

Original Communication

# Estimation of stature from dimensions of hands and feet in a North Indian population

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## Abstract

In medico-legal autopsies, establishing personal identity of the victims is often required. Estimation of stature from extremities and their parts plays an important role in identifying the dead in forensic examinations. The study examines the relationship between stature and dimensions of hands and feet among Rajputs of Himachal Pradesh – a North Indian endogamous group. The purpose for understanding these examinations was the paucity in the literature of studies that allow the reconstruction of stature from various dimensions of hands and feet amongst Rajputs. Hand length, hand breadth, foot length and foot breadth of 246 subjects comprising 123 males and 123 females ranging in age from 17 to 20 years were taken independently on left and right side of each individual. Statistical analyses indicated that the bilateral variation was insignificant for all the measurements except hand breadth in both the sexes ( $P < 0.01$ ). Sex differences were found to be highly significant for all the measurements ( $P < 0.01$ ). Linear and multiple regression equations for stature estimation were calculated using the above mentioned variables. The correlation coefficients between stature and all the measurements of hands and feet were found to be positive and statistically significant. The highest correlation coefficient between stature and foot length and lowest SEE (standard error of estimate) indicate that the foot length provides highest reliability and accuracy in estimating stature of an unknown individual. The regression equations were checked for their accuracy by comparing the estimated stature and actual stature. © 2006 Elsevier Ltd and AFP. All rights reserved.

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## 1. Introduction

Stature provides insight into various features of a population including nutrition, health and genetics. Stature is considered as one of the parameters for personal identification and one of the ‘big fours’ of forensic anthropology. The stature of an individual is an inherent characteristic; its estimate is considered to be an important assessment in the identification of unknown human remains.

Adult height may be attained anywhere from the early teens to early twenties, though it is most commonly reached during mid-teens for females and the late-teens

for males. For better accuracy, stature estimation may be attempted only after the attainment of maturity.

There is an established relationship between stature and various body parts like head, trunk, upper and lower extremities. This allows a forensic scientist to estimate stature from different parts of the body. With the increasing frequency of mass disasters, homicides, air plane crashes, train and road accidents etc., there is always need for such studies which help in identifying the deceased from fragmentary and dismembered human remains. In such a situation, measurements of hands and feet provide good approximation about the height of a person.

Some of the authors have successfully tried to estimate stature from percutaneous body measurements,<sup>1–13</sup> some from the isolated long and other bones<sup>14–22</sup> and some focused their attention on the estimation of stature using radiographic material.<sup>23–26</sup>

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The purpose of the present study is to analyze the anthropometric relationship between dimensions of hands and feet with stature and to devise regression formulae to estimate stature from these dimensions.

## 2. Materials and methods

The present study consists of a cross-sectional sample of 246 Rajputs (123 males and 123 females), ranging in age from 17 to 20 years. Rajputs are one of the major endogamous caste groups of North India, a large number of them living in Himachal Pradesh. The study was conducted in Theog tehsil of district Shimla in the state of Himachal Pradesh. Theog is geographically located at latitude (31.12° 31' 7" 12" North of the Equator and longitude (77.35° 77' 20' 59" East of the Prime Meridian on the Map of the world. The town of Theog is situated at an altitude of 1964 m above mean sea level on Chandigarh–Shimla–Tibet National Highway. The temperature varies considerably in the region while minimum temperature goes down much below 0 °C during the winter months and experiences heavy snow fall; the maximum temperature exceeds even 25 °C during summer months.

The sample for the present study was drawn from Government Senior Secondary School and Government Degree College, Theog. Four anthropometric measurements viz. hand length, hand breadth, foot length and foot breadth were taken independently on the left and right side of each individual. Besides these, stature and weight of each subject were also recorded. Only right handed subjects were included in the present study. All the measurements were taken in a well lighted room. Before taking the measurements, each subject was asked to remove the shoes. The measurements were taken by one observer (AS) in order to avoid inter-observer error. The measurements were taken using standard anthropometric instruments in centimeters to the nearest millimeter according to the techniques described by Vallois.<sup>27</sup> The subjects included in the study were healthy and free from any apparent symptomatic deformity. The study was conducted during the month of September, 2004. Some general information pertaining to economic status, family size, caste, education, occupation etc. was also recorded.

The data were subjected to statistical analysis using statistical package for social sciences (SPSS) and regression formulae were calculated for various combinations to reach the best estimate possible.

### 2.1. Landmarks and techniques involved in taking anthropometric measurements

#### 2.1.1. Height-vertex (stature)

It is the vertical distance between the point vertex and the floor.

Vertex: It is the highest point on the head when head is held in F.H. (Frankfurt Horizontal) plane.

Instrument: Anthropometer.

Technique: The subject is made to stand in an erect posture and measurement is taken without any wear on head and foot. The subject should stand up against the wall, feet axis parallel or slightly divergent with head balanced on neck in F.H. plane. Hands should hang down. If a wall is not available the subject should stand in an erect posture on a leveled floor. Held the anthropometer vertically in front of the subject exactly in mid-sagittal plane and by the right hand, movement of cross rod is controlled. No pressure should be exerted since this is a contact measurement.

#### 2.1.2. Hand length

It is projected distance between the points inter-styilion and the tip of the third finger.

Inter-styilion: It is the middle point of the line connecting the point styilion radiale (the most distal point on the styloid process of radius) and styilion ulnare (the most distal point on the styloid process of ulna).

Instrument: Anthropometric rod compass.

Technique: The subject is asked to stand erect. The hand, being pendent along the body, is held with the left hand, which presses on the fingers to keep them fully extended. The measuring apparatus, held in the right hand is placed along the radial border at the hand, its stem being strictly parallel to the axis of the hand (the axis of the medius extending the axis of the fore-arm). The end of the upper branch is applied to the inter-styilion point and the end of the lower branch to the tip of the third finger and reading is recorded.

#### 2.1.3. Hand breadth

It is the distance between the most prominent point, outside of the lower epiphyses of the 2nd metacarpal (metacarpal radiale) to the most prominent inside point of the lower epiphyses (metacarpal ulnare) of the 5th metacarpal.

Metacarpal-radiale: It is the point most medially projected on the head of the 2nd metacarpal when the hand is stretched.

Metacarpal-ulnare: It is the point projecting most laterally from the head of the 5th metacarpal.

Instrument: Sliding caliper.

Technique: The measurement is taken over the dorsum of the hand in full extension. It is easy to locate the points by palpation of the landmarks corresponding to the heads of the metacarpal which should not be confused with the upper epiphyses of the finger joints. This 'breadth' is somewhat oblique with regards to the axis of the hand.

#### 2.1.4. Foot length

It is the distance from the most prominent part of the heel backward to the most distal part of the longest toe (2nd or 1st).

Acropodian: It is the most forwardly projecting point on the head of the 1st or 2nd toe which ever is larger when the subject stands erect.

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