Estimation of Height from Measuring Foot, Hand and Head Length in Northern Indian Population

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ABSTRACT

BACKGROUND & OBJECTIVES: Estimation of height from foot length, hand length and head length is important for forensic experts for establishing the identity, for anthropologists regarding data collection and research and for epidemiologists in performing statistical analysis. The aim of the study was to deduce the height from foot length, hand length and head length in North Indian population by conducting a pilot study in medical students of North India

MATERIALS & METHODS: Ethical clearance was taken from college human ethical committee. A total of 194 students both male and female with the age group 19-23 years were analyzed by SPSS software. The foot length, head length, and hand length was correlated with estimation of height by using linear and multiple regression analysis. Results were compared among male and female in similar age group.

RESULTS: It was found that hand and foot length is strongly associated with height whereas head length showed no correlation with the height in both male and females.

CONCLUSION: Hand length and foot are strong predictors for estimating the height of an individual.

Key words: Height, hand length, foot length, head length, anthropometry, identification.

الملخص

المقدمة: تقدير الطول من طول القدم، طول اليد، وطول الرأس مهم جدا بالنسبة لخبراء الطب الشرعي وذلك لتحديد الهوية، ولعلماء الأنثروبولوجيا فيما يتعلق بجمع البيانات والبحوث، ولعلماء الأوبئة لأداء التحليل الإحصائي. **هدف الدراسة:** الاستدلال على طول الجسم بواسطة معرفة طول القدم، طول اليد وطول الرأس في سكان شمال الهند عن طريق إجراء دراسة تجريبية في طلاب الطب من شمال الهند. **منهج الدراسة:** بعد أخذ الموافقة الأخلاقية، تم تحليل قياسات طول القدم واليد والراس لعدد 194 طالب من الذكور والإناث من الفئة العمرية 19-23 عاما بواسطة برنامج SPSS. تم حساب الارتباط بين طول القدم وطول اليد وطول الرأس مع تقدير طول الجسم باستخدام التحليل الخطي والتراجع المتعدد. وتمت مقارنة النتائج بين الذكور والإناث في نفس الفئة العمرية. **النتائج:** لقد وجد ارتباط قوي بين طول اليد وطول القدم مع طول الجسم في حين لم يظهر طول الرأس أي ارتباط مع طول الجسم في كل من الذكور والإناث. **الخلاصة:** لطول اليد والقدم القدرة القوية لتقدير طول الفرد .

INTRODUCTION

All human beings are not identical; they differ in their measurements; even monozygotic twins are different, and this can be attributed to different geographic location, diet and socioeconomic status. Height is an important indicator of nutritional status, body surface area, growth and pulmonary function. It can useful for forensic experts for the identification of unidentified human body. It also facilitates anthropologist for determining the race. Therefore, the estimation of height from different body parts is of utmost importance as height measurement by long bones was done frequently in the past and deduced different formulae for different bones. In the current study, we used hand, foot and head length which can be correlated with living or dead human body for height estimation. Height estimation by long bones was done in the past[1-4]. Attempts had been in the past to estimate height by using foot length[5-7]. All of them stressed upon the importance of morphometric analysis of the human body, especially estimation of height by different methods.

MATERIALS AND METHODS

It was a cross-sectional study by design. A total of 194 (Males=107 and Females=87) asymptomatic, apparently healthy, young adult of age group 19-23 years were selected. The data was collected from

Received on: 25th September, 2014; Accepted on: 15th January, 2014

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August 13, 2013 – January 25, 2014. The sample size was calculated using level of precision formula. All of the subjects were students of Government Dental College at Aligarh. Their socioeconomic and nutritional status was not assessed and four parameters were assessed i.e., Height, Foot Length, Hand length, Head length.

Measurements were taken by using standard anthropometric instruments in centimeters to the nearest millimeter according to techniques described. [8] Height of the individual was measured in standing erect anatomical position with standing height measuring instrument. Head length was measured by measuring tape from glabella to inion Foot length was considered as the maximum length between the most prominent posterior point of the heel and the tip of hallux and the tip of the second toe if it is larger than the hallux. Hand length –The distance between the midpoint of the inter styloid line and the tip of the middle finger in extension.[9-10]

OBSERVATION AND RESULTS

The data was analyzed by SPSS software, and the methods were used with linear and multiple regression analysis. The observations were done on 107 male and 87 female students. Correlations were applied to observe the direction of the relationship between various parameters. The results showed that, in males, significant positive correlation was observed between height & hand (r=0.932, p<0.001), height & foot (r=0.896, p<0.001) and between hand & foot (r=0.865, p<0.001). In females, also significant positive correlations were observed between height & hand (r=0.952, p<0.001), height & foot (r=0.920, p<0.001) and between hand & foot(r=0.897, p<0.001). However, in both males and females; head length was not significantly correlated with hand, foot and height (p>0.05). Table 1, 2 and 3 reflects linear regression analysis for observations among males, females and total cases respectively. It clearly reflects that foot and hand length are very good indicators of height as p value<0.001. On the other hand, head length is not significant (p value < 0.05).

Multiple linear regression analysis was also applied separately in males and females to develop a model for predicting height from hand, foot, hand and head length. In males, the three predictor model was able to account for 89.7% of the variance in height, F (3, 106) = 308.83, p<0.001, adjusted R2 = 0.897. Hand and foot were the significant predictors for height (p<0.01) respectively. In females, the three predictor model was able to account for 86.3% of the variance in height, F (3, 86) = 181.72, p<0.001, adjusted R^2 = 0.863. For females also, hand and foot were the significant predictors for height (p<0.01) respectively. However, head length was the non-predictable parameter for height in both males and females (p>0.05) respectively.

Table 4, 5 and 6 reflects multiple regression analysis in which hand and foot length are highly significant (p value<0.001), whereas head length is a poor indicator of height.

Table 1. Estimation of Height from Measuring Foot, Hand and Head Length in Male cases

Parameter	Correlation coefficient (r)	Regression equation	p value
Foot	0.896	Height = -68.409+9.902	<0.001
Hand Length	0.932	Height = -12.076+9.559	<0.001
Head Length	-0.116	Height = 185.238–1.216	0.234

Table 2. Estimation of Height from Measuring Foot, Hand and Head Length in Female cases

Parameter	Correlation coefficient (r)	Regression equation	p value
Foot	0.952	Height = -37.285+8.917	<0.001
Hand Length	0.920	Height = 129.221+6.528	<0.001
Head Length	0.035	Height = 149.769+0.274	0.750

Table 3. Estimation of Height from Measuring Foot, Hand and Head Length in total cases

Parameter	Correlation coefficient (r)	Regression equation	p value
Foot	0.882	Height = 23.054+6.047	<0.001
Hand Length	0.764	Height = 84.985+4.266	<0.001
Head Length	0.088	Height = 141.630+1.013	0.221

Table 4. Multiple Regression Analysis for Estimation of Height from Measuring Foot, Hand and Head Length in Male cases

Parameter	Multiple correlation coefficient (R and R2)	Regression equation	p value
Foot	R= 0.947 R2= 0.897	Height = -46.864 + 6.954 + 6.388 + 0.024	<0.001
Hand Length			<0.001
Head Length			0.942

Table 5. Multiple Regression Analysis for Estimation of Height from Measuring Foot, Hand and Head Length in Female cases

Parameter	Multiple correlation coefficient (R and R2)	Regression equation	p value
Foot	R= 0.947 R2= 0.897	Height = -41.939 + 8.897 + 7.356 + 0.271	<0.001
Hand Length			<0.001
Head Length			0.905

Table 6. Multiple Regression Analysis for Estimation of Height from Measuring Foot, Hand and Head Length in Total cases

Parameter	Multiple correlation coefficient (R and R2)	Regression equation	p value
Foot	R = 0.822 R2 = 0.759	Height = 38.159 + 5.461 + 4.646 - 0.745	<0.001
Hand Length			<0.001
Head Length			0.261

DISCUSSION

The current study predicts height from head, hand and foot length. Results showed height depends on hand and foot length whereas head length has no correlation with the height. Height was estimated from foot/shoe measurements.[11] Whereas ethnic differences were found between foot and height measurements,[12] Singh and Phookan reported that height estimation by foot length measurement gives better results than height estimation by foot width measurement. Ashizawa et al. stressed that the morphometric assessment must be done with the attention to society.[13] Print media was used by Jasuja and Manjula.[14] The study conducted by Singh JP et al. showed that bare foot measurements are the better predictor of height than shoe measurements.[15]

One of the similar research done by Abdel-Malek et al. concluded that, in multiple linear regression analysis, R2 was 0.68 for hand length, which means if one have hand length, the height can be calculated with 68% accuracy.[16] Similarly this study found R^2, for hand, foot and head length were 0.897 among males, and 0.863 among females, that showed that if the hand, foot and head length altogether available, the height can be predicted with 89.7% accuracy in males and 86.3% accuracy in females (Table 4, 5). Hands and feet are quite good indicator of height, these findings of the current study are in alignment wit study conducted by Kewal[17] that the multiple regression equations are more reliable than linear regression equations. Height prediction by head length alone was found to be insignificant and no correlation was found between head length and height in either sexes. This observation was congruous with the findings of Sonali Khanapurkar.[18] Further study is required to confirm.

CONCLUSION

After comparing all the parameters, it was conclude that foot length (r=0.952) is a better indicator of height in females whereas hand length (r=0.932) is the best indicator of height among males. Head length cannot be used to predict the height as no significant correlation has been found between head length and hand length, foot length, height (P>.05). If all the three parameters were taken together, the accuracy increases in both males and females [r= 0.947 (males), r=0.928 (females)]. It is also clear from the observations that the multiple regression analysis is more effective tool for predicting height more accurately than linear regression analysis.

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