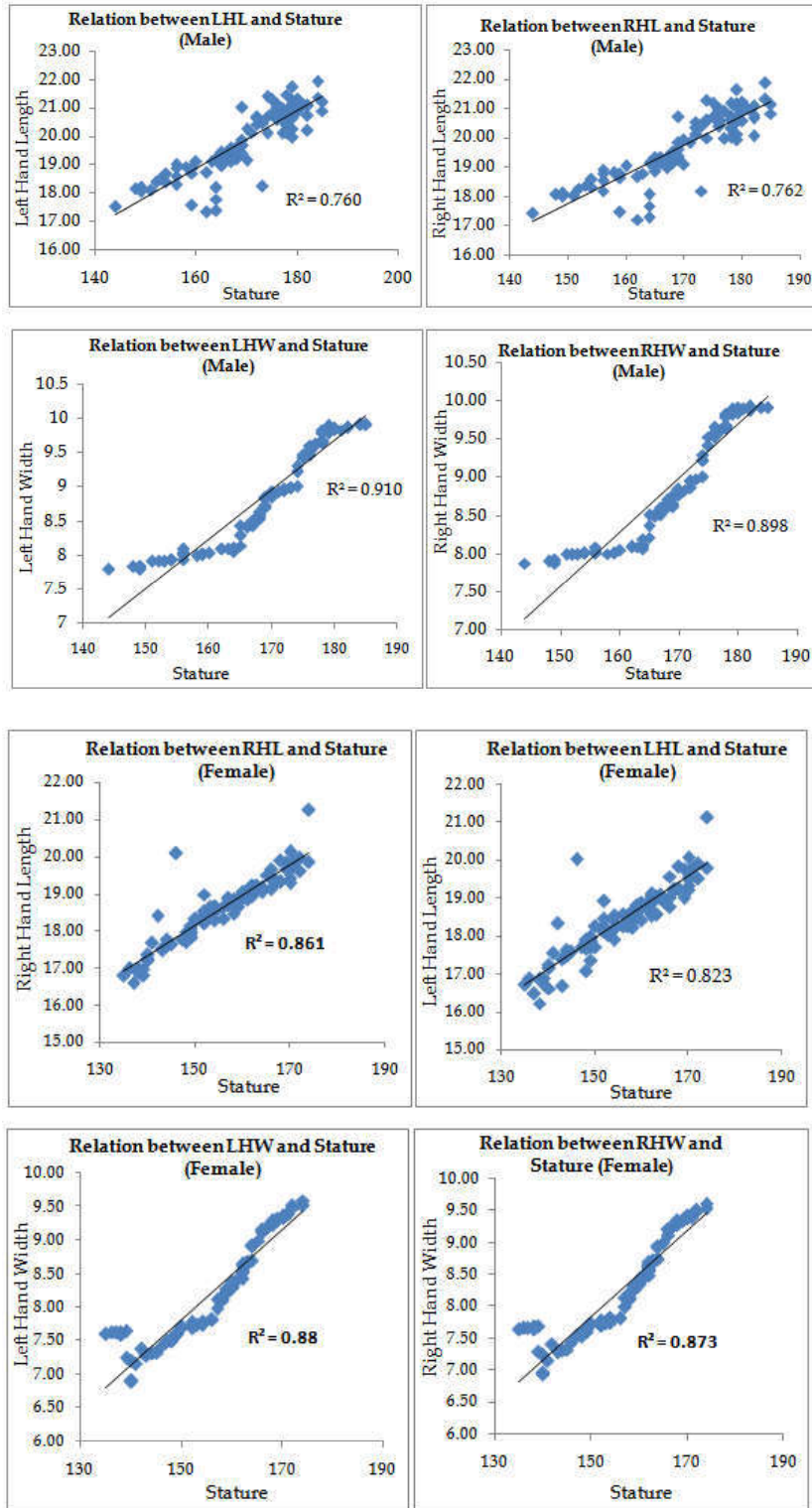
### *Data Analysis*

In Digital Vernier calliper, Length = reading of the main scale + Vernier coincidence x Vernier constant + mechanical error. (Here Vernier constant = 0.01 and mechanical error = 0) Calculation of stature using regression equation: Stature = value

of constant + regression coefficient x Hand length and Breadth. Value of the constant and regression coefficient was calculated using SPSS Version 19 program. The regression equation thus calculated, to find significant difference between estimated and

predictive value. The statistical data so obtained i.e. Mean SD, p value and t test were compared to see validity of equations.

**Results**



**Fig. 1:** Scatter diagram and regression line showing the relationship between stature and hand length and breadth in Males.

**Fig. 2:** Scatter diagram and regression line showing the relationship between stature and hand length and breadth in Females.

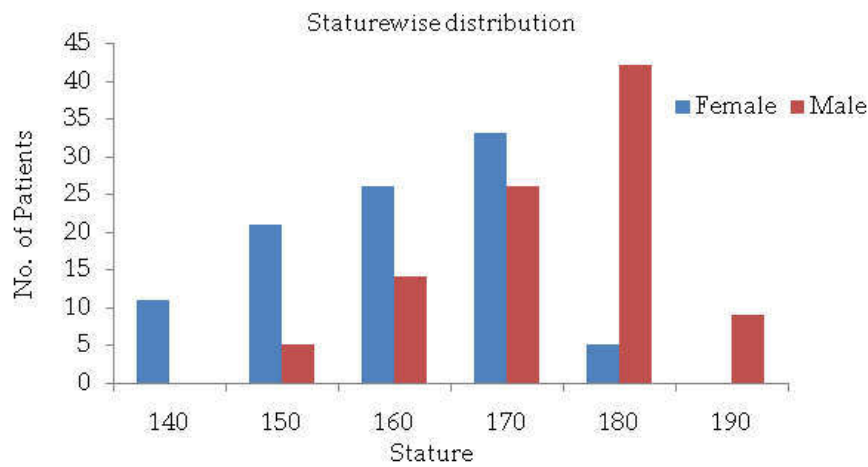


Fig. 3: Stature wise distribution

Table 1: Gender wise various parameters

Characters		Male	Female	Combine (M + F)
Age	Min	19	19	19
	Max	26	26	26
Stature	Min	144	135	134
	Max	185	174	185
Left Hand Length	Min	17.34	16.22	16.22
	Max	21.94	21.12	21.94
Right Hand Length	Min	17.21	16.59	16.59
	Max	21.86	21.25	21.86
Left Hand Width	Min	7.8	6.89	6.89
	Max	9.92	9.59	9.92
Right Hand Width	Min	7.88	6.93	6.93
	Max	9.93	9.59	9.93

Table 2: Gender wise comparison of parameters

Variables	Mean		Standard Deviation		Confidence Interval		P-Value
	Male	Female	Male	Female	Male	Female	
Age	22	22.5	2.4	2.29	22 ± 0.5	22.5 ± 0.46	0.7856
Stature	169.98	156.07	9.96	10.46	169.98 ± 1.99	156.07 ± 2.09	0.0032
LHL	19.88	18.43	1.15	0.95	19.88 ± 0.23	18.43 ± 0.19	0.04341
RHL	19.74	18.63	1.14	0.92	19.74 ± 0.23	18.63 ± 0.18	0.0412
LHW	8.96	8.22	0.75	0.75	8.96 ± 0.15	8.22 ± 0.15	0.03978
RHW	8.99	8.24	0.75	0.76	8.99 ± 0.15	8.24 ± 0.15	0.040023

Table 3: Correlation between hand length breadths with stature

Variables		Stature	p Value	p Value
Left Hand Length	Male	0.8722	3.07726E-31	0.00000001
	Female	0.9077	1.27843E-37	0.00000001
Right Hand Length	Male	0.8729	2.408E-31	0.00000001
	Female	0.9284	1.10885E-42	0.00000001
Left Hand Width	Male	0.9543	9.39338E-52	0.00000001
	Female	0.9381	1.31314E-45	0.00000001
Right Hand Width	Male	0.9476	5.63072E-49	0.00000001
	Female	0.9345	1.80578E-44	0.00000001

In our study of 192 enrolled subjects, males were 96 and females were 96. All subjects were in a range of 19 to 26 years. Stature in male was  $169.98 \pm 1.99$  and in female was  $156.07 \pm 2.09$ . It is observed that males have greater stature than females, and it was statistically significant ( $p < 0.0032$ , 95% confidence interval [CI] =  $169.98 \pm 1.99$  &  $156.07 \pm 2.09$ ). In males, the right HL (RHL) was  $19.74 \pm 0.23$  cm and left HL (LHL) was  $19.88 \pm 0.23$  cm. It is observed that LHL was more than RHL, but it was statistically significant ( $p = 0.0412$ ). In females, the RHL was  $18.63 \pm 0.18$  cm and LHL was  $18.43 \pm 0.19$  cm. It is observed that RHL is more than LHL, and it was statistically significant ( $p < 0.0412$ ). Stature is dependent on Left & Right hand length also depend on Width.

Therefore, Regression equation of Male stature on different parameters.

1. Stature =  $18.86 + 4.9729 \times \text{Right Hand Length} + 2.6630 \times \text{Left Hand Length}$
2. Stature =  $48.8079 + 1.0284 \times \text{Right Hand Length} + 11.2262 \times \text{Right Hand Width}$
3. Stature =  $51.8593 + 0.6698 \times \text{Left Hand Length} + 11.6953 \times \text{Left Hand Width}$
4. Stature =  $58.8001 + 28.0805 \times \text{Left Hand Width} - 15.6323 \times \text{Right Hand Width}$
5. Stature =  $54.9582 - 0.1036 \times \text{Right Hand Length} + 0.5953 \times \text{Left Hand Length} + 26.7198 \times \text{Left Hand Width} - 14.9372 \times \text{Right Hand Width}$

(Stature =  $54.9582 - 0.1036 \times \text{LHL} + 0.5953 \times \text{RHL} + 26.7198 \times \text{LHW} - 14.9372 \times \text{RHW}$ )

Regression equation of Female stature on different parameters:

1. Stature =  $9.7721 \times \text{Right Hand Length} + 0.8204 \times \text{Left Hand Length} - 41.1058$
2. Stature =  $5.5456 \times \text{Right Hand Length} + 7.2840 \times \text{Right Hand Width} - 7.2854$
3. Stature =  $3.7572 + 4.5571 \times \text{Left Hand Length} + 8.3130 \times \text{Left Hand Width}$
4. Stature =  $46.318 + 77.4558 \times \text{Left Hand Width} - 63.9332 \times \text{Right Hand Width}$
5. Stature =  $5.1498 \times \text{Right Hand Length} - 0.07043 \times \text{Left Hand Length} + 30.8486 \times \text{Left Hand Width} - 22.8656 \times \text{Right Hand Width} - 3.6943$

(Stature =  $5.1498 \times \text{RHL} - 0.07043 \times \text{LHL} + 30.8486 \times \text{LHW} - 22.8656 \times \text{RHW} - 3.6943$ )

For all regression equation the p-value is 0.0000001. Therefore all values of regression are significant.

## Discussion

This study aimed at the estimation of stature from Hand length and hand breadth by formulating linear regression equation and multiplication factors. It is not always possible to measure all variables, so it is useful to have separate regression equation available for each variable. In the present study, a total of 192 subjects (96 males and 96 females) healthy volunteers from the age of 19 to 26 years were enrolled. Since the maximum height of an individual is attained between 18 and 24 years, we took the range in between 19 to 26 years, these individuals were selected for the study. Like our study many researchers in recent past also had the same age group subjects [12-14]. However to the contrary Pandhare et al. [15] in his study enrolled only children's in his study similarly Idegbu et al. [16] also enrolled only children's. In the research carried by Mohanty SP et al. [17] it was concluded that the age is insignificant in estimation of stature from arm span. In our study we had we had taken into consideration age as well regression equations which were derived for 19 to 26 years age group in both the genders. In our study the stature estimated in male was  $169.98 \pm 1.99$  cm and in female was  $156.07 \pm 2.09$  cm. It is concluded that males have greater stature than females. This phenomenon can be explained by the genetic constitution of male's age of puberty being 2 years later in males as compared to females give them additional time for growth. This also suggests that the formula for one gender cannot be applied to estimate stature for other gender.

There had been multiple studies in India in different geographical location, region or state and is to some extent different and this element can be explained by the reasoning that there is different genetic constitution, environmental factors and nutritional differences in different population groups [18,19]. The most versatile part of the body which is mostly used is human hand and it is of great importance to the researchers in the field of anthropometry. From India It was Rastogi et al. [20], Jakhhar et al. [21], Pawar et al. [22], Pandhare et al. [15] who estimated stature and used hand length. In the research done by Sunil et al. [23] he observed that Right hand length was  $19.6 + 1.3$  and left hand length was  $19.5 + 1.2$ , when we compared with our study his finding were comparatively more that our findings.

To estimate stature in males and females multiplication factors are used similarly various authors also used to estimate stature from various

body parameters, however the error which can be relatively large when multiplication factor is being used, It was Chhabra SK et al. [24] who estimated the stature by 3 methods and found regression equation as the best method to predict stature. In the present research we have formulated regression equations and multiplication factors for stature estimation. It is emphasized that all measurement exhibit high correlation in both the gender and hence offers a reliable tool to estimate stature for both the gender of this region. Depending upon various body parts available, estimation of stature using regression equations with multiplication factors stature can be estimated with reasonable accuracy. Stature estimated shall be useful for medico legal forensic purposes since bilateral and bisexual differences had been taken into account while deriving the linear regression equation along with multiplication factor.

### Conclusion

In forensic investigation identification of mutilated dismembered remains is a challenge to Forensic and anthropological experts, hence a strong need to study on stature estimation from various body parts in different region and geographical locations and populations. Such research help in narrowing of pool of possible victim matches in cases of Identification from mutilated dismembered skeletal remains. The present study indicates that hand length and breadth can be effectively used for estimation of stature in both males and females. Several authors have insisted the need for population specific stature estimation formulae. In this study we have derived regression equations and multiplication factors to estimate stature from hand length and breadth for south Indian population from Mahbubnagar region.

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