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Original Article

An Autopsy-Based Correlation Study about Developing Standards for Estimation of Stature from Anthropometry of Combined Length of Forearm and Hand in Male Population of Central India Region (Indore, MP)

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ABSTRACT

Estimation of stature holds a special mention in the field of forensic medicine and forensic anthropology, Among the various parameters of identification, In our institute estimation of stature has obvious utility in identification process as there are number of cases are reported every year where identity remains unknown. This study will be conducted to find out possible correlation between stature of an individual and combined length of forearm and hand and derive regression formula to estimate the stature from anthropometry of combined length of forearm and hand. This cross-sectional study was carried out on 250 deceased males of age 21 years and above brought for post mortem examination in mortuary of Forensic Medicine Department, M.G.M. Medical College and M.Y. Hospital, Indore (MP).The mean combined length of right and left forearm and hand in males was 45.87 ± 2.31 and 45.90 ± 2.31 respectively, whereas mean stature was found to be 163.82 ± 5.42 cm in males. In this study maximum stature in males was found to be 179.5 cm, while minimum stature was found to be 153.6 cm. It can be concluded that this study has provided regression equations for parameters that can be used for stature estimation in the population of Indore. These equations should not be used for other Indian population groups. Definite proportion exists between the stature and combined length of forearm and hand in all individuals

Keywords: Identification, Anthropometry, Stature, Combined length of forearm and hand

INTRODUCTION

The forensic expert is well aware of the fact that the complete skeleton may not be available at the scene of crime. Hence they may not be able to use anatomical method of stature reconstruction. Thus, the expert may have no choices than to use mathematical method for stature reconstruction due to its obvious advantage that it is workable even if a single long bone of its fragment is available for examination In most advanced countries documented skeletal remains are available to the forensic experts [1]. In India documented skeletal remains are not available for establishing the norms of stature reconstruction. In the absence of documented skeletal material the researchers have focused their attention towards living population groups of India and have taken

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relevant bone length over the skin and correlated them with the stature to find out the degree of relationship between them and subsequently formulated multiplication factor and regression formulae for long bones and their fragments for reconstruction of stature [2]. Thus, the studies conducted by researchers [1–4] in India pertains to use of percutaneous measurement of long bones and their fragments for reconstruction of stature It is opined that, the study of residents of one state are not necessarily applicable to residents of another state [5] due to improved socioeconomic condition, population specially in India, is getting taller, and relationship between height and length of long bones is changed. Hence, fresh formulae are needed for generation [6,7]. Regression formulae and multiplication formulae (M.F.) formed on population need to be revised at least ones in decade to have greater accuracy in the prediction of stature among the living population [1]. Limb bone length is known to be the best indication of stature because, the long bone have got a greater definite correlation to height of an individual [3]. There are no universally acceptable formulae to express relationship in between stature and length of long bones of an individual. Estimation of stature of an individual in India by using formulae given by western workers involves an error of 5%–8% [8]. Various factor like race, sex, side of body, climate, heredity and nutritional status are attributed to variation in the ratio of length of limb bones to that of stature [6,9]. Literature regarding regression equation from this part of the world is scant. However, the only available method for stature estimation in central Indian is multiplication factors derived for Madhya Pradesh thus, this study on subject from central India is undertaken. Our study will be useful for identification of a person by estimating stature when only a part of dead body is available.

'Regression Formulae' have been most commonly adopted for the estimation of stature when bones of their fragments are available. Regression formulae is statistical measure of average relationship between two variable – one independent (long bone length x) and other the dependent height of individual (y). Regression equation is obtained, by various statistical analyses which require mean standard deviation (SD), coefficient of variation and its correlation, regression coefficient, intercept and standard error of mean. In 1899, Pearson first introduced regression equation. He used regression formulae for calculation of stature from length of long bones of right side in French male cadavers. He published paper titled 'reconstruction of stature of prehistoric races and opined that stature is an important racial character [10]. In 1929, Stevenson P.H. worked on 48 northern Chinese male cadavers. He derived stature regression formulae. He suggested that better results from regression formulae will be obtained by applying a formulae peculiar to race itself than by applying a formulae from a second race[11].

The lack of anthropometric data concerning the local population of Indore was felt as the city is prone to disasters like the blast, mass accident. Hence this study was aimed at and concentrated on the Indian population of Indore of known stature of which anthropometric measurements of combined length of forearm and hand were calculated and correlated with stature to find regression formulae. Study was carried out at Department of Forensic Medicine and Toxicology, M.G.M. Medical College and M.Y. Hospital, Indore (MP).

MATERIAL AND METHODS

This cross-sectional study was carried out on a sample of 250 deceased males in mortuary of Department of Forensic Medicine, Mahatma Gandhi Memorial Medical College and M.Y. Hospital, Indore (MP). In this study, convenient sampling procedure was done. Study subjects are all male cases of post-mortem examinations of age more than 21 years. Subjects with skeletal abnormalities, deformities, amputated lower limbs, mutilated and decomposed body were excluded. Written informed consent was taken prior to the research after giving detailed information to the relatives of the subjects regarding the study.

Firstly detailed history was taken both regarding the incident and complete clinical history including operative procedures. Detailed individual demographic data including the height, sex and age were also recorded on

the pre-structured perform. Anthropometric measurements of the combined length of forearm and hand on the left and right side of each individual. Stature of each subject was also recorded. All the measurements were taken in daylight. The measurements were taken twice for accuracy. The measurements were taken using standard anthropometric instruments in centimetres to the nearest millimetres. Proper care has been taken to avoid any excessive compression of underlying tissues and to record the measurement precisely.

Stature is measured as the vertical distance between the vertex and the heel in mid sagittal plane, where the vertex is the highest point on the head when the head is held in Frankfurt Horizontal (FH) plane using Standard measuring tape.

The length of Forearm and hand was measured between tip of olecranon process of ulna and the tip of middle finger of Left hand of the subjects using sliding calliper as well as standard measuring tape. The measurements were taken where the pronated and forearm were placed on flat, hard and horizontal surface with extended and abducted fingers but without any abduction adduction, flexion or extension of wrist-joint so that the forearm was directly in longitudinal axis with the middle finger.

At first, the researcher selected and analysed the variables, then the base line data were represented using tables. Statistical analysis was carried out using IBM SPSS Statistics (IBM, current version 2015-statistical package for the social sciences) software package to calculate linear regression equations and compute multiplication factor. Every questionnaire had a code number to input into the SPSS software. Multiplication factors for hand dimensions were calculated by dividing the stature of an individual by combined length of forearm and hand for each subject in males. The mean values and standard deviation of forearm and hand dimensions were calculated. Pearson's correlation coefficient was calculated to establish the correlation between the stature and combined length of forearm and hand dimensions. Paired sample *t*-test was performed to find the right and left side differences in combined length of forearm and hand dimensions among males. The significance of results was tested using Student's *t*-test. *p*-value was used for testing statistical hypothesis. *p*-value <0.05 was considered as significant and <0.001 as highly significant.

RESULTS

This study was carried out on a sample of 250 deceased males in mortuary of Department of Forensic Medicine, Mahatma Gandhi Memorial Medical College and M.Y. Hospital, Indore (MP). Table 1 shows age wise distribution of the study subjects. In this study, mean age of the study subjects was found to be 44.14 ± 14.17 years. Table 2 shows maximum number of cases were in age group of 21–25 years (12%), whereas minimum

Table 1: Distribution of Anthropometric Parameters for Age in Study Subjects

Variable	Age in years
	Male
Mean	44.14
SD	14.17
Max	80
Min	21
Range	21–80

Table 2: Age-Wise Distribution of Study Subjects

S.No.	Age group (years)	No. of cases	Percentage (%)
1.	21–25 years	30	12
2.	25–30 years	27	10.8
3.	30–35 years	27	10.8
4.	35–40 years	29	11.6
5.	40–45 years	27	10.8
6.	45–50 years	29	11.6
7.	50+ –55 years	29	11.6
8.	55–60 years	25	10.0
9.	60–65 years	15	6.0
10.	65–70 years	3	1.2
11.	70–75 years	5	2.0
12.	75–80 years	4	1.6
13.	80–85 years	0	0.0
14.	85–90 years	0	0.0

Table 3: Distribution of Height among Study Subjects

Variables	Mean	SD	Max	Min	Range
HT in cm	163.82	5.42	179.5	153.6	153.6–179.5

number of cases were in age group 80–85 years and 85–90 years (0 %).

Table 3 shows mean stature in subjects was 163.82 ± 5.42 cm. In this study, maximum height reported was 179.5 cm, whereas minimum height was 153.6 cm. Table 4 shows the statistical analysis for combined length of forearm and hand in study subjects (Figure 1). The table shows that mean combined length of forearm and hand on right side (45.87 ± 2.31 cm) are more than mean combined length of forearm and hand on left side (45.90 ± 2.31 cm) in subjects. In this study, maximum combined length of forearm and hand was 52.6cm, whereas minimum combined length of forearm and hand was 41cm on right side and the range was from 41cm to 52.6 cm, whereas maximum combined length of forearm and hand was 52.4 cm and minimum combined length of forearm and hand was 41.2 cm on left side and the range was from 41.2 cm to 52.4 cm. In this study, average combined length of forearm and hand was found to be 45.89±2.30 cm. Maximum average combined length of forearm and hand was 52.35 cm whereas minimum combined length of forearm and hand was 41.1cm.

Figure 1: Showing Measurement of Combined Length of Forearm and Hand of a Study Subject by a Vernier Calliper

Table 5 shows the regression equation of combined length of forearm and hand with stature. The equation obtained is 67.12 + 2.1080×RCLF&H, 67.34 + 2.1021×LCLF & Hand 66.61 + 2.1185× Av CLF & H, shows that by putting the value of RCLF&H, LCLF & H & Av. CLF&H in the equation stature can be measured.

Table 6 shows statistically significant, positive correlation was seen between all the parameters. In this study, a strong correlation was found between right and left combined length of forearm and hand (r=0.987). A significant correlation was found between combined length of forearm and hand and stature (r=0.668).

DISCUSSION

This study was carried out on a sample of 250 deceased males in mortuary of Department of Forensic Medicine,

Table 4: Statistical Analysis for Combined Length of Forearm and Hand in Study Subjects

Variables	RCLF&H (cm)	LCLF&H (cm)	Av. CLF&H (cm)
Mean	45.87	45.90	45.89
SD	2.31	2.31	2.30
Max	52.6	52.4	52.35
Min	41.0	41.2	41.1
Range	41–52.6	41.2–52.4	41.1–52.35

Table 5: Association of Different Variables for Combined Length of Forearm and Hand with Stature in Study Subjects

Combined length forearm and hand with stature	Regression equation
HT with RCLF&H	67.12 + 2.1080×RCLF&H
HT with LCLF&H	67.34 + 2.1021×LCLF&H
Av. CLF&H with HT	66.61 + 2.1185×ACLF&H

Table 6: Correlation between Different Variables in Study Subjects

Variables	Correlation coefficient (*r*)	Correlation	Impression
Correlation between RCLF&H and LCLF&H	0.987	*P*=0.000*	Strong, positive, statistically significant correlation
Correlation between Av. CLF&H and HT	0.668	*P*=0.000*	Strong, positive, statistically significant correlation

HT, height; RCLF&H, Right combined length of forearm and hand; LCLF&H, Left combined length of forearm and hand; Av. CLF&H, Average combined length of forearm and hand

Mahatma Gandhi Memorial Medical College and M.Y. Hospital, Indore (MP). An attempt was made to correlate combined length of forearm and hand with stature and derive regression equations to calculate stature from combined length of forearm and hand. On the basis of this combined length of forearm and hand, stature was found to be positively correlated and the association was highly significant. The combined length of forearm and hand and stature correlation coefficient (*r*) in males was 0.668. In this study, the mean stature of male subjects was found to be 163. 82 ± 5.42 cm, which was slightly lower than the findings of the other studies except Kumar *et al*.[12] (170.905 ± 6.02), Kumar *et al*.[12] (164.97 ± 5.52), Choudhary *et al*.[14] (169.76 ± 6.23), Illayperuma *et al*. [15] (170.14 ± 5.22) and Vaghefi *et al*.[16] (177.73 ± 5.73) as compared with this study.

The regression equation obtained is 67.12 + 2.1080× RCLF&H, 67.34 + 2.1021× LCLF&H and 66.61 + 2.1185× AvCLF&H in our study. There is variation in mean stature between same sex groups of different studies [17,18]. The stature is determined by several factors which include genetic and environmental factors. This is the reason for wide variation in mean stature amongst individuals of same sex belonging to different endogamous groups.

There is dimensional/proportional relationship between specific body segments and the whole body. Anatomically limbs exhibit consistent ratio relative to the total height of a person and these ratios are linked to the age, sex and race. So the principle of biological correlation of the body parts with each other is applied to estimate stature on an individual. Although anthropometric measurements (stature and built) differ in different sex and ethnic groups due to demographic factors and are strongly influenced by genetic and environmental factors, suggesting the need for different nomograms for each endogamous group. Furthermore, the need for the alternative formulae for the genders is also proved as the rate of skeletal maturity in both sexes vary during the course of development. The results of this study can be used as baseline information for population-based studies in central region of Madhya Pradesh, India. So that anthropologists, forensic and other medico-legal experts can estimate the stature of the individual of this part of India of either sex by the use of combined length of forearm and hand within the standard error of estimate. One must consider differences between populations to apply such formula to other populations.

These types of studies are of medico-legal importance, as the first step in forensic analysis is establishing the identity of the person in question, where stature remains one of the primary characteristics of identification. So the findings of this study will be useful for forensic experts and anthropologists. These studies also help to know the differences between different population groups.

REFERENCES

[1] Nath BS. Use of lower limb measurements in reconstructing stature among Shia Muslims. Internet Journal of Biological Anthropology 2009;2(2):86–97.

[2] Nath B. Estimation of stature from measurements of lower limbs. Anthropologist 2007;3:219–222.

[3] Mohanty KN. Prediction of height from percutaneous tibial length amongst Oriya population. Forensic Science International 1998;98(3):137–141.

[4] Kate BR, Muzumdar RD. Stature estimation from femur and humerus by regression and autometry. Acta Anatomica 1976;94:311–320.

[5] Siddiqui MAH, Shah MA. Estimation of stature from long bones of Punjabis. Indian Journal of Medical Research 1944;32:105–108.

[6] Trotter M, Gleser GC. Estimation of stature form long bones of American Whites and Negroes. American Journal of Physical Anthropology 1952;10:463–514.

[7] Lal CS, Lala JK. Estimation of height from tibial and ulnar lengths in North Bihar. Journal of Indian Medical Association 1972;58(4):120–121.

[8] Athawale MC. Estimation of height from length of forearm bones. A Study of 100 Maharashtrian male adults of ages between twenty five and thirty years. American Journal of Physical Anthropology 1963;21: 105–112.

[9] Kolte PM, Bansal PC. Determination of regression formulae for reconstruction of stature from long bones of upper limb in Maharashtrian of Marathwada region. Journal of the Anatomical Society of India 1974;23:611.

[10] Pearson K. Mathematical contributions to the theory of evolution. V. On the reconstruction of the stature of prehistoric races. Philosophical Transactions of the Royal Society of London 1899;192:169–244.

[11] Stevenson PH. On racial differences in stature long bone regression formulae, with special reference to stature reconstruction. Chinese Biometrka 1929;21(1–4):303–321.

[12] Kumar A, Srivastava AK, Verma AK. Estimation of stature by percutaneous measurements of distal half of upper limb (forearm & hand). Journal of Indian Academy of Forensic Medicine 2010;32(4):325–328.

[13] Srivastava A, Sahai M. Estimation of stature by anthropo-metric examination of forearm and hand. Journal of Indian Academy of Forensic Medicine 2010;32(1):62–65.

[14] Choudhary S. Estimation of stature from combined length of forearmand hand in Jammu region of India. International Journal of Basic and Applied Sciences 2014;3(1).

[15] Ilayperuma I. Prediction of personal stature based on the hand length. Galle Medical Journal 2009;14(1).

[16] Vaghefi SHE, Sheikbahaei F, Mokhtari T, Khademi F, Bahari H, Ghorbani R. A model for individual height estimation from forearm length in natives of Kerman, Iran. Aesthetic Surgery Journal 2014;11(3):141–144.

[17] Krishan K. Anthropometry in forensic medicine and forensic science-Forensic anthropometry. Internet Journal of Forensic Science 2007;2(1).

[18] Kanchan T, Krishan K, Sharma A, Menezes RG. A study of correlation of hand and foot dimensions for personal identification in mass disasters. Forensic Science International 2010;199(1–3):112.e1–6.