

Prediction of personal stature based on the hand length

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ABSTRACT

Introduction: Estimation of stature from incomplete skeletal and decomposing human remains is particularly important in personal identification. Prediction of stature has been achieved from measurements of various long bones with varying degrees of accuracy. All such calculations depend on the fact that limbs exhibit consistent ratios relative to the total height of a person and these ratios are linked to age, sex and race.

Objectives: This study was carried out to investigate the relationship between personal stature and hand length among a group of male and female Sri Lankan adults and to derive a linear regression formula between the hand length and height of an individual.

Materials and Methods: A total of 258 individuals with an age range of 20-23 years. were included in the study. The hand length, direct linear distance between the distal wrist crease and the distal end of the most anterior projecting point of the middle finger, was measured using a sliding caliper capable of measuring to the nearest 0.01 mm. The height of the individual was measured standing erect, in anatomical position using a standing height measuring instrument.

Results: The differences of the hand length between the genders were found to be highly significant. A positive correlation between height and hand length was observed in both sexes and it was statistically significant. Regression equation for stature estimation was formulated using the hand length for both sexes.

Conclusion: The results indicate that hand length provides precise means of estimating the stature of an unknown individual. The regression formula derived in this study will be useful for anatomists, archaeologists, anthropologists and forensic scientists.

Key words: height estimation, hand length, Sri Lankans.

Introduction

Dimensional relationship between body segments and the whole body has been the focus of scientists, anatomists and anthropologists for many years. Furthermore, the relationship between body segments has been used to compare and highlight variations between different ethnic groups and to relate them to locomotor patterns, energy expenditure, and lifestyle^{1,2}. Prediction of the dimensions of body segments is useful in many areas of modern science. For example, in growth and development the use is made of the relationships between body segments in the assessment of normal growth as well as in specific syndromes^{3,4}. Body

proportions and the dimensions of various body segments, including the long bones of the limbs and the bones of the hand and foot have been used to estimate stature. The long bones of the limbs, however, have been the most widely studied^{5,6}.

Estimation of stature from incomplete skeletal and decomposing human remains is particularly important in personal identification. The relationship between specific body dimensions / proportions can be used to help solve crimes in the absence of complete evidence. For example, it has been proved that stature can be estimated from imprints of the hand, foot or footprints or from a shoe left at the scene of a crime⁷. Similarly, the

stature of a victim can be estimated when a part of body, such as a long bone, or hand, is all that remains⁸.

Despite the relationships between body parameters that have been determined, it has been emphasized that these vary from population to population and ethnic origin to ethnic origin due to differences in nutrition and levels of physical activity⁹. To the best of our knowledge such data are not available for Sri Lankans. Therefore, this study was carried out to investigate the relationship between the hand length and stature among a group of male and female Sri Lankan adults.

Material and methods

This study was conducted on 258 medical students (140 male and 118 female) of the Faculty of Medicine, University of Ruhuna, Galle, Sri Lanka. The subjects were from different parts of the island belonging to different socio-economic backgrounds. The age of the subjects ranged from 20-23 years. Left-handed students were excluded from the study.

Hand length was defined as the direct linear distance between the distal wrist crease and the distal end of the most anterior projecting point, i.e., tip of the middle finger. The subjects were asked to place their hands supine on a flat hard horizontal surface with fingers extended and adducted, following which the hand length was measured. Care was taken to see that there was no abduction or adduction at the wrist joint, i.e., the forearm was directly in line with the middle finger.

Hand lengths were taken independently on left and right sides of each individual using a sliding caliper capable of measuring to the nearest 0.01 mm (Mitutoyo, Japan). The height of the individual was measured between the vertex and floor, when the person is standing erect, in anatomical position and the head in the Frankfort plane, using a standing height measuring instrument. All the measurements were taken at a fixed time between 14.00–16.30 hrs to eliminate discrepancies due to diurnal variation. Furthermore, the measurements were recorded by the same person to minimize the errors in methodology. Results were analyzed using a statistical package SPSS (Version 15).

Results

Statistical analysis indicated that bilateral variation was insignificant for the measurements of hand length in both sexes. Various important parameters of the study are summarized in Table 1. Gender differences with respect to the hand length and height were found to be highly significant ($P < 0.01$). Mean hand lengths of the male were significantly larger than that of the females ($P < 0.01$).

Table 1 - Height, hand length, correlation coefficient, regression coefficient and value of constant in males and females. * $P < 0.01$ when compared with the females.

Gender	Male	Female
Total number	140	118
Mean height \pm SD (cm)	170.14 \pm 5.22*	157.55 \pm 5.75
Mean hand length \pm SD (cm)	19.01 \pm 0.86*	17.62 \pm 0.93
Correlation Coefficient	0.58	0.59
Regression Coefficient	3.493	3.625
Value of Constant	103.732	93.689

Regression equation for stature estimation was derived as follows;

For male: Height = 103.732 + 3.493 (hand length).

For females: Height = 93.689 + 3.625 (hand length).

For both male and female (combined): Height = 60.807 + 5.637 (hand length).

Discussion

Estimation of an individual's stature is an important parameter in forensic examinations and anthropological studies. Morphometry of the hand provides important evidence in a crime scene investigation which helps in the estimation of stature of a criminal. The available data usually apply to Caucasians in Europe or North America. Only few studies of other racial groups exist which emphasize the need to establish standards in different ethnic populations^{5,7}. Therefore, this study was carried out to investigate the relationship between the foot length and stature among a group of male and female Sri Lankan adults.

Effect of hand dominance on hand measurements

has been suggested¹⁰ and hence, left-handed students were excluded from the study. Correlation coefficient between stature and hand length was found to be statistically significant and positive indicating a strong relationship between the two parameters. Regression equation for stature estimation was formulated using hand lengths and checked for their accuracy by comparing the estimated stature and the actual stature. The results indicate that hand length provides an accurate and reliable means in reconstructing the stature of an unknown individual.

The present study shows a correlation coefficient of +0.58 for male and +0.59 for females which is very significant. These formulae are valid for the age group (20-23 yrs) of the study population. It is shown in earlier studies that various hand measurements tend to differ in various ethnic groups¹¹. Consequently, the formulae designed to estimate stature from various anatomical dimensions in one population do not apply to another^{12,13}. Furthermore, the need for the alternative formulae for the genders is also proved as the rate of skeletal maturity in males and females vary during the course of development¹². Females tend to show a higher growth rate during the first half of the second decade, whereas in males it is during the second half of the second decade, both being under hormonal control^{9,14}.

Significant and positive correlation coefficient has been shown to exist between stature and measurements of hand length. The results of the current study further highlight the ethnic differences in the anatomical dimensions and its relation to stature which were described earlier^{5,11,15}. Taken together the evidence suggests that the relationship between hand length and stature is of practical use in medico-legal, anthropology and archeological studies when such evidence provides the investigator the only opportunity to gauge that aspect of an individual's physical description.

Acknowledgement

The authors wish to thank Dr. W.A.A. Wijayasiri and Dr. T. Ponnampereuma, Department of Community Medicine, Faculty of Medicine, University of Ruhuna for helping with the statistical analysis.

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