

ANTHROPOMETRIC STUDY OF EXTERNAL EAR: A COMPARATIVE STUDY

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**ABSTRACT****Introduction:** Ear is the most defining feature of the face and its structure shows the signs of age and sex. The external ears consist of the auricle and the external acoustic meatus. This study was specifically under taken to study the variations in the auricle dimensions, specially height and width, amongst Nepalese medical and nursing students and compare them.**Materials and Methods:** This study was conducted on medical and nursing students of National Medical College, Birgunj, Nepal, with no evidence of congenital ear anomalies or previous ear surgeries. The study consisted of 110 females and 110 males, aged 18–25 years.**Result:** The descriptive statistics of the ear variables evaluated and measured on both right and left sides. The ear length ranged from 6.31-6.30 cm with the right ear length being significantly larger than the left ear length ($p=0.010$). Similarly, the right ear breadth was significantly wider in comparison to the left ear breadth, range from 3.39- 3.38 cm ($p=0.084$). The lobular length range 2.38- 2.36 cm ($p=0.001$) and the lobular breadth range 1.96- 1.93 cm ($p=0.000$) which were also larger in the right ear compared with the left ear and the differences reached the level of statistically significant.**Conclusion:** PThe ear anthropometric measurements of male students showed higher value when compared to the female nursing students. These results support the findings that the sexual dimorphism does exist and showed the statistically significant differences between the sexes. The length of the ear was found to be higher when compared to the width of the ear in both sexes.**Keywords:** Anthropometry; External ear; Sex determination.**INTRODUCTION**

Ear is the most defining feature of the face and its structure shows the signs of age and sex.¹ The external ears consist of the auricle or pinna and the external acoustic meatus.² Greater part of the auricle is made up of a core of crumpled plate of elastic cartilage and hence it is irregular.² Postnatal abnormalities in ear dimensions and position are common findings in several alterations of human chromosomes and karyotype, and in developmental defects of the first and second

branchial arches.³ The external ear and its prints have important role in establishing the identity of criminals and victims of crimes or accidents.⁴ The anatomy of the auricle differs according to the age, sex, race and ethnic group and has been used by forensic experts and physical anthropologists in identification.⁵ A thorough knowledge of the normal ear dimensions, position and symmetry is also necessary for the timing of surgical reconstruction and for the design of hearing aid instruments.⁶

Quantitative data on age related changes in ear dimensions have been reported in Koreans, Japanese, Turkish Caucasians, British Caucasians, American Caucasians, Italian Caucasians, Berlin Caucasians, African populations and Han population.⁷ There are few studies that exist on Nepalese's, among them one study focused only on particular caste belonging to Newar's by Sharma et al.⁸ And another study that was conducted on students of Nepalgunj Medical college Gupta et al.⁹ This study was specifically under taken to study the variations in the auricle dimensions, specially height and width, amongst Nepalese medical and nursing students and to compare them.

MATERIALS AND METHODS

This study was conducted on medical and nursing students of National Medical College, Birgunj, Nepal, with no evidence of congenital ear anomalies or previous ear surgeries. The study consisted of 110 females and 110 males, aged 18–25 years. The subjects were informed about all the adopted procedures and verbal consent was obtained. Clearance of institutional ethical committee was obtained before starting the work.

Bilateral sizes of auricles were measured. Standardized measurements of the ear auricles were taken according to the landmarked points defined by De Carlo et al. and the methodology was adopted from McKinney et al. and Brucker et al.¹⁰⁻¹² The parameters measured were total ear height (TEH), ear width (EW), lobular height (LH), and lobular width (LW) for each subject's right and left ears, when the head was in the Frankfort horizontal plane. Figure 1 shows the measurement of ear reference points used for anthropometric measurements. The TEH was measured as the distance from the most inferior projection of the ear lobule (L) to the most superior projection of the helix (H). The EW is measured as the distance between the most anterior (A) and posterior (P) points of the ear. The LH was taken as the distance from the most inferior end of the lobule (L) to the base of the tragal notch (T). The LW was measured as the transverse or horizontal width of the lobule (C–D). Figure 2, 3, 4 and 5 shows the measurement of ear by a digital vernier caliper. Additionally, indices defining the proportions of the ear such as ear index (ear width/

ear height $\times 100$) and lobule index (lobule width/lobule height $\times 100$) were calculated. All the measurements were taken by a single investigator using standard vernier caliper capable of measuring to the nearest 0.1 mm. For each subject, the measurements were carried out twice to ascertain accuracy and the arithmetical mean of the two measurements was recorded on the proforma. Secondly, all the measurements were carried out by the same investigator in order to minimize bias and error of identification of the parts of the ear pinna involved in the measurements. The numerical data were analyzed using a Statistical Package for Social Sciences Version (SPSS) 20.0. Comparisons of the measurements according to gender were performed using an independent samples t-test. Comparison of measurements taken from the right and left ears of a given sex was performed using a paired samples t-test. P-values of less than 0.05 were considered to be statistically significant.

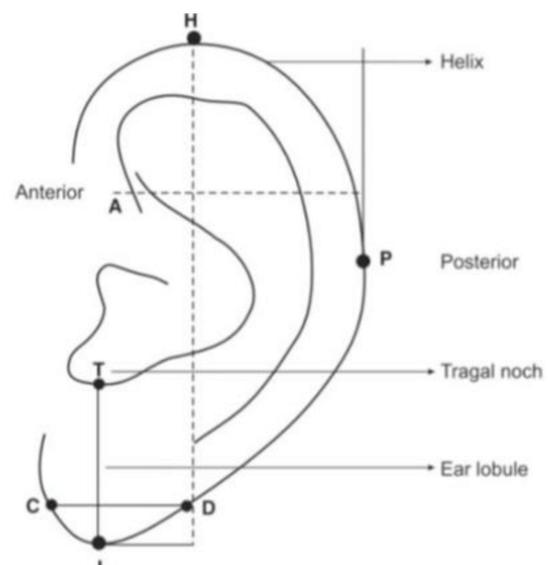


Fig. 1: Reference Points used for anthropometric measurements of ear (Total ear height=L-H, Ear width=A-P, lobular height=L-T, lobular width=C-D).



Figure 2: Showing measurement of total ear height.

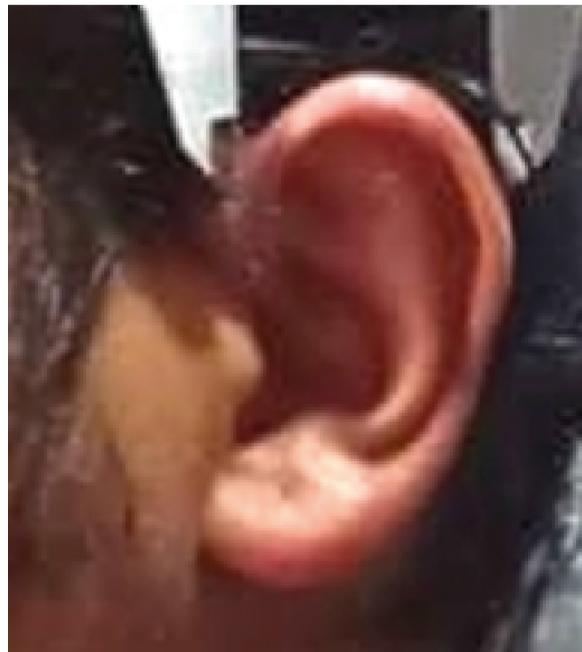


Figure 3: Showing measurement of ear width.



Figure 4: Showing measurement of lobular height.

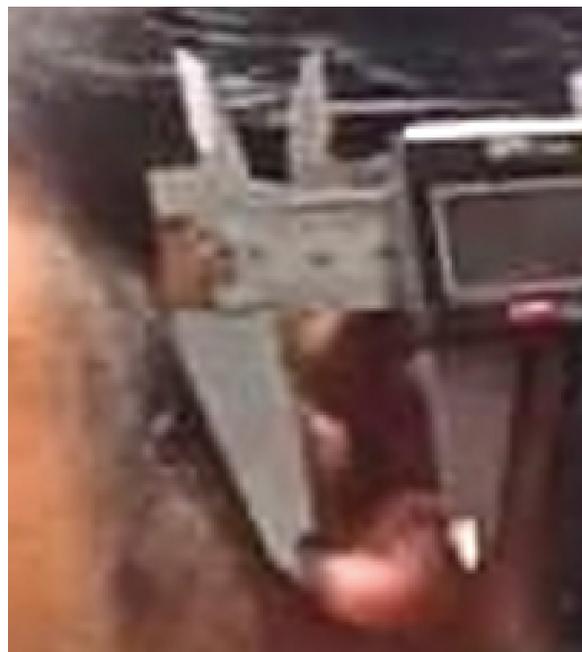


Figure 5: Showing measurement of lobular width.

RESULTS

The mean and standard deviation (SD) of right and left ear linear anthropometric measurements of male and females students are shown in tables 2, 3 and 4. The mean values of ear anthropometric measurements of male showed higher value when compared to female in all parameters.

Table 2 shows the descriptive statistics of the ear variables evaluated and measured on both right and left sides with the degree of symmetry analyzed using the paired t-test.

The ear length ranged from 6.31- 6.30 cm with the right ear length being significantly larger than the left ear length ($p=0.010$). Similarly, the right ear breadth was significantly wider in comparison to the left ear breadth, range from 3.39- 3.38 cm ($p=0.084$). The lobular length range 2.38- 2.36 cm ($p=0.001$) and the lobular breadth range 1.96- 1.93 cm ($p=0.000$) which were also larger in the right ear compared with the left ear and the differences reached the level of statistically significant.

Table 1: Comparison of measured ear variables according to gender.

Measurements	Male (n=110)	Female (n=110)	P Value
	Mean ±SD	Mean±SD	
Right Ear Length	6.67 ±0.49	5.95 ±0.38	0.003*
Left ear length	6.65 ±0.47	5.94 ±0.38	0.012*
Right ear Width	3.78 ±0.57	3.00 ±0.47	0.025*
Left ear width	3.77 ±0.57	2.98 ±0.46	0.006*
Right ear lobule length	2.86 ±0.66	1.90 ±3.48	0.000*
Left ear lobule length	2.84 ±0.65	1.89 ±0.32	0.000*
Right ear lobule width	2.27 ±0.59	1.66 ±0.26	0.000*
Left ear lobule width	2.23 ±0.57	1.64 ±0.24	0.000*
Right ear index	56.58 ±6.62	50.42±7.53	0.697
Left ear index	56.62±6.64	50.30±7.27	0.955
Right ear lobule index	80.04±14.51	89.34±18.00	0.078
Left ear lobule index	79.72±14.95	88.63±16.65	0.591

Table 2: Descriptive statistics of the measured ear variables and paired 't' test for evaluation of symmetry of ear (measured in cm)

Measurement	Right (n=220)	Left (n=220)	t-value	p-value
Ear length	6.31±0.57	6.30±0.56	2.612	0.010*
Ear width	3.39±0.65	3.38±0.65	1.734	0.084*
Lobule length	2.38±0.71	2.36±0.70	3.322	0.001*
Lobule width	1.96±0.54	1.93±0.53	4.390	0.000*
Ear Index	53.50±7.72	53.46±7.63	0.442	0.659
Lobule Index	84.69±16.96	84.17±16.41	1.527	0.128

Table 3: Range of ear variables

Measurements	Minimum	Maximum
Right ear length	5.20	8.20
Left ear length	5.00	8.10
Right ear width	1.71	5.30
Left ear width	1.70	5.40
Right ear lobule length	1.20	4.70
Left ear lobule length	1.20	4.60
Right ear lobule width	1.20	3.90
Left ear lobule width	1.20	3.80
Right ear Index	29.23	75.71
Left ear Index	29.69	77.14
Right ear lobule Index	45.71	133.33
Left ear lobule Index	44.83	129.41

DISCUSSION

The ear height is important in the evaluation of congenital anomalies like Down syndrome.¹³ The ear reaches its mature height at 13 years in males and at 12 years in females.¹⁴ Study done by Bozkir et al., the height of the

left ear was found to be 6.31 cm in men and 5.97 cm in women.¹⁵ Brucker et al. on their morphometric study of the external ear, obtained a mean TEH of 6.30 cm.¹² In the present study, it was observed that the mean length of the auricle in males and females was 6.67-6.65 cm for right and left ears and 5.95-5.94 cm for right and left ears respectively. It was observed that the mean ear length in males was more than in females in various population and age groups and supports our study.

Disproportionately wide ears are seen mostly in Apert and Crouzon syndromes and narrow ears mostly in cleft lip and palate patients. In males, the width of the ear gets matured at 7 years and in females at 6 years.¹³ A study consisting of 100 males and 100 females found the EW to be 3.24 cm for the left ear and 3.3 cm for the right ear in men, and in women, 3.19 cm for the left ear and 3.24 cm for the right ear.¹⁶ But, DellaCroce et al., found the EW to be 3.05 cm.¹⁷ In our study, the mean EW in males, for the right and left ear was 3.78 cm and 3.77 cm respectively, and the mean EW in females, for the right and left ear was 3.00 cm and 2.98 cm respectively. When our results were compared with previous findings, more or less same values of EW are found which statistically significant ($p < 0.005$).

An acquired deformity develops with aging may be due to elongation or ptosis of the ear lobe. This condition leads to the loss of elastic fibers and gravitational forces.¹⁸ Earrings are an additional weight on the ears, and they therefore affect ear lobe height.¹⁹ In the study of Bozkir et al. the measurement found was 1.8 cm in young men and 1.7 cm in young women.¹⁵ In our study, the LH in young men in both right and left ear lobule was 2.86 cm and 2.84 cm and 1.90 cm and 1.89 cm in young women. The values are more in males and increase with age. The increase in the LH with age is not due to the weight effect of earrings since the majority of the women and none of the men had pierced earlobes in our study. In esthetic earlobe reconstruction, the primary aim is to achieve a more youthful appearance.¹² Therefore, our study group consisted of young adults.

In the present study, the mean LW on the right side was 2.27 cm in males and 1.66 cm in females respectively. The same when compared on the left side was 2.23

cm in males and 1.64 cm in females respectively. It was observed that the ear lobe size varied significantly between the men and women. Brucker et al. reported the ear lobe width to be 1.95 cm in men and 1.97 cm in women, and observed that in men, the LH and LW remain nearly identical to those in women and with increasing age, the TEH and LH increase, while the LW decreases.¹² The study by Purkait and Singh on the age group 18–70 years measured the length and width of auricle and lobule to calculate auricular and lobular indices and they found a steady increase in size with age.³ Sharma et al. studied on age group 1–80 years in the north–west region of India on ear lobule and observed that the maximum length of the lobule increased appreciably between 6–15 years and 41–80 years.⁸ The breadth of ear lobule increases up to the age of 15 years, almost static between 16 - 40 years, increased again from 41 years onward.

Ferrario et al. found that the ear indices of both sides in males were significantly higher than those in females. In this study, no statistical difference was found in the ear index and lobular index of males and females although the right ear indices were found to be higher than the left ear indices for all the subjects.

Comparing our study with those of others, we find that there is a difference in the values of ear measurement. These discrepancies could be a result of factors such as race, genetic variables, individual constitution, environment, age, and human error.

CONCLUSION

The ear anthropometric measurements of male students showed higher value when compared to the female nursing students. These results support the findings that the sexual dimorphism does exist and showed the statistically significant differences between the sexes. The length of the ear was found to be higher when compared to the width of the ear in both sexes.

Knowledge about the normal ear dimension is clinically important for the treatment for the treatment of congenital deformities, traumatic injured ears and for establishing baseline data for forensic scientists in personal identification. A successful outcome in otoplasty

requires thorough and accurate preoperative planning and awareness of the morphological differences.

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