

*Letter to the Editor*

## **Anthropometric Measurements of the External Ear in a Group of Turkish Primary School Students**

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Many studies have defined human body parts and their proportions to each other morphometrically [1–3,6,7,10]. These studies are important because they enable accurate definitions for morphometric properties of different body parts in different human populations. In this context, both of the ears play a vital role in producing a natural and harmonious look and an aesthetically fine facial appearance [1,2,6]. They also are helpful in defining population standards, congenital malformations, and the ergonomic design of hearing aids [6,7,9,11,12]. This study aimed to establish morphometric properties for the ears, a determining feature of the human face, in a group of Turkish children.

### **Materials and Methods**

The study population consisted 153 primary school students (87 boys and 66 girls) ages 6 to 13 years. The demographic characteristics of the study population are depicted in Table 1. Ear height, ear width, lobule height, and lobule width for each subject's right and left ears along with face height were measured while the head was in the Frankfort horizontal plane [1–3,6,7,10]. A digital compass (Shan 150 mm; Guillin Measuring and Cutting Tool Works, Guillin, Guangxi, China) with a resolution of 0.01 mm was used for the measurements. Each variable was measured twice by the same investigator, and the arithmetical mean of the two measurements was used for

each dimension. The reference points used for the anthropometric measurements are shown in Table 2 and Fig. 1.

Additionally, indices defining the proportions of the ear such as the ear–face index (ear height/face height  $\times$  100), ear index (ear width/ear height  $\times$  100), and lobule index (lobule height/ear height  $\times$  100) were calculated [3,12]. The type of lobule, whether pendulous (free) or nonpendulous (partially or totally adherent), also was recorded.

### *Statistical Analysis*

Statistical analysis was performed using SPSS for Windows, version 11.0. 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.

### **Results**

The measurements and comparison of results for the right and left ears of all the subjects who participated in the study are shown in Table 3. The mean width of the left ear was found to be significantly wider than the mean width of the right ear in all subjects. The left ear indices were found to be significantly higher than the right ear indices for all the subjects. Although the ear height, the lobule width, and the ear-face indices were higher for the right side than for the left side, the differences were not statistically significant.

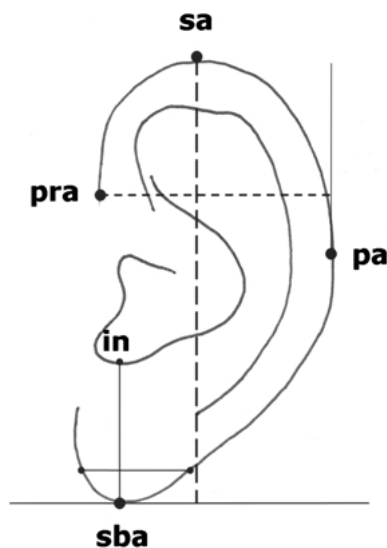
When the results were compared according to gender, the findings showed that face height, heights

**Table 1.** Demographic characteristics of the study population

	Male (n = 87)	Female (n = 66)	Total (n = 153)
Age (years)	9.56 ± 1.76	9.27 ± 1.69	9.43 ± 1.73
Weight (kg)	34.33 ± 10.85	31.21 ± 9.58	33.00 ± 10.41
Height (cm)	135.56 ± 12.36	133.36 ± 11.68	134.61 ± 12.08

**Table 2.** Reference points used for anthropometric measurements

Face height	Nasion–gnathion (n–gn)
Ear height	Supra-auricle–subauricle (sa–sba)
Ear width	pre-auricle–postauricle (pra–pa)
Lobule height	intertragic notch–subauricle (in–sba)
Lobule width	The line perpendicular to the line defining lobule height

**Fig. 1.** Reference points used for anthropometric measurements.

of right and left ears, widths of right and left ears, heights of right and left lobules, widths of right and left lobules, right ear–face index, and left ear index values were higher for males, and the differences were statistically significant. Also, the right ear index, the right and left lobule indices, and the left ear–face index were slightly higher for males, but the differences were not statistically significant Table 4.

When the values obtained for the males who participated in the study were evaluated, ear height, lobule height, lobule width, ear–face index, and lobule index values were higher for the right ear, although the differences were not statistically signifi-

cant. The findings showed the left ear to be significantly wider than the right ear and the left ear index to be significantly higher than the right ear index in the male subjects Table 5.

There were no statistically significant differences between the heights of the right and left ears of the female subjects. The height and width of the lobule, the ear–face index, and the lobule index were slightly higher for the left than for the right ear, but the differences were not statistically significant. The left ear was found to be significantly wider than the right ear and the left ear index to be significantly higher than the right ear index in the female subjects Table 6.

Of all the subjects, 78.4% (n = 120) had pendulous (free) lobuli, whereas the remaining 21.6% (n = 33) had nonpendulous lobuli (partially or totally adherent) Table 7.

## Discussion

Evaluation of structural differences by anthropometric measurements is important for timely application of surgical procedures to the external ear and to the ergonomic design of hearing aids. Structural differences in the human ear create almost unique shapes similar to the unique fingerprint of each human being [8]. The differences in ear measurements among people of different ethnic and sociocultural origins also may be caused by environmental and nutritional factors [9]. There is no normal appearance of the ear, even among people of the same ethnic origin [4,9]. From a clinical point of view, a patient with an abnormal external ear should also be evaluated for deafness and urinary tract malformations [8].

Ears are among the few organs that continue to develop during the adult period of life. Generally, the width remains almost unchanged, whereas longitudinal growth is sustained partially after 10 years of age [8]. It is reported that the external ear is somewhat longer in males than in females [8]. Several studies in the literature show that the mean height of the external male ear is higher than that of the female ear in various population and age groups [4,6,7,9,10]. In our study of children, the mean height of the ears on both sides was significantly higher in males than in females Table 4.

Kalcioglu et al. [9] found no statistically significant differences in mean widths of ears between males and females from 15 of 19 different age groups. Farkas et al. [4] found that male subjects had wider ears than female subjects, but did not mention any statistical

**Table 3.** Right and left ear measurements and comparison of the results (n = 153)

	Right	Left	<i>p</i> Value <sup>a</sup>
Ear height (mm)	56.61 ± 4.45	56.50 ± 4.10	0.490
Ear width (mm)	32.11 ± 2.67	33.10 ± 2.79	0.000
Lobule height (mm)	14.50 ± 2.36	14.56 ± 2.24	0.560
Lobule width (mm)	15.44 ± 2.44	15.35 ± 2.80	0.543
Ear–face index	50.22 ± 3.14	50.14 ± 3.03	0.574
Ear index	56.85 ± 4.08	58.66 ± 3.91	0.000
Lobule index	25.56 ± 3.25	25.74 ± 3.14	0.363
Face height (mm)	112.79 ± 6.81		

<sup>a</sup>Paired samples *t*-test.**Table 4.** Comparison of the measurements according to gender (n = 153)

	Male (n = 87)	Female (n = 66)	<i>p</i> Value <sup>a</sup>
Face height (mm)	114.11 ± 6.85	111.05 ± 6.40	0.005
Right ear height (mm)	57.79 ± 4.04	55.04 ± 4.53	0.000
Right ear width (mm)	32.82 ± 2.43	31.18 ± 2.67	0.000
Right lobule height (mm)	14.95 ± 2.23	13.91 ± 2.41	0.006
Right lobule width (mm)	15.98 ± 2.16	14.77 ± 2.62	0.002
Right ear–face index	50.70 ± 3.00	49.59 ± 3.23	0.029
Right ear index	56.90 ± 3.91	56.78 ± 4.31	0.859
Right lobule index	25.86 ± 3.42	25.16 ± 3.00	0.187
Left ear height (mm)	57.57 ± 3.88	55.08 ± 3.99	0.000
Left ear width (mm)	34.10 ± 2.55	31.78 ± 2.56	0.000
Left lobule height (mm)	14.88 ± 2.11	14.15 ± 2.34	0.044
Left lobule width (mm)	15.99 ± 2.41	14.50 ± 3.05	0.001
Left ear–face index	50.52 ± 3.11	49.64 ± 2.87	0.077
Left ear index	59.34 ± 3.98	57.78 ± 3.67	0.014
Left lobule index	25.84 ± 3.08	25.61 ± 3.23	0.661

<sup>a</sup>Independent samples *t*-test.**Table 5.** Comparison of the right and left ear values in males (n = 87)

	Right	Left	<i>p</i> Value <sup>a</sup>
Ear height (mm)	57.79 ± 4.04	57.57 ± 3.88	0.226
Ear width (mm)	32.82 ± 2.43	34.10 ± 2.55	0.000
Lobule height (mm)	14.95 ± 2.23	14.88 ± 2.11	0.669
Lobule width (mm)	15.98 ± 2.16	15.99 ± 2.41	0.979
Ear–face index	50.70 ± 3.00	50.52 ± 3.11	0.263
Ear index	56.90 ± 3.91	59.34 ± 3.98	0.000
Lobule index	25.86 ± 3.42	25.84 ± 3.08	0.917

<sup>a</sup>Paired samples *t*-test.**Table 6.** Comparison of the right and left ear values in females (n = 66)

	Right	Left	<i>p</i> Value <sup>a</sup>
Ear height (mm)	55.04 ± 4.53	55.08 ± 3.99	0.879
Ear width (mm)	31.18 ± 2.69	31.78 ± 2.56	0.008
Lobule height (mm)	13.91 ± 2.41	14.15 ± 2.34	0.164
Lobule width (mm)	14.74 ± 2.62	14.50 ± 3.05	0.395
Ear–face index	49.59 ± 3.23	49.64 ± 2.87	0.830
Ear index	56.78 ± 4.31	57.78 ± 3.67	0.036
Lobule index	25.16 ± 3.00	25.61 ± 3.23	0.136

<sup>a</sup>Paired samples *t*-test.

**Table 7.** Type of lobule in subjects

	Pendulous n (%)	Nonpendulous n (%)
Female (n = 66)	46 (69.7)	20 (30.3)
Male (n = 87)	74 (85.1)	13 (14.9)
Total (n = 153)	120 (78.4)	33 (21.6)

significance. Ferrario et al. [6] and Fok et al. [7] found significantly wider ears in males than in females. In our study, we also observed significantly wider ears in males than in females Table 4.

Several studies have reported that the face height of males was higher than that of females without mentioning any statistical analysis [5,10]. In the study of Ferrario et al., face height was found to be higher in males than in females, and the difference between the groups was statistically significant [6]. In our study, face height values obtained from males were higher than those of females, and the difference between the groups was statistically significant Table 4.

Ferrario et al. [6] found that the ear indices of both sides in males were significantly higher than in females. In our study, we observed insignificantly higher right ear indices and significantly higher left ear indices in males than in females Table 4.

Farkas et al. [4] stated that the height of the face and ears should be proportionate to produce a harmonious look. Another Farkas [3] study emphasized that certain proportional values should be used to evaluate ear morphology. Ferrario et al. [6] suggested that for an attractive facial expression, the ear–face index should be 50% in males and 53% in females. In our study, the right ear–face index was  $50.70 \pm 3.00$  in males and  $49.59 \pm 3.23$  in females, whereas the left ear–face index was  $50.52 \pm 3.11$  in males and  $49.64 \pm 2.87$  in females Table 4. The values obtained in our study were inconsistent with those in the literature [6]. This may reflect the fact that our subjects were at a different developmental stage than the subjects in the study of Ferrario et al. [6].

Ferrario et al. [6] stated that gender-dependent differences in adolescents are minimal, but become more significant with age. They also observed that the ear index values differed minimally for the left ear, but were significantly different for the right ear [6]. Despite the age difference in our study, most of the linear measurements were significantly different between the two sexes. The ear–face indices were only significantly higher on the right side of males. The ear indices were only significantly higher on the left side also of males Table 4.

Ferrario et al. [6] reported symmetric ear measurements in their study. They reported that for both groups, the difference in linear measurements between the two sides was less than 1 mm, and that the difference in ear indices was less than 2% [6]. In our study, the difference in linear measurements between

the two sides was less than 1 mm without being significant. A difference in linear measurements exceeding 1 mm was found to be statistically significant. All of the differences in ear indices between the two sides ranged between 1% and 2.44% (Tables 3, 5, and 6).

In the study of Kalcioğlu et al. [9], the attached lobulus auricula was found in 25.3% of males and in 27.8% of females. Azaria et al. [1] in their study among adults reported that lobules were asymmetric, the left lobule being shorter than the right lobule. In our study, lobules were attached in 14.9% of the males and 30.3% of the females. Of all the patients, 21.6% had attached lobules. Also the differences in lobule height and width between the two sides were statistically insignificant (Tables 3, 5, and 6. This finding may support the idea of symmetry of ear lobes.

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