Use of Head Circumference as a Predictor of Height of Individual

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ABSTRACT

Background

Establishing personal identity is one of the main concerns in forensic investigations. In forensic anthropology, estimation of height from head circumference has a significant role in establishing personal identity.

Objective

The objective of the present study was an attempt to understand the relationship between height and head circumference of an individual and to derive regression formulae to estimate the height from the head circumference.

Method

The present study consisted of 440 (258 male and 182 female) students of age group 17 to 25 years studying in Kathmandu University School of Medical Sciences, Dhulikhel, Nepal during the period from November 2012 to October 2013. Height and head circumference of an individual were measured in centimeter. Data were analyzed by using statistical software SPSS-16

Result

The findings of the present study were significant correlation between height and head circumference ($r = 0.443$, $p < 0.01$ for male, $r = 0.302$, $p<0.01$ for female, and $r = 0.398$, $p < 0.01$ for combined (male and female). The regression equation for height and head circumference was found to be $Y = 1.734X + 70.36$ ($R^2 = 0.196$) for male, $Y = 0.916X + 106.8$ ($R^2 = 0.091$) for female, and $Y = 1.648 X + 71.69$ ($R^2 = 0.158$) for combined (male and female), where Y is the height of Individual and X is the Head Circumference.

Conclusion

Head circumference showed highly significant positive correlation with individual's height. Therefore, the present study will help in medico-legal cases in establishing the identity of an individual and this would also be useful for Anatomists and Anthropologists.

KEY WORDS

F*orensic anthropology, head circumference, height of individual*

INTRODUCTION

Stature or body height is one of the important and useful anthropometric parameter that determines the physical identity of an individual.[1] Stature has a definite and proportional biological relationship with each and every part of the human body, i.e. head, face, trunk and extremities. This relationship helps a forensic scientist to calculate stature from dismembered and mutilated body parts in forensic examinations. For such a calculation, two methods, i.e. regression method and multiplication method have been extensively used by the scientists all over the world, and it has been universally concluded that the regression analysis provides best estimates for stature reconstruction.[2-6] Although a number of long bones are used for this purpose but cranial dimensions are more reliable and precise mean of predicting the stature.[7,8]

Though works concerning estimation of stature from long bones as well as from certain body dimensions have been put forward for some of the Nepalese populations, works concerning estimation of stature from head dimensions are scanty. As any part of the human body can be found as the evidences, there is perhaps a need to investigate whether there is any possible significant correlation between stature and head dimension in human body.

Estimation of height from head circumference has also attracted many authors to derive a formula, but no significant formula has been derived to calculate the height from the head circumference in Nepalese population. Hence in the present study an attempt has been made to find out the correlation between height of individual and head circumference and to derive regression formulae to estimate the height from the head circumference in the Nepalese population.

METHODS

The study was an observational, cross-sectional and descriptive in nature with some analytical components. The present study consisted of 440 (258 male and 182 female) asymptomatic, healthy students studying in Kathmandu University School of Medical Sciences, Dhulikhel, Nepal under Department of Anatomy. Healthy individuals were included in the study after taking informed consent, belonging to various religious and regions. The participants were aged between 17 – 25 years. Students were chosen for the easy availability of the subjects. The subject having any disease or deformity was not included in this study. Height and head circumference of an individual were measured in centimeter.

Height of the individual was measured in standing erect anatomical position with standing height measuring instrument in centimeter. Head circumference was measured by the measuring tape which was encircled the head just above the supercilliary arch on the anterior aspect, just above the auricle on the lateral aspect and at the level of external occipital protuberance on posterior aspect in centimeter. Data were analyzed by using statistical software SPSS-16 and Excel.

RESULTS

As shown in table 1, the height varied from 134 cm to 183 cm with the mean height of 165.66 ± 8.34cm SD in male and from 140 cm to 185 cm with the mean height of 156.704 ± 6.161 cm SD in female. It was observed that height of male was more than the height of female. The head circumference ranges from 48 cm to 67 cm with an average of 54.960 ± 2.130 cm SD in male and from 50 cm to 63 cm with an average of 54.444 ± 2.028 cm SD inh female. The height of combined male and female varied between 134 cm - 185 cm with the mean height of 161.955 ± 8.713 cm SD and the head circumference varied from 48 cm to 67 cm with the mean of 54.746 ± 2.102 cm SD.

Table 1. Statistical Measurements of Height and Head Circumference.

Statistics	Sex					
	Male (258)		Female (182)		Male and Female (combined)	
	Height	Head circum-ference	Height	Head circum-ference	Height	Head circum-ference
Range (cm)	134 – 183	48 – 67	140 – 185	50 - 63	134-185	48-67
Mean (cm)	165.660	54.960	156.704	54.444	161.955	54.746
Standard Deviation (SD)	8.344	2.130	6.161	54.444	8.713	2.102
Correlation (r)	r = 0.443		r = 0.302		r = 0.398	
Regression Coefficient (b)	1.734 (p < 0.01)		0.916 (p < 0.01)		1.648 (p < 0.01)	
Value of constant of regression equation (a)	70.36		106.8		71.69	

As shown in table 1, there were significant correlation between height and head circumference (r = 0.443, p < 0.01 for male, r = 0.302, p<0.01 for female, and r = 0.398, p < 0.01 for combined (male and female). It showed that there was strong positive correlation between height and head circumference for male as compared to female. Linear regression analyses were performed for estimation of height using the head circumference as independent variables. Pearsons' correlation coefficient was used to find the relationship between the head circumference and individual's height. Scatter diagram and linear regression lines demonstrating the relationship between height and

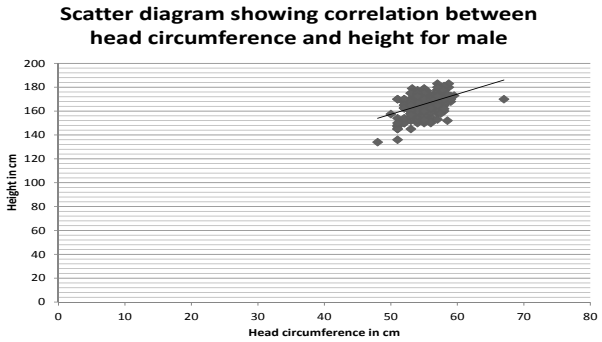

Figure 1. Scatter diagram showing correlation between head circumference and height for male

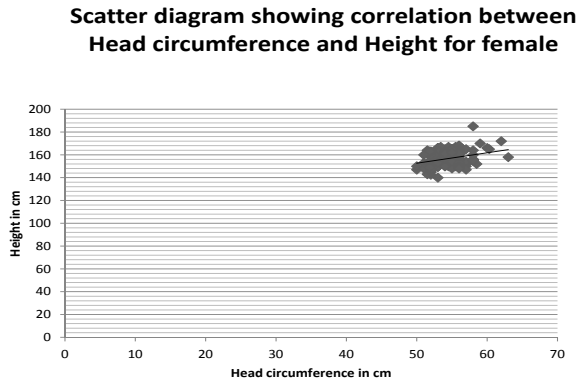

Figure 2. Scatter diagram showing correlation between head circumference and height for female

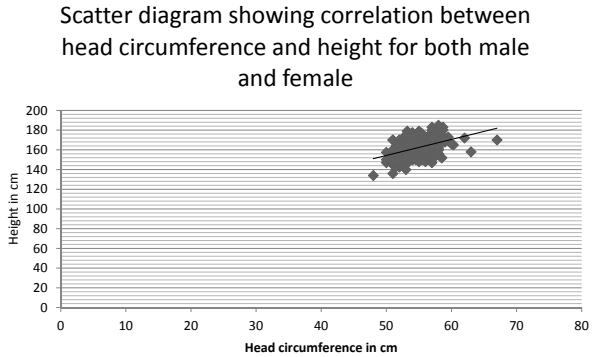

Figure 3. Scatter diagram showing correlation between head circumference and height for both male and female

head circumference are shown in Fig 1- 3. Simple regression formulae were generated for both sexes for prediction of height from head circumference as follows:

Regression Equations are:

Height = value of constant (a) + regression coefficient (b) × head circumference.

For Male: $Y = 70.36 + 1.734X$ ($R^2 = 0.196$)

For Female: $Y = 106.8 + 0.916X$ ($R^2 = 0.091$)

For both Male and Female: $Y = 71.69 + 1.648\ X$ ($R^2 = 0.158$)

Y is the height of individual and X is the head circumference.

Therefore, if either of the measurement of head circumference or body height is known, the other can be calculated and this would be useful for Anatomists, Anthropologists and Forensic Medicine experts.

DISCUSSION

When the body has been mutilated, it is common to have the extremities or head amputated from the trunk. An estimate must then be made based on the known relationship of the remains to stature.[9] Various studies have been conducted on the estimation of stature from the human skeleton. Although variety of methodologies have been proposed to predict stature from various bones, regression analysis proved to be the easiest and the most reliable method.[10]

In the present study head circumference was found to be good parameter for predicting individual's height. A significant correlation coefficient was observed between height of individual and head circumference. The linear regression equation derived from head circumference for estimation of height, showed a statistically highly significance amongst the students of Kathmandu University School of Medical Sciences, Dhulikhel, Nepal. The students were chosen for the easy availability of the subjects. Evaluation and comparison of present findings with the previous studies revealed several differences as well as similarities.

In 2008, Krishna et al studied 252 Koli male adolescents from North India and suggested that head circumference were significantly correlated with stature. Their correlation coefficient between head circumference and height was +0.781 in male which was more than the value (+0.443 in male) found in the present study.[11] Therefore, there was stronger positive correlation between height and head circumference in North Indian male than Nepalese male. Akhter et al, 2009 conducted a study in Bangladesh and measured head circumference and height of 100 Garo female and advised head circumference showed significant positive correlation with stature (+0.278)[12] which was slightly less than the finding (+0.302) of the present study. Therefore, head circumference was slightly better correlation with stature of Nepalese female than Bangladeshi female.

In 1981, a study was done by Saxena et al, who derived a regression equation between head length and height.[13] Their correlation coefficient between head length and height was +0.2048 which was relatively less than the correlation coefficient between stature and head circumference of the present study (+0.398). Therefore, head circumference was found to be better than the head length for estimating individual's height. But contrary to the present study, head length was having strong positive correlation with stature of both genders which was suggested by various authors in different regions of India such as Jadav et al, 2004 in Gujarat region (+0.53), Krishan, 2008 in North India (+0.775); and Seema and Mahajan, 2011 in Punjab zone (+0.52),India.[7,12,14]

A study was conducted on 87 male bodies subjected to medicolegal autopsy and the relationship between body height and cranial sutures of male was examined.[15]

According to them, coronal suture was having positive correlation (+0.363) with stature but sagittal suture having poor correlation (+0.090) which were less than the finding (+0.443) of the present study.[15] So, the head circumference was found to be having better significant correlation with height than coronal and sagittal sutures.

In 2006, a study done by Kumar and Chandra on 199 male Kabuis of the Imphal valley, India in the age group of 18 to 45 years revealed that height of individual was correlated with total facial height (+0.213), physiogonomic facial height (+0.245), external bi-ocular breadth (+0.326), inter-ocular breadth (+0.273), breadth of bizygomatic arch (+0.185) and bi-gonial breadth (+0.365)which were less than the value obtained in the present study (+0.443).[16] Therefore, the head circumference was found to be good parameter for predicting individual's height than the facial measurements.

From above facts, it is clear that the head circumference is also one of the best parameter which is found to be having strong significant correlation with height of individual. Therefore, if either of the measurement of head circumference or individual's height is known, the other can be estimated and this fact may be of practical use in Medico-legal investigations and in Anthropometry.

In the present study, age range of only 17 to 25 years was considered.

Measurements of only healthy individuals were considered. Hence the data may not be applicable to individuals who are malnourished and/or suffering from congenital structural malformations.

Applicability of anthropometric measurements in living and deceased individuals may practically differ.

The present study is a preliminary one and would be followed up by other studies to address the above limitations.

CONCLUSION

The present study concluded that head circumference has a strong relationship with height of an individual in Nepalese population. Hence, the height of an individual can be successfully estimated from the head circumference using different regression equation derived in the present study. It will help in medico-legal cases in establishing identity of an individual when only some remains of the body are found as in mass disasters, bomb explosions, accidents etc. If either of the measurement (head circumference or individual's height) is known, the other can be predicted and this would be useful for Anthropologists and Forensic Medicine experts. It will also help in establishing identity in certain civil cases.

There are lot of variations in estimating height from limb measurements among the people of different regions and races. Hence there is a need to conduct more studies among the people of different regions and ethnicity so that height estimation becomes more reliable and identity of an individual is easily established.

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