Estimation of Stature from Fragmented Human Remains

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Introduction

Stature is one of the most important parameters in the identification of an individual, living or dead. When intact bodies are to be examined, stature estimation does not pose any problem. But when dismembered human body parts are the materials to work with, it is of an even greater challenge for the forensic pathologists. Most methods employ the basic process of comparison [1]. Therefore, the identification depends mainly upon the availability and completeness of ante-mortem records. When dealing with human remain, estimating living stature can also help to identify an unknown individual because there is a close relationship between the body parts dimensions and height. The forensic pathologists/anthropologists can measures the dimensions of available body parts for examination, and put these measurements into a mathematical formula as per gender and ancestry group. The formula produces a height range, which can exclude the individuals that fall outside those limits. The aim of writing this review is to discuss the estimation of stature from fragmented human remains by using different studies conducted on the cephalo-facial, extremities and other body parts.

Cephalofacial Dimensions

There are many studies available in the literature concerning the estimation of stature from anthropometry of cephalo-facial region [2-6]. Agnihotri et al. [2] studied 14 measurements (maximum head length, maximum head breadth, horizontal head circumference, head vault, minimum frontal diameter, bizygomatic breadth, bizional diameter, nasal height, nasal breadth, nasal depth, morphological facial length, physiognomic facial length, physiognomic ear length, physiognomic ear breadth) of cephalofacial region to observe the relationship with height in Indo-Mauritian population and successfully devise the regression formulae for estimation of stature. Since the correlation coefficients of these measurements were less than 0.5, therefore they were not considered as reliable predictors. Similarly, Pelin et al. [3] observed that these percutaneous dimensions are not good predictors for estimating stature in a Turkish population. Krishan et al. [4] conducted a study in North Indian Population to estimate the stature from cephalo-facial anthropometry and indicated that all the cephalo-facial measurements are strongly and positively correlated (p<0.001) with stature. Akheter et al. [5] in their study in Bangladeshi Garo adult females showed a significant positive correlation of head circumference with the stature (p=0.005), but head length, bizygomatic breadth and facial height did not reach statistically significant level with stature. Recently, Wankhede KP et al. [6] concluded that percutaneous maxillofacial anthropometry can be used but not as a primary method for stature estimation.

Upper Extremity Segments Dimensions

In cases where the human remains of upper extremity are available, the estimation of a living height could be made possible by using various dimensions of the upper extremity. Agnihotri et al. [2] performed the study in an Indo-Mauritian population to estimate the stature from the forearm length (percutaneous ulna length) [7], hand length [8] and hand breadth [8] and formulated the regression models. Results indicated that percutaneous length of ulna (forearm length) and hand length can be efficiently used for stature dimension. Akhlaghi et al. [9] also identified meaningful relation between the stature and upper limb dimensions (p<0.05) in Iranian population. Recently, Ahmed [10] studied the relationship between the upper limb dimensions (upper arm length, ulna length, wrist breadth, hand length, and hand breadth) and stature in Sudanese adults and developed regression formulae to estimate stature from these dimensions.

The results of this study indicated the significant sexual dimorphism for all measurements and a positive correlation between upper limb measurements and stature, which was highest for ulna length [10]. Laila et al. [11] observed that the arms pan lengths can be used as a basis for estimating age-related loss in stature and as an alternative measure to stature in Bangladeshi adult females. A study by Rastogi et al. [12] reveals that the Middle Finger Length can be used successfully to predict stature in the Indian population. Krishan et al. [13] derived the linear regression models and multiplication factors for estimating stature from Index Finger Length and Ring Finger Length in adolescent population of North India.

Lower Extremity Segments’ Dimensions

Ozaslan et al. [14] studied the anthropometric relationships between dimensions of lower extremity (trochanteric height, thigh length, lower leg length, leg length, and foot height, breadth, and length) and body height in adult Turks residing in Istanbul, and concluded that the estimation of living height can be made possible by using various dimensions of the lower extremity. According to Han et al. [15], lower leg length (knee height) gives a good prediction of height. Agnihotri et al. [7] studied the stature estimation from percutaneous length of tibia (lower leg length) on a sample of Indo-Mauritian population and found that tibial length has strong linear relation with stature. Ahmed [16] observed the tibia length and foot length as the best predictors of stature in Sudanese Arabs. The foot is one of the most well preserved fragments in mass disasters as it is protected by footwear. Another study conducted by Agnihotri et al. [17] in Indo-Mauritian Population showed that foot length is a prime criterion in estimating stature of an individual. Krishan et al. [18] observed that foot length estimate stature with greater accuracy when compared to foot breadth.

Other Body Parts Dimensions

Very few studies have been carried out for the stature estimation by using the dimensions of other body parts. Menezes et al. [19] formulated a linear regression equation from the length of sternum concluded that...
the length of the sternum is a reliable predictor of stature in adult South Indian females that can be used as a tool for stature estimation when the limbs are not available for the examination. According to Campobasso et al. [20] scapula sample can be reliably employed for the estimation of stature in forensic practice in absence of intact or fragmented long limb bones. Nagesh et al. [21] estimated the stature from different segments of the vertebral column in the South Indian population.

Conclusion

Identification of an individual from fragmented remains is still a very challenging task for forensic experts in spite of so many studies carried out across the globe. This is because equations formulated in a particular population do not always fit worldwide; not only because of sex differences but also because of ethnic, dietary, climatic variations amongst others. Sometimes obesity makes percutaneous measurements difficult and may increase the margin of error. But if different measurements from different body parts are compared we can conclusively determine the stature of an individual from unknown human remains. More studies need to be conducted to estimate the stature from different parts of the body in other racial groups and different geographical areas, as it is extremely useful to estimate stature when only fragmented human remains and mutilated bodies are available for examination.

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