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Estimation of Stature from Cephalo-facial Measurements in Adult Nepali Females of Kurseong

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Abstract

Estimation of stature is one of the most important aspects in forensic investigation for personal identification. The objective of the present study was to derive regression equations to estimate stature from different cephalo-facial measurements in adult Nepali females. The sample for the study constituted one hundred and eight adult females from Kurseong of Darjeeling district, India. The age range of the participants was between 18 to 46 years. Anthropometric measurements include stature (ST) and five cephalo-facial measurements namely head length (HL), head breadth (HB), head circumference (HC), morphological facial height (MFH) and bizygomatic breadth (BB). The mean age of the studied population was 35.36 (SD, 8.57) years. Results of the Pearson's correlation coefficient of stature with different cephalo-facial measurements revealed that all cephalo-facial measurements were positively correlated with stature. Results of the linear regression analysis revealed that BBgives the most accurate estimation of stature by linear regression analysis.

Keywords: Cephalo-Facial; BizygomaticBreadth; Stature; Forensic Anthropology.

Introduction

Estimation of stature is one of the most important aspects in forensic investigation for personal identification. Along with age, sex and ancestry stature helps in narrow down the pool of probable victim in the forensic investigation and also helps in establishing the personal identity of the individual (Krishan et al., 2011). Estimation of stature turns out to be a very important in medico legal and forensic examination, especially when unknown, highly decomposed, mutilated bodies and fragmentary like cephalo-facial remains are examined for personal identification (Krishan, 2008; IIayperuma, 2011). Stature has a proportional biological relationship with other parts of the human body including head, face, trunk and extremities. This association helps an investigator to estimate stature from fragmented and mutilated body parts in forensic examinations (Bidmos 2008; Mansur et al., 2014). Many studies have been conducted on the estimation of stature from various body parts like hands (Habib and Kamal, 2010), vertebral column (Nagesh and Kumar, 2006), limbs (Hasegawa et al., 2009), long (Smith, 2007) and short bones (Abdel-Moneim et al., 2008), foot and footprints (Robbins, 1986; Ozaslan et al., 2012). It was observed that long bones are relatively better in accuracy for prediction of stature (Krishan, 2007). Since all these body parts and bones may not always available for forensic examination, studying other body dimensions like cephalo-facial measurements (Krishan 2008; Agnihotri et al., 2011) for the estimation of stature is also very important for the uncertainty of the available body remains especially in mass disasters such as earthquakes,bomb blasts, air plane crashes and other high impact accidents. Although some (Krishan 2008; Agnihotri et al., 2011) formulae forstature estimation using different cephalo-facial measurements have been proposed, there isconcern regarding the accuracy of the use of these population specific equation on other populations. There are no generally applicable formulae for the estimation of stature using cephalic-facial measurements as the relationships between cephalo-facial measurements and stature varies with age, sex and ethnicity. This envisages theneed for population specific studies in the process of personal identification. In view of the above, the objective of the present study was to derive regression equations to estimate the stature from different cephalo-facial measurements in adult Nepali females.

Materials and Methods

The present study was carried out in Kurseong of Darjeeling disteict, West Bengal, India. It was carried out among randomly selected adult Nepali speaking Hindu females. A total of one hundred and eight females were incorporated in the present study. Participants included in the present study were free from any deformity of the foot and vertebral column. The age range of the participants was between 18 to 46 years.

Anthropometric measurements include stature (ST) and five cephalo-facial measurements namely head length (HL), head breadth (HB), head circumference (HC), morphological facial height (MFH) and bizygomatic breadth (BB). Both stature and cephalo-facial measurements were taken following standard techniques (Mukherji et al., 2009). In brief, stature was the linear distance between floor of standing and vertex, in erect position. HL is the linear distance between glabella and opisthocranion in the median plane. HB is the linear distance between the two euryons. HC is measured from glabella to glabella which has passed through the opisthocranion. MFL is the linear distance between nasion and gnathion. BB is the linear distance between two zygia. All measurements were measured to the nearest 0.1 cm using a moveable anthropometer, sliding caliper, spreading caliper and inelastic measuring tape.

Descriptive statistics were performed by mean, standard deviation (SD), standard error (SE) and range. Multiplication factor as well as linear regression equations was derived to estimate stature by cephalo-facial measurements, using stature as the dependent and cephalo-facial measurements as an independent variable. The statistical analysis was done using the Statistical Package for Social Sciences (SPSS).

Results and Discussion

The mean age of the studied population was 35.36 (SD, 8.57) years. The mean stature was 150.97 (SD, 7.26) cm. Mean, SD and range of cephalo-facial measurements of the studied population arepresented in Table 1.

Table 2 shows the result of multiplication factors for the estimation of stature from cephalo-facial measurements. Results of the Pearson's correlation co-efficient of stature with different cephalo-facial measurements revealed that all cephalo-facial

Table 1: Characteristics of the studied population

Variables	Mean	SE	SD	Minimum	Maximum	Range
Age (years)	35.36	0.82	8.57	18.00	46.00	28.00
Stature (cm)	150.97	0.69	7.26	131.70	166.20	34.50
Head Length (cm)	17.56	0.06	0.63	16.00	19.00	3.00
Head Breadth (cm)	14.29	0.07	0.77	12.50	19.30	6.80
Head Circumference (cm)	55.98	0.15	1.61	52.00	65.50	13.50
Morphological Facial Height (cm)	10.47	0.06	0.59	9.00	11.90	2.90
Bizygomatic Breadth (cm)	12.80	0.08	0.82	11.30	17.40	6.10

Table 2: Multiplication factors for estimation of stature (in cm) from head and face measurements

Variables	Mean	SD
Head Length (cm)	8.60	0.48
Head Breadth (cm)	10.59	0.71
Head Circumference (cm)	2.70	0.14
Morphological Facial Height (cm)	14.46	0.92
Bizygomatic Breadth (cm)	11.82	0.71

Table 3: Linear regression models for estimation of stature (in cm) from head and face measurements

Variables	Regression Equation	SEE
Head Length (cm)	ST=118.59 + 1.84 (HL)	7.20
Head Breadth (cm)	ST=147.32 + 0.26 (HB)	7.29
Head Circumference (cm)	ST=112.92 + 0.68 (HC)	7.21
Morphological Facial Height (cm)	ST=113.27 + 3.60 (MFH)	6.97
Bizygomatic Breadth (cm)	ST=106.94 + 3.44 (BB)	6.72

HL-head length; HB-head breadth; HC-head circumference; MFH-morphological facial height; BB-bizygomatic breadth.

measurements were positively correlated with stature. Similar positive associations were also observed in other studies (Agnihotri et al., 2011; Mansur et al., 2014; Swami and Patnaik., 2015). This might be due to the fact that like stature cephalo-facial dimensions of skull are also genetically determined (Agnihotri et al., 2011). Table 3 shows the linear regression models derived for reconstruction of stature from each cephalo-facial measurements in the studied population.

Stature is the most important anthropometric parameter for the determination the physical identity of an individual. Thus, estimation of stature is an important step in the identification of skeletal remains. Anthropometry being an inexpensive technique is widely used in forensic investigation to approximate stature for the purpose of identification and different methods have been used to formulate equations for estimation of stature (Sheta *et al.*, 2009). It was observed in the present study that stature can be estimated more accurately from bizygomatic breadth than other cephalo-facial measurements. Bizygomatic breadth gives the most accurate estimation of stature by linear regression analysis. Though the SEE value waslowest for bizygomatic breadth followed by morphological facial height, accuracy of other cephalo-facial measurements in predicting stature was comparable. In contrast, in a recent study Ukoha et al. (2015) observed that horizontal head circumference had the lowest SEE. In another study conducted in Indo-Mauritian population, Agnihotri et al. (2011) observed strongest association of stature with horizontal head circumference. In contrary Pelin et al. (2010) found that head length wasstrongly correlated with stature and Jibonkumar and Lilinchandra (2006) [7] demonstrated highest correlation of stature with bigonial breadth. However, study in Haryanvi Baniyas revealed that the most reliable facial measurement to estimate stature using regression analysis among males was morphological facial length(Swamiand Patnaik.,2015). Thisinconsistency in relationship might be due to the ethnic variations in cephalo-facial measurements and stature as well as in their relationships. It is well established that the racial characters are best defined in the skull (Krishan and Kumar, 2007).

Conclusion

The results of the present study indicate that stature can be estimated from different cephalo-facial measurements in situations where cephalo-facial remains are available for forensic examinations. It was also observed that the regression equation derived from bizygomatic breadth was more reliable than those from other cephalo-facial measurements to predict stature among Nepali speaking Hindu females. However, owing to vast ethnic diversity in Indian population, it is important to conduct similar studies in other ethnicgroups to develop population specific regression equations for the identification of individuals from human remains.

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