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ORIGINAL ARTICLE

Estimation of stature from hand dimensions in Bengalee population, West Bengal, India

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Abstract: Stature estimation from decomposing bodies and incomplete skeletons particularly in personal identification is considered as one of the biggest aspects of forensic science. This issue has gained importance in recent times due to mass disasters like terrorist attacks, mass murders, transport accidents, floods and earthquakes. Thus, the present study was undertaken to set up a standard formulae to estimate stature from hand dimensions in the Bengalee population. Measurements of different hand dimensions and statures were taken from 1662 adult Bengalee women aged from 20 to 40 years following the standard technique and appropriate landmarks. There was no statistically significant bilateral variation of the measurements. The correlation coefficients between stature and all variables were positive and statistically significant ($p < 0.001$). The hand length and palm length showed a better correlation with stature than the other variables. Simple linear regression equations and multiple linear regression equation were formulated for stature estimation using the hand dimensions. The derived equations were applied to the control group and it was noted that the percentage difference between true stature of the control and the estimated stature ranged from 0.01% to 0.15%. The multiple linear regression equation was more reliable than the simple linear regression equations as a lower standard error of estimate and higher value of determination coefficient and multiple correlation coefficient. From the results of the present study, it may be concluded that hand dimensions can be successfully used for estimating stature of adult Bengalee women in forensic practice by enforcement agencies and forensic scientists.

1. Introduction

Personal identification is one of the main tasks of forensic research. Stature, age, sex, and ancestry helps in narrowing down the pool of the possible victim matches in the forensic investigation process and thus provide useful clues to the investigating agency in establishing the identification of the individuals. The relationship between different body

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dimensions can be utilized to solve crimes in the absence of complete evidence. This relationship can help a forensic scientist to calculate stature from mutilated and dismembered body parts in forensic examinations. Estimation of stature from the incomplete skeletal remains or from the mutilated or amputated limbs or parts of limbs or highly decomposed, fragmented human remains has obvious importance in personal identification in the events of murders, accidents or natural disasters considered as one of the biggest aspects of forensic science. Similarly, stature can be estimated from feet or footprints, imprints of the hand or from a shoe left at the scene of a crime. Anthropometric techniques have been used for stature and bone length estimation from unknown body parts and skeletal remains by anthropologists, medical scientists, and anatomists for over a hundred years.[1–3] This has been important in recent times due to natural disasters like cyclones, tsunamis, earthquakes, floods and man-made disasters like terror attacks, bomb blasts, mass accidents, wars, plane crashes etc. In such cases, the forensic pathologist is often opining about the identity of the deceased.

The relationship between body segments has been utilized to compare and highlight the differences between different ethnic groups and to narrate them to locomotor patterns, energy expenditure and lifestyle.[4] Stature is indeed a very important indicator of growth and development and is used in the clinical setting for nutrition and health research. Together with body weight, stature is an important parameter used to calculate basal energy expenditure, body mass index, basal metabolic rate, body composition, vital capacity and estimations of nutrient requirements.[5–8]

The relationship between body segments has been the focus of anatomists, anthropologists and scientists for many years. Prediction of the dimensions of different body segments is useful in many areas of modern science. Body proportions and the dimensions of different body segments, including the vertebral column, long bones of the limbs and the bones of the hand and foot have been used for stature estimation. However, the long bones of the limbs have been the most widely studied.[9–12] Different body parts can be used in the estimation of stature. Many studies have been conducted to estimate stature from various parts of the body like the trunk, vertebral column, limbs, long and short bones, hand, foot and hand and foot prints.[3,13–19] Many studies have shown the correlation of stature with body parts.[16,20–26] The Indian perspective of the problem of stature estimation has been studied by Krishan,[13]; Rastogi et al.[16]; Nagesh and Kumar,[17]; Khanapurkar and Radke,[20]; Chikhalkar et al.[21]; Jasuja and Sing,[22]; and Krishan and Sharma.[27]

The present study was undertaken to measure the stature, as well as the length and breadth of hand and to find out whether any correlation exists between the stature and hand dimensions. Consequently, a set linear regression formulae for estimation of stature from hand dimensions in the Bengalee population was made.

2. Materials and methods

2.1. Study design and sampling

This cross-sectional study was conducted on 1875 women selected from different villages of different districts of the West Bengal state, India. This study was a part of a research project assisted by the Rashtriya Vigyan Evam Sanchar Parishad (RVPSP), Department of Science and Technology, New Delhi, India. The eligibility criteria for recruitment of the participants included age range between 20–40 years, apparently healthy individuals with no physical deformity. The authors disqualified 27 orthopaedically challenged participants. Among the 1848 eligible, 186 participants were not interested in participating in the present study. Among the 1662 participants, 73 were excluded from the study due to missing or incomplete data. Thus, a final total of 1589 (85.98% of eligible) women participated in the present survey.

The two-stage sampling method was utilized. At first, a cluster sampling method was utilized to identify 20 clusters (villages) in each district e.g., East Midnapore, West Midnapore, Bankura, Purulia and Howrah of West Bengal, India. In the second stage, a systematic random sampling method was utilized to identify 20 households per cluster. All households in the cluster were listed and the number of the households was divided by the required number to get the sampling interval. The first household was chosen randomly using a lottery method and then subsequent households were selected by adding sampling interval to the random number. The selected participants were approached during field visits and the protocol of the study was explained verbally in the local language (Bengali). Written and signed consent was obtained from each participant. Before commencement of the study, ethical approval, and prior permission was obtained from the Institutional Ethics Committee and the study was carried out in accordance with the Helsinki declaration and with the ethical standards of the committee.

2.2. Measurement of body dimensions

Anthropometric measurements were taken from the participants following the standard technique and appropriate landmarks.[28,29] Weight was measured to the nearest 0.1 kg using a portable weighing machine (Libra, Libra Weighing Machine Limited, Bangkok, Thailand) and stature was measured to the nearest 0.1 cm using anthropometer (Hindustan Minerals, The Hindustan Mineral Products Co. Ltd., Kolkata, India). Hand length, palm length, hand breadth, maximum hand breadth and phalange lengths were taken to the nearest 0.1 cm using sliding caliper (Hindustan Minerals, The Hindustan Mineral Products Co. Ltd., Kolkata, India). The landmarks of different hand dimensions taken for measurements are shown in Fig. 1. Each participant was measured twice. When the two initial measures did not satisfy the 0.4 cm criterion, two additional measurements were taken and the mean of the closest records was used as the best estimate. All participants were wearing light clothes and were barefooted during measurements.

2.3. Statistical analysis

While conducting the present study, the technical error of the measurement (TEM) was taken into consideration. The technical error of measurement is an accuracy index for anthropometrical measurements and represents the measurement accuracy. It is the most common way to express the error margin in anthropometry. When performing repeating anthropo-