LENGTH OF EXTERNAL EAR: A TOOL FOR PREDICTION OF HEIGHT- STUDY IN WESTERN MAHARASHTRA POPULATION

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ABSTRACT

BACKGROUND

In medicolegal and forensic examination, estimation of stature is considered an important anthropometric parameter that defines physical identity of an individual. Therefore, present study was carried out to investigate the utility of estimating stature from length of external ear in western Maharashtra population and predict the accuracy of regression equation.

MATERIALS AND METHODS

The length of right and left external ear was measured by using vernier calliper and measurement of height of person done by using standard height frame. This study was carried on 102 males and 102 females with the age of 18 to 30 years.

RESULTS

Data were analysed by SPSS version 20. Mean and standard deviation of stature, ear length and correlation coefficient between ear length and stature was observed. A linear equation model for prediction of stature was generated from given measurement of external ear.

CONCLUSION

Present study showed significant positive correlation between ear length and stature from western Maharashtra population. Finally, it is concluded that length of ear can be used as an additional tool in estimation of nearly accurate stature. This study is useful in forensic anthropology and for medicolegal purpose to estimate the approximate height of the individual.

KEYWORDS

Age, regression equation, vernier caliper.

BACKGROUND

Anthropology is the study of humans. Individuality of person means personal identification. Most useful anthropometric parameter is stature or body height that determines physical personal identity of an individual. Stature measurement is also essential for identification of skeletal remains and for comparison of different population. In anthropological research, stature prediction occupies central position for medical jurisprudence or for medicolegal experts.[1]

Ears in humans are the defining feature of the face and its structure shows the signs of age and sex. Human ear consists of external, middle and internal parts. Pinna forms part of external ear. The lateral surface of pinna is irregularly concave and shows various prominences and depressions.[2]

Many studies have been carried out to estimate stature by measuring the length of long and short bones of upper and lower limbs and feet. A number of regression equations derived to determine stature from long bones.[3-7]

The present study was carried out to investigate the utility of estimating stature from length of external ear in western Maharashtra population and predict the accuracy of regression equation.
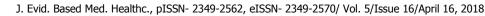
MATERIALS AND METHODS

Study subjects are 102 males and 102 females of Western Maharashtra origin, within age group 18-30 years irrespective of their caste, religion, dietary habits and socioeconomic status. The present study is aimed at predicting the stature from the length of both ears.

Vernier calliper, Anthropometer, data sheet, consent form. Subject with normal pleasing face with no any craniofacial abnormality, with no history of plastic or reconstructive surgery and any accidental injury to ears. Each subject was explained with the procedure and consent was taken.

Measurement of Height (stature)

Height is the vertical distance from vertex of the subject to the floor. During measurement subject was asked to stand erect, barefoot on a level floor and the feet parallel to each other. The anthropometer rod which was kept in the median sagittal plane of the subject. The reading was taken when the cross bar was touching the subject vertex.

Measurement of Ear Length
Measurement of ear length was taken according to standard landmark points defined by De Carlo et al (1998) and methodology was adopted from McKinnry et al (1993) and Brucker et al (2003). Ear length was measured as the distance from the most inferior projection of the ear lobule to the most superior projection of the helix. All measurements were taken by a single investigator using vernier calliper in order to minimize bias. For each subject the measurements were carried out thrice to ascertain accuracy.

These measurements were compiled on master chart and in excel format and analysed using a statistical package for social sciences Version (SPSS 12). The mean and standard deviation of standing height and length of right and left ears and their average were derived from which their correlation coefficient with standing height was calculated. Regression equation for stature were derived from right and left ear and the average of both ears in male and female separately by presuming X as an independent variable and Y as dependent variable.

RESULTS
Related data was collected and used for statistical analysis using SPSS (VERSION) 12 to derive regression equation.
Stature

It was found that standing height of males varied from 162 cm to 179 cm with mean value of 169.43 and standard deviation (S.D) 4.90. The stature of females varied from 152 cm to 174 cm with mean value of 162.17 and standard deviation 4.51. (Table 1)

Subject	Minimum (cm)	Maximum (cm)	Mean (cm)	S. D. (cm)
Male (102)	162	179	169.43	4.90
Female (102)	152	174	162.17	4.51
Table 1. Stature of the Study Group				

Ear Length
The length of right side ear found varied from 5.25 cm to 6.1 cm of males with mean value of 5.63 cm, standard deviation 0.258 and correlation coefficient with stature 0.950. The length left side ear found varied from 5.23 cm to 6.08 cm with mean value 5.62 cm, standard deviation 0.264 and correlation coefficient with stature 0.949. The average of length of right and left ears varied from 5.24 cm to 6.09 cm with mean value of 5.62 cm, standard deviation 0.261 and correlation coefficient with stature 0.949. (Table 2)

Measurement	Minimum(cm)	Maximum(cm)	Mean(cm)	S.D. (cm)	Correlation coefficient (r)
Right side	5.25	6.10	5.63	0.258	0.950
Left side	5.23	6.08	5.62	0.264	0.949
Average	5.24	6.09	5.62	0.261	0.949
Table 2. Showing Ear Length, Mean, Standard Deviation (S.D.), Correlation Coefficient with Stature (r) in Male					

Similarly, the length of right side ear found varied from 5.23 cm to 5.84 cm of females with mean value of 5.55 cm, standard deviation 0.194 and correlation coefficient with stature 0.908. The length left side ear found varied from 5.19 cm to 5.99 cm with mean value 5.53 cm, standard deviation 0.217 and correlation coefficient with stature 0.933. The average of length of right and left ears varied from 5.21 cm to 5.91 cm with mean value of 5.54 cm, standard deviation 0.205 and correlation coefficient with stature 0.920. (Table 3)

Measurement	Minimum (cm)	Maximum (cm)	Mean (cm)	S.D. (cm)	Correlation coefficient (r)
Right side	5.23	5.84	5.55	0.194	0.908
Left side	5.19	5.99	5.53	0.217	0.933
Average	5.21	5.91	5.54	0.205	0.920
Table 3. Showing Ear length, Mean, Standard Deviation (S.D.), Correlation Coefficient with Stature (r) in Female					

The linear regression equation for estimation of stature were derived from the lengths of the right side, left side and average of both sides separately in male and female.

These were calculated as:
1. For male
   a. Right side: y = 67.98 + 18 X x
   b. Left side: y = 62.78 + 19.01 X x
   c. Average: y = 69.2 + 17.8 X x

2. For female
   a. Right side: y = 44.61 + 21.15 X x
   b. Left side: y = 54.72 + 19.4 X x
   c. Average: y = 49.11 + 20.38 X x

Where x is the length of ear. Stature were calculated by putting value of x in different situations and compared with actual standing height and were found close (+/- 6) in most of the cases. As in a male of 162 cm the length of right ear was 5.25 cm and the stature calculated by regression equation 67.98 + 18 X x was 162.48 cm which was 0.48 cm more than the actual standing height. Similarly, as in female of 152 cm the length of right ear was 5.23 cm and the

stature calculated by regression equation 44.61+ 21.15 X x was 155.22 cm which was 3.22 cm more than the actual standing height. (Table 4)

Subject	Side	Regression equation	Ear Length cm	Standing Height cm	Calculated Stature cm	Variation in cm
Male	Right	67.98 + 18 X	Min. 5.25	162	162.48	0.48
			Max. 6.10	179	177.78	- 1.22
	Left	62.78 + 19.01 X	Min. 5.23	162	162.20	0.20
			Max. 6.08	179	178.36	- 0.64
	Average of both	69.2 + 17.8 X	Min. 5.24	162	162.47	0.47
			Max. 6.09	179	177.60	- 1.4
Female	Right	44.61 + 21.15 X	Min. 5.23	152	155.22	3.22
			Max. 5.84	174	168.12	- 5.88
	Left	54.72 + 19.4 X	Min. 5.19	152	155.40	3.4
			Max. 5.99	174	170.92	- 3.08
	Average of both	49.11 + 20.38 X	Min. 5.21	152	155.28	3.28
			Max. 5.91	174	169.55	- 4.45
Table 4. Regression Equation and Variations in Calculated Stature						

DISCUSSION

Many workers have studied on various parameters of long bones for measurement of stature. However, a practical difference arises in a situation where only dismembered body parts were available for medical examination like in mass disaster. So, it has been great interest to anthropologist to study the relationship that exists between different parts of the body and height.

Ear length is important in evaluation of congenital anomalies, facial reconstruction and in forensic purposes. P Verma, H Kaur in their studies found mean ear length more among males in both NE (6.00 cm on left side, 6.15 cm on right side) and NW (6.11 cm on left side, 6.37 cm on right side) population.[8]

Purkait R, Bozkir et al and Asai Y et al, where length of ear was found 6.24 cm, 6.31 cm and 6.14 cm in males respectively.[9,10,11]

Stature is being one of the criteria of personal identification that helps in reducing the investigation process. When isolated remains of body parts are brought then it becomes very difficult for anthropologist for forensic examination as standards available are scanty. Therefore, facial measurements (e.g. nose, mouth and ear measurements) act as a useful tool in absence of the other evidences for calculation of stature.[12]

Magaji et al study revealed that there was a statistical significant correlation between ear length and ear width of both ears and stature.[13]

Our study is in concordance with result of Magaji et al. when we compare our study with those of others, we found that there was difference in the values of ear measurements and these could be due to many factors such as race, age, genetic variables, environmental factors and human error in measurement of both ears and stature calculation.

CONCLUSION

Present study showed significant positive correlation between ear length and stature from western Maharashtra population. Finally, it is concluded that length of ear can be used as an additional tool in estimation of nearly accurate stature by using simple statistical method. The regression equation derived from right, left and average length of ears can be a supplementary approach for estimation of stature when other parts of the body not available. Also, regression equation derived in this study will be of potential use in clinical, medicolegal and anthropological studies.

REFERENCES

[1] Jasuja OP, Singh G. Estimation of stature from hand and phalanges length. J Indian Forensic Med 2004;26(3):100-106.

[2] Ekanem AU, Garba SH, Musa TS. Anthropometric study of the pinna among adults Nigerians resident in Maiduguri metropolis. J Med Sci 2010;10(6):176-180.

[3] Sunil, Dixit PC, Agarwal A, et al. Estimation of stature from hand length. J Indian Acad Forensic Med 2005;27(4):219-221.

[4] Oommen A, Mainker A, Oommen T. A study of the correlation between hand and foot length in humans. J Ana Society India 2005;54(2):55-57.

[5] Jasuja OP, Manjula. Estimation of stature from footstep length. Forensic Sci Int 1993;61(1):1-5.

[6] Khanapurkar S, Radke A. Estimation of stature from the measurement of foot length, hand length and head length in Maharashtra region. Indian J Basic Appl Med Res 2012;1(2):77-85.

[7] Wakode NS, Wakode SL, Ksheersagar DD. Prediction of stature based on measurement of hand length in Maharashtra region. Indian Journal of Clinical Anatomy and Physiology 2015;2(3):131-135.

[8] Verma P, Sandhu KH, Verma KG, et al. Morphological variations and biometrics of ear: an aid to personal identification. J Clin Diagn Res 2016;10(5):ZC138-ZC142.

[9] Purkait R. Ear biometrics: an aid to personal identification. Anthropologist Spl 2007;3:215-218.

[10] Bozkir MG, Karakas P, Yavuz M, et al. Morphology of external ear in our adult Aesthetic Plast Surg 2006;30(1):255-259.

[11] Asai Y, Yoshimura M, Yamada T, et al. Why do old men have big ears? Correlation of ear length with age in Japan. BMJ 1996;312(7030):582.

[12] Mahesh K, Patnaik VV. Estimation of stature from cephalo-facial anthropometry in 800 Haryanvi adults. International Journal of Plant, Animal and Environmental Sciences 2013:3(2):42-46.

[13] Taura MG, Adamu LH, Gudaji A, et al. Height prediction from external ear morphometry; a pilot study. Int J Res in Health Sci 2016;4(1):15-19.