# ORIGINAL ARTICLE

# ESTIMATION OF HEIGHT FROM THE LONG BONES OF UPPERLIMB AND HAND DIMENSIONS IN SOUTH INDIAN POPULATION

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**ABSTRACT:** Prediction of stature from incomplete and decomposing skeletal remains is vital in establishing the identity of an unknown individual. It has been stated that a variety of factors such as race, gender and nutrition play an important role in determining the height of an individual. Estimation of stature holds a special place in the field of Forensic anthropometry. Establishing individuality on the mutilated part of a dead body is quite a difficult work in forensic medicine. Among the factors required, to establish the individuality of an unidentified dead body or any mutilated part of such dead body, height is one of them. The present study is an attempt to evaluate a possible correlation between stature of an individual & four parameters of upper limb; hand-length, hand-width, forearm length & arm's length individually in a local population of Kerala. A sample of 359 medical students studying in the KMCT Medical College & Hospital was considered & measurements were taken for each of the parameters. It was found that all the four parameters showed a correlation with stature but at different degrees. Forearm-length showed the highest degree of correlation (r=0.771) Mathematical formulae for estimating stature were developed for each of these parameters through basic linear regression. It can be concluded that the present study has provided regression equations for four different parameters that can be used for stature estimation in the population of Kerala.

**KEYWORDS**: Skeletal remains, Height, Stature, Hand-Length, Hand-Width, Arm-Length, Forearm-Length.

**INTRODUCTION:** Estimation of stature has a significant importance in the field of forensic anthropometry. Establishing the identity of an individual from mutilated, decomposed, & amputated body fragments has become an important necessity in recent times due to natural disasters like earthquakes, tsunamis, cyclones, floods and man-made disasters like terror attacks, bomb blasts, mass accidents, wars, plane crashes etc. Stature evaluation based on the lengths of the limb bones, is one of the oldest problems in the history of anthropology. In fact, height as a measure of biological development of both an individual and a population is commonly used in physical anthropology.

Human development and growth is a function of a variety of factors such as age, race, gender and nutritional status. These factors are unique to different types of demography. Therefore, different nomograms are required for different population sets. For this reason, the application of the general formula to a particular population is does not yield accurate estimations. Many studies have shown the correlation of stature with body appendages[1-4] & with long bones.[6-9] But there are interracial & inter-geographical differences in measurements & their

correlation with stature. What may be true for one race or one region may not be true for the other.

A good example of such heterogeneity in stature evaluation parameters is found in the vast homeland of India. The Indian population is made up of different ethnic populations & them having their own variations in statures and physical measurements.[3,4,6] It is established that there are no universally applicable formulae for stature estimation from the length of long bones as the relationship between them is influenced by the demography of the individual. Thus, the need for race, age and sex specific stature estimation formulae for a population as diverse as that of India is proved beyond doubt.

For the scope of this paper, the authors have selected the demography of the state of Kerala. The lack of anthropometric data concerning the local population of Kerala was felt as there is a rise in the number of disasters like terror attacks, bomb blasts, mass accidents; plane crashes etc., affecting the population of this state.

The present study was aimed at & concentrated on estimation of stature, of the population of Kerala. Anthropometric measurements of upper limb were calculated & correlated with stature to find multiplication factors & regression formulae. A study was carried out at the Department of Forensic Medicine & Toxicology, KMCT Medical College and Hospital, Calicut, Kerala. In the present study an attempt has been made to estimate the height from arm-length, forearm-length, hand-length and hand-width.

**MATERIAL METHODS:** This study was conducted on 359 medical students of the KMCT Medical College & Hospital. The procedure, aims & objectives of the study were informed & explained in a group. A written valid informed consent was taken from each of the participants. All the subjects are above the age of 21 years as the ossification is complete till this age and the maximum height is achieved.

The subjects were apparently healthy and without any physical deformity. They were from different parts of the state belonging to different religions and socioeconomic status. Also the individuals having skeletal or pathological abnormalities of limb and spine are not taken in the study.

They were placed in the standard anatomical position with the head held in the Frankfurt horizontal plane. All of the measurements were taken from the left side. The dimensions were taken in 0.1 cm unit with standard anthropometric instruments such as stadiometer (for height), measuring tape and standard vernier caliper.

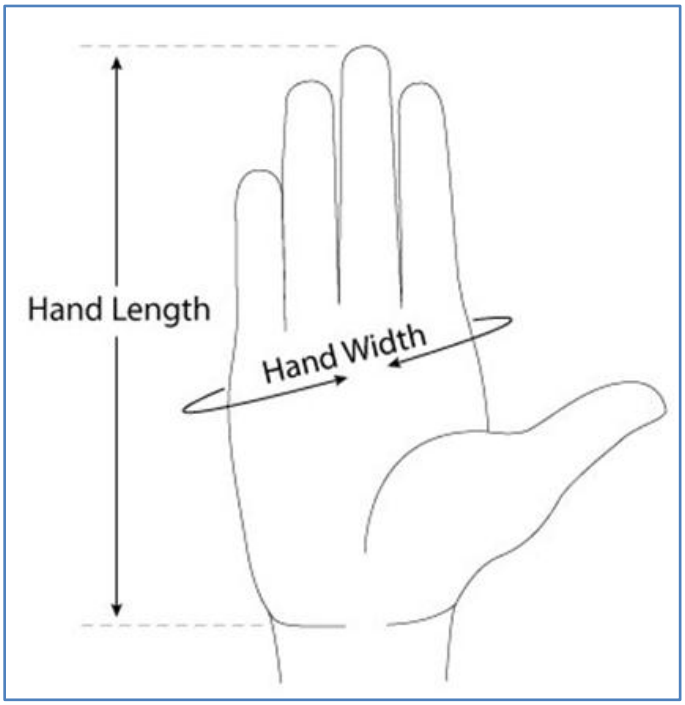
To ensure accurate results, all the measurements were done by one person to avoid interpersonal errors. All the measurements were taken thrice and then mean was recorded. The students were measured for the following parameters:

**HEIGHT:** The height of the individual was measured between vertex and the floor, when the person is standing erect, in anatomical position and the head in the Frankfort plane, using a standing height measuring instrument. Height was measured to the nearest 0.1 cm.

**ARM LENGTH:** length from acromion (the most lateral point on the end of the acromial process of the shoulder blade) to the most distal point on the capitulum of humerus. This is done by holding the forearm at right angles to the upper arm, when the capitulum of the humerus can be palpated very easily.

**FOREARM LENGTH:** From tip of olecranon process to mid-point joining styloid process of radius & ulna using a standard measuring tape with forearm in flexed position and dorsum of hand facing forward.

**HAND WIDTH:** when thumb is approximated to the palm, the point of diversion of distal phalanx of thumb at the head of the second metacarpal to the point of the distal palmer crease at the medial border of the hand using a standard vernier caliper.




**HAND-LENGTH:** From midpoint between the styloid process of radius and ulna to tip of middle finger using a standard measuring tape with hand and forearm straight in position and metacarpophalangeal joints and interphalangeal joints are in fully extended position.

**STATISTICAL ANALYSIS AND RESULT:**

The primary outcome was the regression equation for each parameter. Correlation coefficient (-1 to +1) was calculated for each parameter as were range, mean and standard deviation.

We analyzed our data using SPSS (version 17.0).

| | Range | | Mean | Standard deviation |
|---|---|---|---|---|
| | Minimum | Maximum | | |
| Height | 144.0 | 188.0 | 160.328 | 8.4439 |
| Arm length | 24.0 | 39.4 | 30.398 | 2.1597 |
| Forearm length | 21.5 | 32.2 | 26.584 | 2.0617 |
| Hand length | 14.0 | 25.0 | 17.779 | 1.3104 |
| Hand width | 6.3 | 9.5 | 7.730 | .6849 |

TABLE 1

| | r value * |
|---|---|
| Arm length | 0.545 |
| Forearm length | 0.771 |
| Hand length | 0.597 |
| Hand width | 0.482 |

TABLE 2: CORRELATIONS WITH HEIGHT

*-significant at p<0.001

**EQUATION FOR GETTING HEIGHT USING DIFFERENT VARIANTS**

1) Height & arm's length
   Height = 95.555+2.131*arm length
2) Height & forearm length
   Height = 76.415+3.157*forearm length
3) Height & hand length
   Height = 91.957+3.846*hand length
4) Height & hand width
   Height = 114.432+ 5.938*hand width
5) Height & all 4 parameters
   Height=40. 040+0.541*Arm length + 2.195* Forearm length + 1.819* Hand length + 1.702* Hand width

| | Mean | SD |
|---|---|---|
| Actual height | 160.328 | 8.4439 |
| Predicted height from all 4 parameters | 160.335 | 7.1822 |
| Predicted height from Arm length | 160.333 | 4.5967 |
| Predicted height from Forearm length | 160.343 | 6.510 |
| Predicted height from Hand length | 160.330 | 4.0659 |
| Predicted height from Hand width | 160.333 | 5.0426 |

TABLE 3: COMPARISON OF ACTUAL HEIGHT AND HEIGHT CALCULATED FROM REGRESSION ANALYSIS

**DISCUSSION:** The Kerala region is an amalgam of different races so there is a lot of variation in the morphometric estimates from rest of India. Our study showed there is a strong correlation between the parameters used in the study, forearm- length shows the highest degree of correlation and hand-width shows the least degree of correlation. A study by Athawle et al. on one hundred Maharashtrian male adults of ages between 25 to 30 years, Showed that height could be reliably estimated from forearm length.[8]

The present study also showed similar results.

A study done by Chikhalkar B.G. and Nanandkar S.D - forearm length showed the highest degree of correlation (r = 0.6558).[9]

This study also has a high degree of correlation (r=0.771) for forearm length.

In the study done by Chikhalkar B.G. and Nanandkar S.D - hand width also showed a high degree of correlation.[9]

The present study also shows a high degree of correlation for hand width (r=.482).

A study was done to examine the relationship between stature and dimensions of hands and feet among Rajputs of Himachal Pradesh - a North Indian endogamous group done by Krishnan et al. And the hand parameters showed a high degree of correlation.[3]

The present study also shows a high degree of correlation for hand length (r=.597) and hand width (r=.482).

**CONCLUSION:** This study shows that there is a definitive and strong correlation between the height and arm- length, forearm- length, hand-length and hand-width.

Among the parameters used in the study forearm- length shows the highest degree of correlation and hand-width shows the least degree of correlation.

This is a study of the first kind in the Kerala region. It will help in medico-legal cases in establishing the identity of an individual when only some remains of the body are found.

The Kerala region is an amalgam of different races so there is a lot of variation in the estimates from rest of India. Hence there is a need to conduct more studies among people of different regions & ethnicity, so that stature estimation becomes more reliable & identity of an individual is easily established.

As this study is done in living individuals so the results may not be applicable to the deceased individuals.

In this study only healthy individuals are included so the results may not be applicable to persons having deformity or any congenital abnormality.

**REFERENCES:**

1. Rastogi P, Nagesh KR et al. Estimation of stature from hand dimensions of North and South Indians. Leg Med (Tokyo). 2008 July; 10(4): 185-9.
2. Sanli SG, Kizilkanat ED et al. Stature estimation based on hand length and foot length.Journal of Clinical Anatomy.2005 Nov; 18(8): 589-96.
3. Krishnan K, Sharma A et al. Estimation of stature from dimensions of hands and feet in a North Indian population. Journal of Forensic and Legal Medicine.2007; 14(6): 327-332.

4. Jasuja OP et al. Estimation of Stature from Hand & Phalange Length. Journal of Indian Academy of Forensic Medicine. 2004; 26(3): 100-106.
5. Trotter M, Gleser G et al. Estimation of stature from long bones of American Whites and Negroes. American Journal of Physical Anthropology.1952; 10: 463-514.
6. Shroff AG et al. Determination of height from length of superior extremity & its segments. Journal of Anatomical Society of India. 1979; 28: 53.
7. Musgrave JH et al. The estimation of adult stature from metacarpal bone length. American Journal of Physical Anthropology.2005; 48(1): 113-119.
8. Athwale. Anthropological study of height from length of forearm bones. A study of one hundred Maharashtrian male adults of ages between 25 to 30 years. American Journal of Physical Anthropology. 1963; 21: 105-112.
9. Chikhalkar B.G et al. Estimation of Stature from Measurements of Long Bones, Hand and Foot Dimensions Original research paper J Indian Acad Forensic Med, 32(4).

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