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Prominent ears: Anthropometric study of the external ear of primary school children of Harare, Zimbabwe

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HIGHLIGHTS

- Study shows prominent ear occurs in African Child with a higher frequency (6.89%) compared to Caucasian children (5%).
- Mean ear height was significantly higher in males than females (p-value = 0.000).
- Ear projection was higher in males than females.
- Among males, 7.69% had prominent ears whilst 6.17% of females had prominent ears.

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ABSTRACT

Background: Prominent ear is the most common congenital ear deformity affecting 5% of children in the Western world and has profound psychosocial effects on the bearer. It is important to know the prevalence in the local population to have a better appreciation of the local burden of the abnormality as well as to know the parameters of ear morphology locally. These parameters can be useful in the diagnosis and evaluation of ear anomalies and may help reconstructive surgeons in reproducing an anatomically correct ear of an African/Zimbabwean child.
Objectives: To evaluate the frequency of prominent ears in black school going children in Zimbabwe and to establish morphometric properties of the ear.
Design: Prospective observational, cross sectional study.
Setting: Three Primary schools in Harare. Two in a high density area and one in a low density area.
Materials and methods: Three Primary schools in Harare were selected at random. The following measurements were taken: ear lengths, ear projection and face height using a sliding caliper. Three hundred and five healthy pupils of the age range 9–13 years of both sexes were included in the study, whilst children with congenital anomalies, ear tumours and history of ear trauma were excluded.
Results: The mean ear height across the cohort was 56.95 ± 5.00 (right ear) and 56.86 ± 4.92 (left ear). Ear projection was 19.52 ± 2.14 (right ear) and 19.59 ± 2.09 (left ear). Gender related differences were noted. Mean ear height was significantly higher in males (p-value = 0.000). Ear projection was higher in males compared to females. A total of 6.89% had prominent ears. Among males, 7.69% had prominent ears whilst 6.17% of females had prominent ears.
Conclusion: The prevalence of prominent ear among black African children in the studied population is comparable to that of Caucasians. The study provides a set of biometric data of auricular dimensions for normal black African children aged 9–13 years.

1. Introduction

The external ear, is a defining feature of the face. It helps make one have the “normal” look with an aesthetically fine appearance. Prominent ears is the commonest congenital deformity of the external ear [1,2]. This deformity has profound psychosocial effects on the bearer [3]. According to the WHO, health is not just the absence of disease or infirmity but is complete physical, mental and

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social well being [4]. Prominent ear interferes with the bearer's social and sometimes even mental wellness. The well being of patients is the ultimate goal of every medical practitioner, thus it is the surgeon's responsibility to bring back “normalcy” in individuals with deformities such as prominent ears.

Prominent ear refers to the ear that sticks out. Most authors agree that a normal ear is one with an ear projection of less than 21 mm. Adamson et al. [5] and Wright [6] defined prominence as a distance greater than 2 cm. Using the same definition, Kalcioglu et al. [7] and Purkait and Singh [8] noted the prevalence of protrusion to be about 10%.

Prominent ears provoke intense ridicule in different societies. This results in the subjects having reduced self-esteem, increased anxiety and social avoidance [3]. In addition there is also increased bullying by the bearer as well as towards the bearer which may result in poor integration at school [9]. MacGregor described what he termed “exquisite cruelty of young children towards children who happen to look different” [10]. This has been defined as peer victimization by psychologists [11].

Children become self-conscious at the age of 4–6 years. They become very sensitive and know when they are accepted or rejected and in this early phase of their lives this can mould their future character [12].

Prominent ear deformity ridicule cuts across different cultures. A variety of derogatory names have been given to prominent ears. The Welsh called them *flap ears*, the English, *bat ears*, *dumbo* or *FA cup ears* and the Norwegians, *flying ears* [13]. In Zimbabwe, people with prominent ears are also subjected to ridicule. In the local venacular Shona, they refer to them as people whose ears are fleeing or flying away from the head. Sometimes they are referred to as *rabbit ears*.

However not all societies view prominent ears negatively. Among the Chinese, prominent ears are viewed in a positive light. Liu- Bei, the founder of the Han dynasty (AD 221) had long ears reaching his shoulders and it was reported that he could see his ears by glancing back over his shoulders [14]. We live in a global village where perceptions are shared across the globe.

This means whatever is called ugly in the West can also easily be called the same locally. Thus the same victimization suffered by the children in the West can also be suffered by the children locally.

The authors are not aware of any studies looking at the prevalence of prominent ear deformity in the black African population. It is thus the aim of this study to find out how common the condition is in Zimbabwe among the school going children.We hope this study will yield parameters for ear morphology that can be useful in the diagnosis and evaluation of ear anomalies. This study should also help in defining local standards.The findings in this study should also help reconstructive surgeons in reproducing an anatomically correct ear of an African/Zimbabwean child during correction of anomalies, be they congenital, traumatic or post tumour resection.

2. Materials and methods

Ethical approval to conduct the study was obtained from the Joint Parirenyatwa Hospital and College of Health Sciences Research Ethics Committee. The head office of the Ministry of Education and Culture as well as the Harare regional office of education were approached for permission to conduct the study in the schools under their jurisdiction. After having obtained this, three primary schools in Harare were selected at random. Two of the schools were from the high density area and one was from the low density area. This study was carried out from November 2010 to June 2011.

School visits were made, where permission to conduct the study was again sought from the school heads and teachers who acted as the in loco parentis. Three hundred and five pupils in grades five to seven from three primary schools were included in the study. All the measurements (i.e. ear height, ear projection and face height) were taken by the principal investigator. An accompanying assistant recorded the data of the ear and face parameters on the data collection sheets. She also obtained measurements of height and weight in all healthy Grade 5–7 (9–13 year olds) pupils of both sexes.Children with congenital anomalies of the ear,ear tumours and history of ear trauma were excluded from the study.

3. Measurement technique

The procedure was explained to the subject in order to get maximum cooperation. With the subject's head in Frankfort horizontal plane, measurements were taken using a sliding caliper with a resolution of 0.01 mm as follows:

- Ear length/height (right and left ear) – measured as the distance between the highest point of auricle and lowest point of the earlobe.
- Ear projection (right and left ear) – measured as the distance from the ear helix to the mastoid process at tragal level.
- Face height-measured as distance from the nasion (the innermost point between forehead and nose) to the gnathion (in the midline, the lowest point on the lower border of the chin)

Other measurements taken and recorded were Figs. 1–4.

- height and weight of the subjects-.

4. Data collection

The following information was collected and recorded on the data collection sheets: age,sex,height, weight,ear length/height,ear projection and face height.

The ear-face index (ear height/face height × 100) to define the ear proportion was also calculated. A minimum sample size of 153 subjects was calculated. However, about double this number of subjects was included in the study.

5. Calculation of sample size

The appropriate sample size for this population based survey was determined by 3 factors: a) the estimated prevalence of the variable of interest, b) the desired level of confidence, c) the acceptable margin of error. Thus the formula for calculation of

Fig. 1. Sliding caliper (accuracy – 0.01 mm).

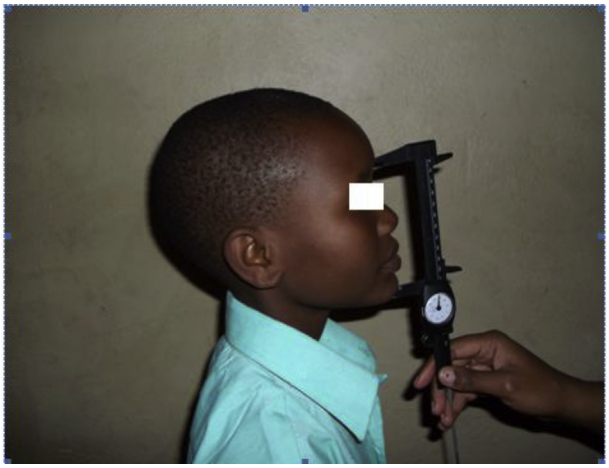

Fig. 2. Face height.

Fig. 3. Ear height.

Fig. 4. Ear projection.

sample size in epidemiological surveys was used.

6. Data analysis

The SSPS program for windows was used for statistical analysis of the results of the measurements. The data was divided into groups representing the right and left ears as well as groups of males and females. The mean and standard deviations were also calculated. A two-tailed "t" test (independent and paired samples "t"-test) at the 95% confidence interval was used to study the bilateral variation as well as to check for statistical significance. A p-value of less than 0,05 was considered to be statistically significant.

7. Results

A detailed analysis of the ear and relevant facial measurements was carried out on 305 pupils in grades five to seven from three primary schools in Harare. The mean age of the three hundred and five pupils was 11.46 years (SD 0.849). The study was carried out from November 2010 to June 2011.

8. Summary: ear measurements

The combined measurements and comparison of results for the right and left ears of all the subjects who participated in the study are summarized in Table 1. Statistical analysis of the data revealed that the mean right ear height was 56.95 (SD 5.00), whilst the mean left ear height was 56.86 (SD 4.92). The difference between the two values was not statistically significant (p value = 0.456). The left ear was noted to be more projected than the right. However the differences were not statistically significant. There were also no significant differences between the right and left ear-face indices (p-value = 0.449) (Table 1).

9. Gender comparison

The study revealed that male pupils had higher values for right and left ear size, right and left ear projection as well as face height. These differences were statistically significant (p-values = 0.0001 and 0.000). There were also differences in the values for ear-face indices, with higher values for males. However the differences were not statistically significant (p-value- right = 0.1735, left = 0.1226) (Table 2).

10. Measurement range

Male subjects had the widest range of measurements recorded for left ear height, left ear projection and face height whilst female subjects had the widest ranges for right ear height and right ear projection. In addition all the maximum recorded values were in male subjects (Table 3).

11. Comparison of right and left ear values (males)

Among the males who participated in the study, there were differences between the right and left ear height, right and left ear projection as well as the right and left ear-face indices. However the differences were not statistically significant (p-value-0.89) (Table 4).

Table 1
Summary of ear measurements (male and female combined).

	Right (mm)	Left (mm)	p-value
Ear height	56.95 ± 5.00	56.86 ± 4.92	0.456
Ear projection	19.52 ± 2.143	19.59 ± 2090	0.315
Ear face index	46.26 ± 3.97	46.20 ± 3.89	0.449

The mean face height was 123.51 mm (SD 10.62).

Table 2
Gender comparison.

	Male (mm)	Female (mm)	p-value
Right ear height	58.10 ± 4.87	55.93 ± 4.91	0.0001
Left ear height	58.08 ± 4.75	55.81 ± 4.84	0.000
Right ear projection	19.76 ± 1.91	19.20 ± 2.16	0.009
Left ear projection	19.90 ± 1.79	19.22 ± 2.14	0.005
Face height	125.25 ± 11.66	121.98 ± 9.37	0.0071
Right ear-face index	46.59 ± 4.01	45.97 ± 3.92	0.1735
Left Ear-face index	46.72 ± 3.83	45.88 ± 3.94	0.1226

Table 3
Measurements range (gender comparison).

	Male (mm)	Female (mm)
Right ear height	46–70	44–70
Left ear height	46–72	45–68
Right ear projection	15–27	11–26
Left ear projection	15–29	13–27
Face height	106–156	106–153

12. Comparison of right and left ear values for females

Female subjects were noted to have higher values for the right ear height and right ear face index. The differences were not statistically significant between these values. (p-value 0.341) (Table 5).

13. Ear projection

The results were analysed to check for prominence of the ears. It was noted that a total of 6.89% of all the subjects had prominent ears (i.e. ear projection greater than 21 mm). A total of 90.49% of the subjects had ear projection within the normal range. A total of 6.89% had a prominent right auricle whilst 6.56% of the study population had a prominent left auricle (Table 6).

14. Right ear projection

Among male subjects, 7.69% had prominent ears whilst 6.89% of female subjects had prominent ears. There were more females with small ears (<15 mm) compared to males (i.e. 4.43% vs 0.7%) (Table 7).

15. Left ear projection

Left ear projection was more common among male subjects as compared to female subjects (7.69% vs 6.56%) (Table 8).

The percentage of males with prominent right and left ears was equal whilst among the female subjects, frequency of prominence of the right ear was more than that of the left (Table 8).

16. Discussion

The external ear is an important component of the human facial complex. It defines the face and conveys information about the age and sex of an individual [15]. The external ear's parameters, shape and proportion to the face are vital in aesthetic surgery as this information helps guide a plastic surgeon in correcting ear defects. It is important to recognize that there is no standard ear morphology and variations across ethnic groups have been noted [16,17]. Thus surgeons in a particular locality should have specific data relating to that particular ethnic group. This study attempts to furnish data for normal children of both sexes aged 9–13 in Zimbabwe. The findings of the study may be representative of ear parameters of black children in Sub-Saharan Africa.

This study goes further than just looking at ear morphometry but also looks at the prevalence of prominent ears in the black African children. There have been studies conducted to obtain ear parameters in some black populations [18]. A recent paper from Nigeria studied the parameters of ear height, lobule height and lobule width from the adult population [18]. The authors have not been able to find a report on the frequency of prominent ears in the black African population from a thorough literature search.

From our study, the right and left ear heights for males were 58.10 (SD 4.87) and 58.08 (SD 4.75), and 55.93 (SD 4.91) and 55.81 (SD 4.84) for females. The results were almost similar to those obtained from a Turkish study of children aged 6–13 years (n = 153) [19]. Skaria studied ear morphometry of three different races, (ie the Indians, Caucasians and Afro-Caribbean adults) [20]. He noted that Indians from the subcontinent had the longest ear length followed by the Caucasians. Afro-Caribeans had the smallest ears. Ear height is important in the evaluation of congenital anomalies (e.g., the small ear in Down's syndrome, Alpert syndrome and Treacher-Collins syndrome).

Gender variations in ear parameters have been noted in the literature. A number of studies in the literature have shown that the mean height of the external male ear is higher than that of the external female ear in various populations and age groups

Table 4
Comparison of right ear values vs left for males.

	Right	Left	p-value
Ear height	58.10 ± 4.87	58.08 ± 4.75	0.890
Ear projection	19.76 ± 1.91	19.90 ± 1.79	0.391
Ear face index	46.59 ± 4.01	46.72 ± 3.83	0.858

Table 5
Comparison of right and left ear values for females.

	Right	Left	p-value
Ear height	55.93 ± 4.91	55.81 ± 4.84	0.341
Ear projection	19.20 ± 2.16	19.20 ± 2.14	0.555
Ear face index	45.97 ± 3.92	45.88 ± 3.94	0.349

Table 6
Ear projection (both sexes).

	Right – frequency (%)	Left – frequency (%)
Small	8 (2.62)	8 (2.62)
Normal	276 (90.49)	277 (90.82)
Prominent	21 (6.89)	20 (6.56)

Small <15 mm, normal 15–21 mm, prominent>21 mm.

Table 7
Right ear projection comparison by sex.

	Male(%)	Female(%)	Total(%)
Small	1(0.70)	7(4.32)	8(2.62)
Normal	131(91.61)	145(89.51)	276(90.49)
Prominent	11(7.69)	10(6.17)	21(6.89)

Table 8
Left ear projection comparison by sex.

	Male(%)	Female(%)	Total(%)
Small	1(0.70)	7(4.32)	8(2.62)
Normal	131(91.61)	146(90.12)	277(90.82)
Prominent	11(7.69)	9(5.56)	20(6.56)

[15,16,19,21]. From the analysis of this study male subjects had higher ear height values compared to female subjects. These differences were statistically significant (p-value 0.000).

Farkas reported that the face height of males was higher than that of females [21]. His paper did not mention any statistical analysis on this parameter. In Ferrario's study, face height was found to be significantly higher in males than in females [19]. In our study we noted that face height was higher in males than females and the difference was statistically significant (p-value 0.007).

For an individual to have an aesthetically fine appearance, the height of the face and ears should be proportionate. For someone with a relatively small face height and relatively longer ears (even if the ear length is within normal parameters for the age), that individual can appear as if he/she has prominent ears. Thus disproportionate ear and face heights can create either "apparent" prominent ear appearance or apparent microtia.

Ferrario suggested that for an attractive facial expression, the ear-face index should be 50% in males and 53% in females [19]. He however did not specify whether this was the right or left ear-face index or the mean. In our study, the right ear-face index was 46.26 (SD 3.97), whilst that of the left was 46.20 (SD -3.89). The reason for the disparity between our study and Ferrario's could be because Ferrario studied the adult ear and not the child's. In a study conducted among Turkish school going children aged between the ages of 6–13 years, the right ear-face index was 50.70 (SD 3.00) in males and 49.59 (SD 3.23) in females, whereas the left ear-face index was 50.52 (SD 3.11) in males and 49.64 (SD 2.87) in females [19]. In the same study the gender difference for the left ear was not statistically significant whilst that of the right side was. In our study, the differences between the ear face indices among the sexes were not significant (p-value, right- 0.173, left 0.123).

There were some subtle differences between the right and left ear parameters within each gender group. This study demonstrated that 65% of the measured subjects had different measurement values for the right ear and left ear height. Other studies also noted the same findings [18–20].As in other studies in the literature, the differences in our study were not statistically significant (p-value 0.456). Farkas also recorded asymmetry between left and right ear length in paediatric population [21]. He also noted that by adulthood, the discrepancy had diminished. Barut observed that the left ear was significantly larger than the right in the paediatric population he studied [19]. Ferrario, in one of his papers reported that the "differences between the left and right parts of the human face, especially differences between the paired structures, are well known in healthy people" [19].

It has been noted that the external ear is an infinitely complex structure with great variation between individuals [1]. Studies have also noted that variations also exist between the two sides of the same individual. The structural differences in the human ear create unique shapes and morphology similar to the unique fingerprint of each human being [19].

One of the major aims of the study was to evaluate the prevalence of prominent ears. We noted that 7.69% of male subjects had prominent ears (right and left sided). Among the female subjects, 6.17% had right sided prominence, whilst 5.56% had left sided prominence. In Turkey, Bozkir studied ears of 341 young adults and found that female ears were slightly more prominent than men's measured at the level of the tragus [22]. In the European literature, 5% of the children at the age of 6 years have prominent ears [1]. Among the Japanese children prominent ear deformity prevalence was noted to be 5.5% [23]. In a study carried out among Indian men, Purkait noted that prominent ear was observed in 11.4% of right and 10.2% of left auricles [16]. A Chinese study showed that prominent ear ranged from 3.7 to 4.1% among the male subjects and 3.3–4.1% among the female subjects [24]. The study population's age ranged from 18 to 75 years.

Measurement of ear projection was done at tragal level. In some studies, the measurements have been done at the supra-auricular level. It has been noted that tragal measurements are generally higher than supra-auricular levels. In a Chinese study conducted using three dimensional computer tomography measurements, projections at the tragal level were up to 50% higher than at the supra-auricular level [24]. In their study the mean protrusion at supra auricular level ranged from 14.1 to15.7 mm among male subjects and at tragal level the mean range was from 19.6 to 21.3 mm. It is possible that the measurements we obtained were slightly higher than the European figure because of the level at which the measurements were taken. In addition the Chinese study showed that protrusion showed a decreasing trend with increasing age. This was attributed to the reduced resilience and elasticity of the skin as well as due to sleeping posture. Thus it is also possible that the often quoted 5% prevalence is from the adult population and this may not be comparable to children.

In the Zimbabwean society, level of stigmatization of children with prominent ears is unknown, so is the level of conscientisation of the deformity. One of the fears of the authors was to provoke this conscientisation during the field visits. We thus devised a way to draw the children's attention from the ears by taking the height and weight of the subjects. It was noted that children were more eager to know their height and weight than their ear measurement values and this helped to allay the author's fears.

The limitation of the study was that it was conducted among local Zimbabwe school going children and it may not be truly representative of the entire African children.

17. Conclusion

Prominent ear is a deformity that cuts across different races and ethnic groups. It causes profound psycho-social problems. Children with the deformity are particularly prone to peer victimisation. Prominent ear deformity in the study population occurred with a slightly higher frequency (6.89%) when compared to Caucasian children (5%).

Knowledge of ear parameters is vital. It helps reconstructive and aesthetic surgeons in reproducing an acceptable ear. In addition this information is helpful in the hearing instruments industry. The study demonstrates the mean values of the different morphometric measurements from the left and right external ears in 305 black primary school going Zimbabwean children.

Ethical approval

Ethical approval from the Joint Parirenyatwa Hospital and College of Health Sciences Ethics Committee.

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Author contribution

Wilfred muteweye: study design, data collection, data analysis, writing, editing.

Godfrey Muguti: study design, data analysis, writing, editing, proof reading, submission of manuscipt.

Conflicts of interest

None.

Guarantor

Wilfred Muteweye.
Godfrey I. Muguti.

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