Journal of Chemical Health Risks

www.jchr.org

JCHR (2024) 14(1), 2524-2530 | ISSN:2251-6727

A study on utility of ear morphometry for estimation of stature among North Indian population

Dr. Kalpana Purohit[1], Dr. Bharati Yadav[2], Dr. Shalini Gupta*[3]

[1] Associate Professor, Department of Anatomy, Maharishi Devraha Baba Autonomous State Medical College, Deoria, Uttar Pradesh, India

[2] Associate Professor, Department of Anatomy, Uma Nath Singh Autonomous State Medical College, Jaunpur, Uttar Pradesh, India

[3] Assistant Professor, Department of Anatomy, Maharishi Devraha Baba Autonomous State Medical College, Deoria, Uttar Pradesh, India

Corresponding author*

Dr. Shalini Gupta*

Assistant Professor, Department of Anatomy, Maharishi Devraha Baba Autonomous State Medical College, Deoria, Uttar Pradesh

Email: shalinigupta231983@gmail.com

(Received: 05 November 2023 Revised: 12 December Accepted: 07 January)

KEYWORDS

Ear, Stature, Regression, Morphometry

ABSTRACT:

Introduction: Human body is different from one another with respect to physical and genetic variations. Anthropometry is a reliable technique to understand physical variations which are useful in various sectors such as surgeries, forensic analysis and individual identification of various parts, human ear morphology acts a crucial part in determining stature and sexual dimorphism in human population

Aim: To compare and determine human external ear morphometry for stature estimation in male and female participants.

Materials and methods: Present study included 300 participants (150 males and 150 females) of age 15-20 years. The study was done in Anatomy department of and the various morphometric features related to ear included were ear length, lobule length, ear width and lobule width. Analysis was done with Pearson's correlation coefficient, student's t-test and regression equations were used.

Results: Males had significantly high ear parameters (length and width) for both ears compared to females. Similar was the case with ear lobule. Both the participants showed strong correlation of stature with the ear parameters. Estimated stature was obtained from the regression equation and it was comparable with that of actual stature ($P>0.05$).

Conclusion: Morphometry of human ear can give almost accurate stature. Also, this study may be worthful in forensic anthropology and is medicolegal cases where stature estimation is important.

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Introduction

Instrumental measurement of human body parts to aid understanding of physical variation is known as anthropometry. Such measurements are beneficial in prosthetics, plastic surgery and personal identification [1]. Certain morphological features are unique to the individuals and can be used for personal identification. However, identification becomes complicated when skeletal remains are obtained and hence requires accurate examination [2].

Stature means height which is a key parameter that represent physical identity of a person. Body height is biologically related to many body parts viz; extremities, head, trunk etc [3].

Bone measurement is an ideal approach used for stature estimation. Using bone dimensions number of regression equations have been generated to calculate stature by the forensic scientists whenever skeletal remains are provided for examination [4]. However, real challenge occurs when the forensic experts come across fragmented remains such as portion of face or decapitated head [5]. In such scenario cephalic or facial dimension measurements are used as supportive tool to estimate stature but studies proving validity for the use of such measurements in determining stature are scanty [6].

With respect to use of physical characteristic of human being in anthropometric studies, human external ear is often an overlooked parameter. Ear is the most defining facial feature that varies in structure with age and in between gender [7]. Hence, morphometrical parameters of ear can be used as a useful tool in determination of stature and gender dimorphism [8].

Human ear has external, middle and inner parts. Pinna and external acoustic meatus comprise external ear. Pinna at its lateral surface is concave irregularly and faces slightly forward. It comprises a number of depressions and eminences [9]. Auricular morphology also varies depending on the gender, age, race and side in same individual. Thus, its measurement is useful data for the purpose of forensic study in identifying individuals of various races, to cosmetic surgeons to conduct otoplastic surgeries etc [10].

Aims and objectives

Considering the availability of few studies regarding use of external ear dimensions for stature estimation, this study was commenced with an aim of generating regression equation from dimensions of ear and determining its validity in the stature estimation in North Indian Population and also to compare the anthropometric data of normal ear between males and females.

Materials and methods

This study comprised 300 participants (150 males and females each) of MBBS first year, BDS and nursing students. The study was commenced in the department of Anatomy, Maharishi Devraha Baba Autonomous State Medical College, Deoria, Uttar Pradesh.

Inclusion criteria

Participants included were residents of North India and of 15-20 years age

Exclusion criteria

Participants with ear deformities, history of reconstructive or plastic surgery and ear injuries were excluded.

Procedure

- Students were detailed about the purpose and procedure of the study followed by taking written consent.
- The basic data of age, gender, residential states were collected.
- Then the students were requested to sit on a chair in relaxed state and head in anatomical position.
- Using digital vernier calliper ear length and breadth; and ear lobule length and breadth were measured and noted as:

1. Ear length: Distance from auricle (highest point) to ear lobe (lowest point).
2. Ear width: Distance between anterior most and posterior most points of ear

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3. Lobule length: Distance between intertragic incisure and caudal part in lobule
4. Lobule width: Horizontal distance at midpoint of lobule height.

Height is the distance measured from the vertex of an individual to the levelled floor keeping their feet parallel to one another. It was measured using anthropometer.

Statistical analysis

All the data were recorded in MS excel sheet and analysed by SPSS software. From the measurement of ear on each side, regression equation was obtained in which X was independent Y was dependent variable. The calculated stature was compared with actual stature using student's t-test. The correlation of ear dimensions with stature was analysed with Pearson's correlation coefficient. For statistical significance, $p<0.05$ was considered.

Results

The ear length and ear width were compared among male and female participants in table 1 while the comparative analysis of lobule length and lobule width was shown is table 2. There was no significant difference these ear parameters on both the sides in male and female participants ($p>0.05$). When comparison was made gender wise, male participants showed significantly larger ear dimensions compared to female participants.

The regression equation was generated from each measured parameters of ear (total length and width of ear, length and width of lobule). From the equation estimated stature was calculated and compared with the actual stature in participants of both sexes (table 3 and 4). There was no significant difference in the actual stature and estimated stature in both cases ($p>0.05$).

The stature was also correlated with the ear parameters in both male and female participants. Significant positive correlation was observed (table 5, $p<0.05$).

Table 1: Comparison of each side length and width of ear in male and female

Gender	Side	Ear length in mm (Mean ± SD)	Ear width in mm (Mean ± SD)
Male	Right	62.28±3.71*	34.98±2.41*
	Left	61.31±3.08*	34.28±2.79*
	p-value	0.11	0.42
Female	Right	60.51±3.11	32.48±2.55
	Left	60.38±3.25	32.36±2.69
	p-value	0.08	0.51

*→Statistical significance (Male vs Female comparison on right and left side)

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Table 2: Comparison of lobule length and lobule width of each side in male and female

Gender	Side	Lobule length in mm (Mean±SD)	Lobule width in mm (Mean±SD)
Male	Right	19.28±2.41*	18.12±2.63*
	Left	19.12±2.38*	18.44±2.29*
	p-value	0.09	0.52
Female	Right	18.79±1.15	17.88±3.51
	Left	18.08±1.27	17.35±2.19
	p-value	0.18	0.31

*→Statistical significance (Male vs Female comparison on right and left side)

Table 3: Comparison of actual stature and estimated stature based on length and width of ear of each side in male and female

Gender	Actual stature (Mean±SD)	Side	Regression equation Stature (S) = c + mx	Ear length (EL)		Regression equation Stature (S) = c + mx	Ear width (EW)	
				Estimated stature (Mean±SD)	p-value		Estimated stature (Mean±SD)	p-value
Male	170.81±7.79	Right	S=77.91 + 1.36 x EL	170.62±5.92	0.37	S= 70.18 + 282x EW	170.64±4.81	0.52
		Left	S= 71.12 + 1.61 x EL	170.87±6.58	0.41	S= 68.89 + 2.75 x EW	170.11±6.72	0.55
Female	155.28±6.18	Right	S= 82.47 + 1.28 x EL	154.98±6.08	0.33	S= 59.6+ 2.86 x EW	155.31±5.16	0.49
		Left	S= 83.79 + 1.33 x EL	155.17±6.38	0.54	S= 60.73 + 2.94 x EW	155.08±6.1	0.18

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Table 4: Comparison of actual stature and estimated stature based on lobule length and lobule width of each side in male and female

Gender	Actual stature (Mean±SD)	Side	Regression equation Stature (S) = c + mx	Lobule length (LL)		Regression equation Stature (S) = c + mx	Lobule width (LW)	
				Estimated stature (Mean±SD)	p-value		Estimated stature (Mean±SD)	p-value
Male	170.81±7.79	Right	S= 131.61 + 1.59 x LL	170.72±3.02	0.57	S120.72 + 2.54 x LW	170.84±1.83	0.55
		Left	S= 119.13 + 3.07 x LL	170.64±1.86	0.51	S=117.59 +2.95xLW	170.71±2.17	0.45
Female	155.28±6.18	Right	S= 131.86 + 1.87 x LL	155.29±2.98	0.43	S=115.84 + 2.61 x LW	154.91±3.16	0.53
		Left	S= 141.6 + 2.75 x LL	155.33±1.35	0.64	S=113.05 + 2.24x LW	155.18±1.14	0.38

Table 5: Correlation of stature with ear length and width, lobule length and width in male and female

Ear parameters	Male		Female	
	r	p	r	p
Ear length (right)	0.81	<0.01*	0.64	<0.01*
Ear length (left)	0.86	<0.01*	0.72	<0.01*
Ear width (right)	0.69	<0.01*	0.83	<0.01*
Ear width (left)	0.77	<0.01*	0.85	<0.01*
Lobule length (right)	0.72	<0.01*	0.66	<0.01*
Lobule length (left)	0.65	<0.01*	0.47	<0.01*
Lobule width(right)	0.83	<0.01*	0.48	<0.01*
Lobule width (left)	0.79	<0.01*	0.51	<0.01*

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Discussion

Many traumatic events and anthropological cases require human identification. In medicolegal sector, forensic experts mostly encounter recover skeletal remains from which they attempt to unravel identity, gender, age, race and stature. In forensic examination, stature estimation from high decomposed, mutilated and fragmented human remains is very important [11].

In most of the previous studies, long bones or related parameters were exclusively explored for the determination of stature. But practical complications arise when only dismantled body parts are available medically such as in case of mass disaster. Therefore, study of the relationship between stature and different body parts is of great interest to the anthropologist.

There are limited standards available which can be used by anthropologist in forensic examination only isolated body part remains are bought. Hence, in such a scenario measurement of cranial and facial parameters such as ear, mouth, nose etc may serve as the useful tool in stature determination [12].

In this study, we attempted to determine stature with the use of four parameters of ear viz; ear length, ear width, ear lobule length and ear lobule breadth. The ear dimensions were compared gender wise and males were found to have significantly larger ear dimensions compared to females. Comparable to this study, Oludiran *et al* [13] also reported significant gender wise difference in ear and ear lobule metrices while in contrast, the sexual variations in ear morphometry were insignificant in the study of Deepa D *et al*. [2]

In this study, ear measurements were used to compute regression equation which was applied for stature calculation in the participants. The calculated stature was compared with the actual stature of the participants and no significant difference could be observed. The findings of this study were similar to that of Murugan M *et al* [14] and Abdelaleem S *et al* [15]. The result of these study also supported the feasibility of using ear parameters in estimation of stature.

A significantly strong positive correlation was traced between stature and studied ear dimensions in both the genders. This was in agreement with the studies of Magaji G *et al* [16] Laxman K [8] and Meijerman L *et al* [17]. However, study of Agnihotri AK *et al* [19] did not report such significant relationship.

Conclusion

This study shows that ear morphometry can be additional tool for the stature estimation. In absence of extremities, the regression equation developed from ear dimensions may act as a supplementary method for stature estimation. Ear parameters may also serve as a valuable tool to determine sexual dimorphism among individuals of unknown identity as this study showed significant difference in the ear dimension (ear length and width, lobule length and width) in male and female participants. The limitation of this study is that, this study included participants of only one region and only certain age group were considered. Hence conduction of larger studies including a greater number of participants of different demography and age groups is recommended.

Conflict of interest: None

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