TO COMPARE RELIABILITY AND ACCURACY OF FOOT LENGTH AND HAND LENGTH IN ESTIMATION OF STATURE IN NORTH INDIAN ADULTS

Rajendra S. Marko¹, Arpan Dubey², Sudha Shrivastava³

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ABSTRACT: AIM: Stature is one of the most important elements in the identification of an individual. It is well known that there is a definite relationship between the height of the person and various parts of the body. The present study was therefore undertaken to estimate stature from the measurement of foot length and hand length with more reliability and accuracy. MATERIAL AND METHODS: The study population comprises of 120 subjects between the age of 21 and 30 years. Their foot length, hand length and stature were measured using standard Martin’s anthropometric instruments. STATISTICAL ANALYSIS: The data was analyzed statistically using SPSS software for comparison, correlation and to derive regression equation. RESULT: The stature can be reliably estimated from foot length and hand length. It was observed that stature estimated from foot length in male and hand length in female is more reliable and accurate respectively. CONCLUSION: It is an important tool for the identification of an individual. It has a significant importance for anthropologist, anatomist and forensic experts in both criminal and civil cases.

KEYWORDS: Anthropometry, Stature, Foot length, Hand length, Standard Error of Estimation and Regression Equation.


INTRODUCTION: Age, sex and stature are the primary characteristics of identification. Estimation of stature has a significant importance for the anthropologist, anatomist and forensic scientist. It is important for medico legal and humanitarian reasons. It is useful for the identification of an individual, when mutilated, decomposed; amputed and diseased body parts are available. It has become an important necessity in recent times due to natural disaster like earthquakes, tsunamis, cyclones, floods and man-made disasters like terror attacks, bomb blast, mass accidents wars, plane crashes etc. Many different body parts can be used in the estimation of stature such as long bones, head length, hand & foot dimensions, and their segments, percutaneous length of tibia & ulna, forearm length, etc.

Several studies have been conducted in the different parts of the world on the different population groups to estimate stature from different parts of the body. Several workers have shown a significant correlation of foot and hand measurements with stature.¹⁻⁵

MATERIAL & METHODS: The study population comprised of 120 (60 male and 60 female) medical students born in north India aged between 21 and 30 years as stature attains its maximum at around 21 years of age and senility related changes of stature starts appearing after 30 years.² In the study population, the subjects included are irrespective of caste, religion, dietary habits and socioeconomic status and having no congenital deformities or previous history of trauma and orthopedic surgeries to foot and hand.
The details of the study were explained to all the subjects and written consent was obtained. The measurement of the female subject was taken in the presence of a female attendant. The measurements taken includes height, foot length and hand length in centimeters up to the nearest millimeters and in a well-lighted room and in a fixed time between 02:00 pm to 4:00 pm and by same person to avoid diurnal variations and personal error in methodology. The measurements were taken twice for accuracy.

**STATURE:** The vertical distance between the highest point of vertex and heel touching the floor. The subject was standing in erect posture with barefoot against the wall with the feet parallel or slightly divergent and the head balanced on the neck and measurement was taken.

**FOOT LENGTH:** It is the distance from the most prominent point of back of the heel (pternion) to the tip of the hallux or to the tip of second toe (acropodian). Position of the subject was standing; his/her leg slightly bent and the body rested mainly on the other foot. The caliper was horizontally placed along to the medial border of the foot. The fixed clamp of the caliper was applied to the pternion and the mobile clamp approximated to the acropodian and measurement was taken.

**HAND LENGTH:** It is the distance from the midpoint of the interstyloid line (stylion) to the tip of the middle finger (dactylion) in extension. The subject was asked to place his/her hand on the table with the palm facing upward keeping the fingers close together with the thumb lying comfortably but not tightly against the radial aspect of the hand and index finger. The fixed clamp of the spreading caliper was placed in the stylion and mobile clamp approximated to the dactylion and measurement was taken.
ETHICS: In the present study the procedures followed were in accordance with the ethical standards of ‘Ethics Review and Scientific Literature Committee’ M. G. M. Medical College, Indore (M.P.), India – 452001.

STATISTICAL ANALYSIS: The comparison, Pearson correlation and regression equation were obtained by using SPSS software.

OBSERVATIONS & RESULT: The correlation coefficient (r) of the foot length and hand length with the stature is positive and suggesting that these are strongly significant. In male foot length and in female hand length shows more reliability for estimation of stature. Reliability was determined by Standard Error of Estimation (SEE) and predicts the deviations of estimated stature from the actual stature. The female subjects exhibit lower values of Standard Error of Estimation. It means foot length and hand length are more reliable to estimate stature in comparison to male subjects.

<table>
<thead>
<tr>
<th>Variables</th>
<th>Sex</th>
<th>Range</th>
<th>Mean</th>
<th>SD*</th>
<th>r†</th>
<th>r²+</th>
<th>P†† value</th>
</tr>
</thead>
<tbody>
<tr>
<td>FL§</td>
<td>Male</td>
<td>23.1-27.9</td>
<td>25.6902</td>
<td>1.1205</td>
<td>0.713</td>
<td>0.508</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td></td>
<td>Female</td>
<td>21.65-26.45</td>
<td>23.8300</td>
<td>0.9224</td>
<td>0.681</td>
<td>0.464</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>HL‖</td>
<td>Male</td>
<td>16.95-20.6</td>
<td>18.6842</td>
<td>0.8176</td>
<td>0.721</td>
<td>0.520</td>
<td>&lt;0.001</td>
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<tr>
<td></td>
<td>Female</td>
<td>16.25-19.2</td>
<td>17.5092</td>
<td>0.6697</td>
<td>0.783</td>
<td>0.612</td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>

Table 1: Comparison and Pearson correlation (r) between FL§ and HL‖ with stature of males and females of all age groups

Sexual differences in the studied parameters were assessed with the help of “t” test. Higher values of “t” test shows the more reliable index for estimation of height.

<table>
<thead>
<tr>
<th>Variables</th>
<th>Sex</th>
<th>Regression equation</th>
<th>SEE**</th>
<th>t-test</th>
<th>P†† value</th>
</tr>
</thead>
<tbody>
<tr>
<td>FL§</td>
<td>Male</td>
<td>76.586+3.539 FL§</td>
<td>3.9381</td>
<td>6.509</td>
<td>&lt;0.001</td>
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<tr>
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<td>Female</td>
<td>78.642+3.369 FL§</td>
<td>3.363</td>
<td>6.941</td>
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<tr>
<td>HL‖</td>
<td>Male</td>
<td>75.847+4.906 HL‖</td>
<td>3.8906</td>
<td>6.547</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td></td>
<td>Female</td>
<td>65.612+5.329 HL‖</td>
<td>2.8632</td>
<td>6.728</td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>

Table 2: Regression equation for prediction of stature from FL§ & HL‖ for both sexes in all age groups
**CONCLUSION:** We concluded that the foot length is more reliable in males whereas hand length is better predictor of stature in female. As a whole hand length can be considered as a better predictor of stature than foot length. Simple linear regression equations have been derived to estimate stature from foot length and hand length.

**DISCUSSION:** The males were found to be taller and had longer feet than females with the intersexes difference being statistically significant (p<0.001). These observations were same as the earlier studies. An attempt was made to correlate foot length and hand length with stature and derive regression equations to calculate stature from foot length and hand length. Analysis using a pooled sample (sample including both males and females) was done to be used when the sex of the foot or hand was not known as in mass disasters when only foot/hand or its fragments are available for analysis.

Sanil et al, D. Deepa et al and Waghmare et al were found strongly positive correlation exists between hand length, foot length and stature in both sexes. Sen et al their study indicates that there were significant differences in stature, foot length and foot breadth in both sexes. Rastogi et al observed that hand length gives better result in estimating stature than hand breadth. Chavan K. D. et al estimated height from foot length of Maharashtrian population and noted that height and foot length was strongly correlated.

Chikhalkar et al they concluded that hand length and foot length can be reliably used for estimation of stature in the Mumbai region. Danbarno et al they concluded that height could be predicted accurately from combination of hand and foot lengths and also showed sexual dimorphism in foot and hand length indices and stature ratio. Rutishauer and Qamra et al found significant correlation of foot length and height and also computed regression equations to calculate height from foot length. Patil S. M. et al and Agnihotri et al conducted a study to develop relationship between foot length and stature and derive a regression equation. Kanchan T. et al found that the foot length provides highest reliability and accuracy in estimating stature of an unknown male and obtained a regression equation to measure the stature from foot length.

| Variables | Regression equation | SEE** | r† | t-test | P|| value |
|-----------|---------------------|-------|----|--------|---------|
| FL§       | 64.329+3.994 FL§    | 3.7194| 0.831| 10.535 | <0.001  |
| HLǁ       | 55.713+5.940 HLǁ    | 3.5462| 0.848| 8.982  | <0.001  |

**Table 3: Regression equation for prediction of stature from FL§ & HLǁ for whole study population**

**ABBREVIATIONS:** * = Standard deviation, † = Regression coefficient, ‡ = Coefficient of determination, § = Foot length, ‖ = Hand length, ** = Standard error of estimation and †† = Significance value.

The equations obtained were:

**In males:** Stature = 76.586 + 3.539 × foot length and Stature = 75.847 + 4.906 × hand length.

**In females:** Stature = 78.642 + 3.369 × foot length and Stature = 65.612 + 5.329 × hand length.

**When sex is unknown:** Stature = 64.329 + 3.994 × foot length and Stature = 55.713 + 5.94 × hand length. The study thus has forensic and anthropological applications.
These types of studies are of medico legal importance, as the first step in forensic analysis in establishing identity of the person in question, where stature is one of the primary characteristics of identification. These studies are also of anthropological importance as it helps to know the differences between different population groups.

REFERENCES:
## Authors:
1. Rajendra S. Marko
2. Arpan Dubey
3. Sudha Shrivastava

## Particulars of Contributors:
1. Assistant Professor, Department of Anatomy, M. G. M Medical College, Indore, M. P.
2. Post Graduate, Department of Anatomy, M. G. M Medical College, Indore, M. P.
3. Professor and HOD, Department of Anatomy, M. G. M Medical College, Indore, M. P.

## Name Address Email ID of the Corresponding Author:
Rajendra S. Marko, 
#38, Praicharika Nagar Nr, 
Geeta Nagar, 
Indore-452001, M. P, India. 
Email: dr.rajendramarko@gmail.com

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