TF Fok
KL Hon
HK So
E Wong
PC Ng
AKY Lee
A Chang

Auricular anthropometry of Hong Kong Chinese babies

Authors' affiliations:
T.F. Fok, K.L. Hon, H.K. So, P.C. Ng, Department of Paediatrics, The Chinese University of Hong Kong, Hong Kong, China
E. Wong, Centre of Clinical Trials and Epidemiology Research, The Chinese University of Hong Kong, Hong Kong, China
A.K.Y. Lee, Union Hospital, Hong Kong, China
A. Chang, Department of Obstetrics and Gynaecology, The Chinese University of Hong Kong, Hong Kong, China

Correspondence to:
T.F. Fok
Department of Paediatrics
Prince of Wales Hospital
Shatin
Hong Kong China
Tel.: (852) 2632 2850
Fax: (852) 2648 9134
E-mail: taifaifok@cuhk.edu.hk

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Structured Abstract

Authors – Fok TF, Hon KL, So HK, Wong E, Ng PC, Lee AKY, Chang A

Objectives – To provide a database of the auricular measurements of Chinese infants born in Hong Kong.

Design – Prospective cross-sectional study.

Setting and Sample Population – A total of 2384 healthy singleton, born consecutively at the Prince of Wales Hospital and the Union Hospital from October 1998 to September 2000, were included in the study. The range of gestation was 33–42 weeks.

Measurements and Results – Measurements included ear width (EW), ear length (EL) and ear position (EP). The data show generally higher values for males in the parameters measured. When compared with previously published data for Caucasian and Jordanian term babies, Chinese babies have shorter EL. The ears were within normal position in nearly all our infants.

Conclusion – The human ear appears to grow in a remarkably constant fashion. This study establishes the first set of gestational age–specific standard of the ear parameters for Chinese new-borns, potentially enabling early syndromal diagnosis. There are significant inter-racial differences in these ear parameters.

Key words: auricular anthropometry; Chinese infants

Introduction

There are numerous congenital birth defects and syndromes associated with abnormal craniofacial development (1–4). In particular, auricular appearance and position constitute an important diagnostic feature in the characterization of these defects. For instance, abnormal ear appearance is associated with hypoglycemia (Beckwith–Wiedemann syndrome), hearing

deficit (Goldenhar syndrome); and 'low-set' ears with cardiac anomalies (Noonan and Smith–Lemli–Opitz syndromes) (2). Also, abnormal ear length (EL) may be a useful parameter in predicting fetal aneuploidy (5). Thus, the recognition of ear abnormalities may prompt relevant investigations. It is often misleading and imprecise to describe dysmorphic physical findings without accurate quantification. Normative standards for auricular measurements are available for Caucasians and many other communities (3, 6–12) but those for pre-term Chinese infants are lacking. The use of Caucasian or other standards, unfortunately, may not be applicable to Chinese infants as such measurements vary in different populations (13). We recently documented significant inter-racial differences in palpebral fissure length, outer canthal distance, intercanthal distance, and philtrum length (14, 15). The findings of this study imply that there may also be significant differences in the auricular (ear) parameters between Chinese infants and infants of other ethnicities. To date, there have been only limited data for the Chinese infants.

In growth studies, the most common method of collecting data is cross-sectional anthropometry. In this method, individuals are measured once, and the mean values for various ages are determined. The purpose of this study is to provide a gestational age–specific database of the auricular parameters and position for the Hong Kong Chinese (HKC) newborns by cross-sectional anthropometry, and to compare these values with published standards. These measurements are useful for assessing infants with dysmorphic features and syndromes and enable quantitative description that is more precise and objective than the current clinical practice of sole reliance on visual impression.

Materials and methods

All protocols were reviewed and approved by the Clinical Research Committee of the Chinese University of Hong Kong. Singleton newborns with gestation 33–42 weeks were eligible for the study provided informed consent was given by the parent(s).

Exclusion criteria

Babies with the following conditions were excluded:

- Moribund condition at birth.
- Major congenital malformations.
- Chromosomal abnormalities.
- Gestational age impossible to determine.

Gestational age determination

Gestational ages were calculated to the completed week from the onset of the last menstrual period of the mother in accordance with the World Health Organization (WHO) recommendation (16). Estimation of gestational age was based on the findings of early dating ultrasound prior to 20 weeks' gestation. When this was not available, maternal last menstrual date was used if the mother had regular menstrual cycle and was certain of her menstrual history, and verified by postnatal assessment using the new Ballard score (17), which had been formally evaluated in our Neonatal Unit and found to be applicable for Chinese infants. Any babies in whom the assessed maturity deviated from that calculated from the mothers' dates by more than 2 weeks were excluded.

Anthropometric measurements

We measured the ear width (EW), EL and ear position (EP). These auricular parameters were measured following the method described by Hall et al. (13) with the baby's head in the Frankfurt horizontal position (Fig. 1). Ear width or the width of the external ear (pinna) is defined as the transverse distance from the palpable anterior base of the tragus through the external auditory canal to the margin of the helical rim at the widest point. It was measured with a spreading caliper (Bicondylar vernier, Holtain, UK). Ear length defined as the maximum distance from the superior aspect to the inferior aspect of the external ear, was measured with the spreading caliper. Ear position defined as the location of the superior attachment of the pinna, was determined by the Leiber's method (13). The instrument employed in the Leiber's method was created by the Technology Department of the Chinese University of Hong Kong. The area of the face between the free margin of the lower eyelid and the upper edge of the nasal ala must be crossed by the line drawn from the ear canal if it is considered to be normal (Fig. 1).

All auricular measurements were carried out within 48 h of delivery. One research staff received specific training in the use of measuring equipment, which was

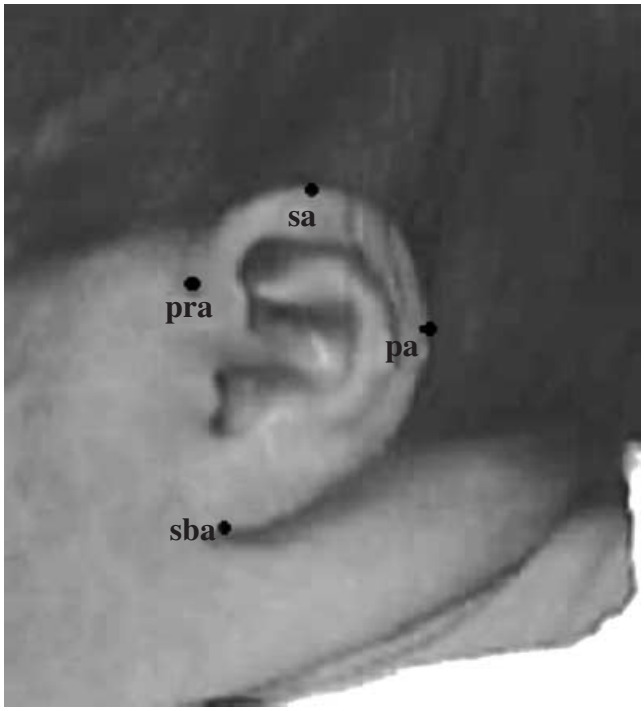

Fig. 1. Landmarks for the determination of EW (pra-pa) and EL (sa-sba).

calibrated each morning before measurements were carried. The equipment was cleansed with alcohol and air-dried. Each baby was measured 30 min after feed. The observer followed the Neonatal Unit policy of scrubbing, gowning and hand washing between babies.

For each variable measured, standardized percentile curves for males and for females were produced by plotting the third, fifth, 10th, 25th, 50th, 75th, 90th, 95th, and 97th percentiles. Values for the smoothened curves were calculated using the LMS method according to Cole et al. (18). The LMS method estimates the measurement centiles in terms of three age–sex–specific cubic spline curves: the L curve (Box–Cox power to transform the data that follow a Normal distribution), M curve (median) and S curve (coefficient of variation). In brief, if $Y(t)$ denotes an independent positive data at t gestation weeks, the distribution of $Y(t)$ can be summarized by a normally distributed SD score (Z) as follows:

$$Z = \frac{[Y(t)/M(t)]^{L(t)} - 1}{L(t)S(t)}$$

Once the $L(t)$, $M(t)$, and $S(t)$ have been estimated for each gestation t, the 100αth centile at t gestation weeks could be derived from

$$C_{100\alpha}(t) = M(t)[1 + L(t)S(t)Z_\alpha]^{1/L(t)}$$

where Z_α is the α centile of the Normal distribution (for example for the 97th centile, $\alpha = 0.75$ and $Z_\alpha = 1.88$).

Results

A total of 2384 normal Chinese singletons (both parents of Chinese ethnicity) born consecutively at the Prince of Wales Hospital and the Union Hospital from October 1998 to September 2000 were included in the study. The range of gestation was between 33 and 42 weeks. Forty percentage of the infants were born in the two hospitals, the estimation of gestational age were based on the findings of early dating ultrasound prior to 20 weeks gestation. Measurements are expressed as mean ± SD and range. Figures 2 and 3 illustrate the EW measurements vs. gestational age in males and females, respectively. Figures 4 and 5 illustrate the ear height measurements vs. gestational age in males and females, respectively. Ear width correlated fairly well with EL (Pearson correlation $r = 0.33$ in males, and $r = 0.33$ in females, $p < 0.001$). In all these parameters, male HKC infants have generally higher values than their female counterparts ($p < 0.005$). When compared with Caucasian and Jordanian term

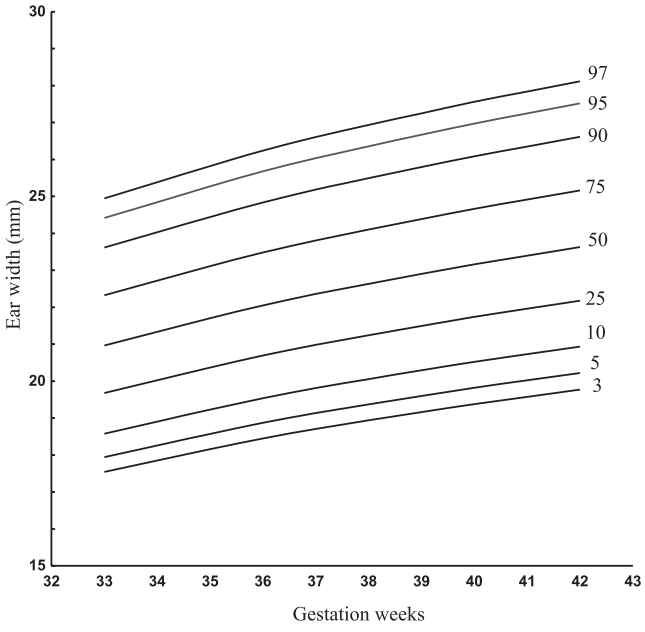

Fig. 2. Ear width vs. gestation for Hong Kong males.

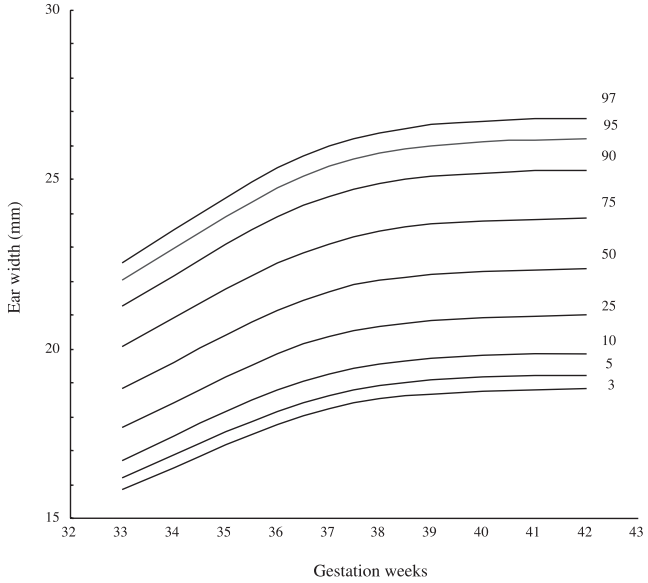

Fig. 3. Ear width vs. gestation for Hong Kong females.

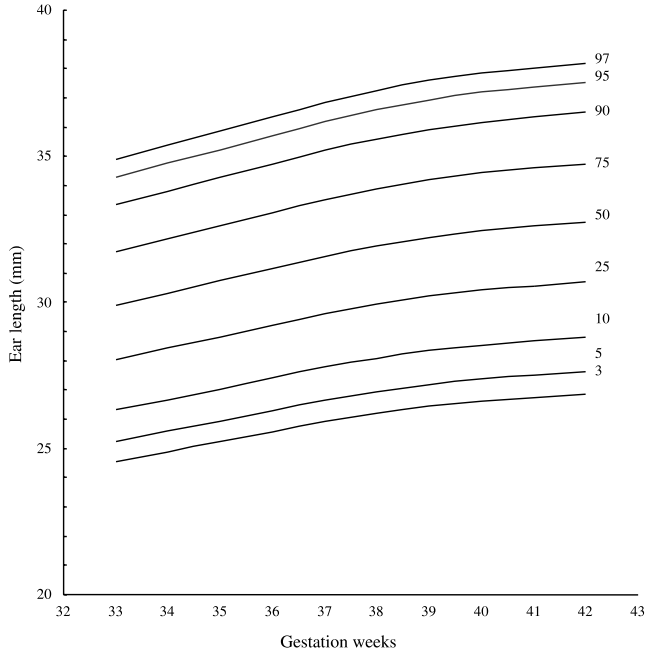

Fig. 4. Ear length vs. gestation for Hong Kong males.

babies, Chinese babies have shorter EL ($p < 0.0001$) (Table 1). The ear grew in a remarkably constant fashion and did not vary between the two genders or with gestation in Chinese babies. Over 99% of EPs were in the normal position (the area of the face between the free margin of the lower eyelid and the upper edge of the nasal ala).

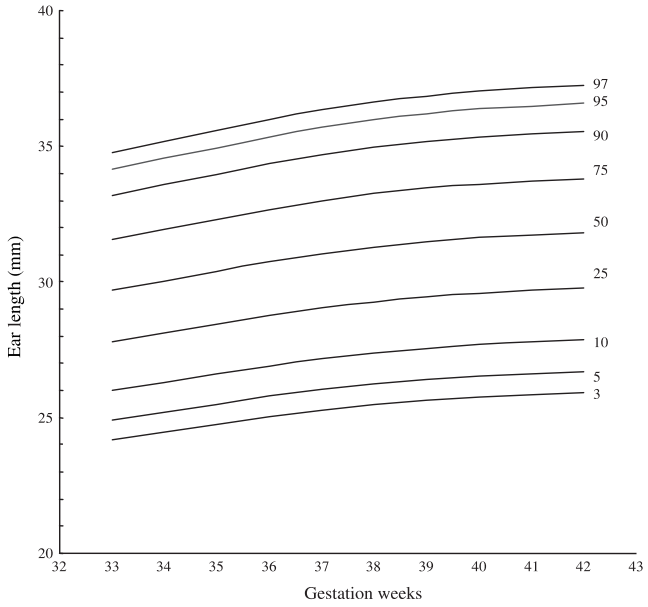

Fig. 5. Ear length vs. gestation for Hong Kong females.

Table 1. **Comparison of ear length in term babies**

Source	Race	n	Mean (mm)	SD (mm)
Merlob et al. (7)	Caucasian	87	39.0	3.0
el Shanti et al. (11)	Jordanian	158	36.2	2.9
This study	Chinese	2095	31.9	3.0

$p < 0.001$.

Discussion

Craniofacial anthropometry is important for characterizing facial features and detection of dysmorphic and syndromal craniofacial appearances. Early clinical diagnosis can aid a timely management plan and estimate prognosis. The EW and EL are useful for the detection of morphological malformation of the face. In this study, the growth of EL and EW remained remarkably constant and did not vary significantly between the two genders or with gestational age. These findings have significant implication in that we can objectively define ear dysmorphism accurately with these parameters even in premature babies in whom identification of dysmorphic features is notoriously difficult. This study extends the database down to 33 weeks of gestation for the Chinese. These values will be useful in the diagnosis of syndromes and dysmorphic features in the pre-term Chinese infants. In addition, these data could also be used in anthropology

studies to compare term and pre-term babies of different ethnicities.

In this study, over 99% of EPs were in the normal position. The area of the face between the free margin of the lower eyelid and the upper edge of the nasal ala must be crossed by the line drawn from the ear canal if it is to be considered normal. Abnormal EP is present in syndromes such as Treacher Collins, Noonan and Smith–Lemli–Opitz syndromes (2).

Paediatricians in Hong Kong have been relying on western parameters for these measurements. We previously documented that palpebral fissure length and outer canthal distance were significantly larger in HKC newborns, whereas inner canthal distance and philtrum length were smaller (14, 15). Findings in this study show that measurements of EL can be markedly different between the Chinese and the Caucasians infants and confirm the presence of racial differences in these physical characteristics. There have been a few reports on auricular measurements in children. In Merlob's study, only Caucasian term infants were included and their number was small (n = 87) (7). The values of EL concur with those of Sivan et al. (19). They also measured EL and position in pre-term infants as young as 27 weeks of gestation. However, they did not report EW. In a Chinese study, the EL of 284 full-term neonates were reported but no pre-term neonates were included (12). They did not find any difference between the EL of Chinese children and that of Caucasian children. In a small Japanese study, when compared with Caucasian newborns, the Japanese babies also had shorter EL (10).

One trained research staff, thereby avoiding interpersonal variation in measurement skills undertook all the measurements. The limitation of this study is that only the newborns of two hospitals in the New Territories (North side of Hong Kong) were included. However, there were no significant differences among the parameters of birth weight, crown-heel length and head circumference of different hospitals in Hong Kong shown by our pervious report (20). This is not surprising since the social infrastructures in Hong Kong allow easy and free access to health care for the entire population, and there is no distinct socioeconomic demarcation between the patients of public and private hospitals. This is the first database documenting the ear parameters for term and pre-term Chinese infants to date.

References

1. Meaney FJ, Farrer LA. Clinical anthropometry and medical genetics: a compilation of body measurements in genetic and congenital disorders. *Am J Med Genet* 1986;**25**:343–59.
2. Jones KL. *Smith's Recognizable Patterns of Human Malformation*, 4th edn. Philadelphia, PA: WB Saunders; 1988.
3. Omotade OO. Facial measurements in the newborn (towards syndrome delineation). *J Medical Genet* 1990;**27**:358–62.
4. Hunt JA, Hobar P, Craig MD. Common craniofacial anomalies: the facial dysostoses. *Plast Reconstr Surg* 2002;**110**:1714–26.
5. Chitkara U, Lee EL, Oehlert JW, Bloch DA, Holbrook RH Jr, el-Sayed YY et al. Fetal ear length measurement: a useful predictor of aneuploidy? *Ultrasound Obstet Gynecol* 2002;**19**:131–5.
6. Feingold M, Bossert WH. Normal values for selected physical parameters: an aid to syndrome delineation. *Birth Defects: Original Article Ser* 1974;**10**:1–16.
7. Merlob P, Sivan Y, Reisner SH. Anthropometric measurements of the newborn infant (27 to 41 gestational weeks). *Birth Defects: Original Article Ser* 1984;**20**:1–52.
8. Sivan Y, Merlob P, Reisner SH. Assessment of ear length and low set ears in newborn infants. *J Med Genet* 1983;**20**:213–5.
9. Lakshminarayana P, Janardhan K, David HS. Anthropometry for syndromology. *Indian J Pediatr* 1991;**58**:253–8.
10. Tateishi H, Kajii T. Physical parameters in Japanese newborns. *Jpn J Hum Genet* 1992;**37**:223–8.
11. el Shanti H, al Lahham M, Batieha A. Craniofacial anthropometric measurements in a population of normal Jordanian newborns. *Leb Med J* 2000;**48**:23–8.
12. Chou CT, Tseng YC, Tsai FJ, Lin CC, Liu CS, Peng CT et al. Measurement of ear length in neonates, infants and preschool children in Taiwan. *Acta Paediatr Taiwan* 2002;**43**:40–2.
13. Hall JG, froster-Iskenius UG, Allanson JE. *Handbook of Normal Physical Measurements*. New York: Oxford University Press; 1989.
14. Fok T, Hon KL, So HK, Wong E, Ng PC, Lee AKY et al. Craniofacial anthropometry of Hong Kong Chinese babies: the eye. *Orthod Craniofacial Res* 2003;**6**:48–53.
15. Fok TF, Hon KL, So HK, Wong E, Ng PC, Lee AKY et al. Facial anthropometry of Hong Kong Chinese babies. *Orthod Craniofacial Res* 2003;**6**:164–72.
16. World Health Organization. Definitions and recommendations. International statistical classification of diseases, Vol. 1. Geneva: WHO; 1979. 763–8.
17. Ballard JL, Khoury JC, Wedig K, Wang L, Eilers-Walsman BL, Lipp R. New Ballard Score, expanded to include extremely premature infants. *J Pediatr* 1991;**119**:417–23.
18. Cole TJ, Green PJ. Smoothing reference centile curves: the LMS method and penalized likelihood. *Stat Med* 1992;**11**:1305–19.
19. Sivan Y, Merlob P, Reisner SH. Upper limb standards in newborns. *Am J Dis Child* 1983;**137**:829–32.
20. Fok TF, So HK, Wong E, Ng PC, Chang A, Lau J et al. Updated gestational age specific birth weight, crown-heel length, and head circumference of Chinese newborns. *Arch Dis Child Fetal Neonatal Ed* 2003;**88**:229–36.