PERCENTILE GROWTH CHARTS FOR HEAD CIRCUMFERENCE IN PUNJABI INFANTS

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ABSTRACT

Percentile growth charts for head circumference of Punjabi infants (male 86 and female 68) measured serially at monthly intervals during the first year of life are presented. Besides, constancy of sample size and strict adherence to time tolerance limit of ±3 days, on the day of monthly measurements other factors considered responsible for the natural smooth course of the percentile grids are highlighted. The presented data would enable easy detection of infants with abnormal course of head growth.

Key words: *Growth charts, Percentiles, Longitudinal data, Punjabi infants.*

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Percentile charts (or grids) permit a study of the kinetics of the development process(1). These charts provide an indication of the position of the growing child relative to his healthy peers with respect to growth parameters measured at one or more age periods. The concept of determining position of a child within percentiles was considered more easy to understand even by those unfamiliar with mathematical concepts and more accurate when applied to skewed distributions(2). The use of growth charts in the clinical assessment of the growing infants and children, in nutritional screening and other epidemiologic assessments of children has already been recommended(3,4).

About six decades ago, Stuart(5), presented growth percentiles of head circumference and their use in clinical practice as norms to judge the growth of child's head was recommended by pediatricians(6). The growth charts based on data emanated from industrially developed nations(3,7-9) are being widely used as reference standards in most parts of the world. However, percentile growth charts based on serial measurements for the detection of head growth abnormalities were considered more reliable than those obtained from isolated measurements(10).

Nellhaus(11) did not find significant racial, national or geographic differences in human head circumference and presented two composite international and interracial graphs on head circumference for detection of abnormal patterns of head growth. In an excellent review of numerous studies, Meredith(12) found substantial racial and regional differences in human head circumference throughout the postnatal stages of human ontogeny, and recommended reinterpretation of the graphs as appropriate for characterising some human

groups, but not as inter-racially and internationally applicable. The need for having race or sub-race specific growth graphs on human head circumference is, therefore, obvious.

Some attempts have been made in India(13,14) to construct growth percentiles of head circumference. The infirmities of these studies include: *(i)* heterogeneity of racial stock; *(ii)* nonadherence to time tolerance limit; *(iii)* pooling of data relating to large age range; *(iv)* inclusion of subjects with different birth weights and gestational age; and *(v)* unknown perinatal histories. There was thus a need to carry out a study based on sound methodology in a homogeneous population to generate reliable and adequate somatometeric data. In this paper, we present percentile growth charts of head circumference of Punjabi male and female infants from birth to the age of 12 months derived from longitudinal data.

Material and Methods

Serially gathered anthropometric data on 154 Punjabi infants (86 males, 68 females) measured for circumference of head at monthly intervals, followed up in the Growth Clinics of PGIMER, comprised the material for this presentation. All the subjects included in the sample were born to normal healthy Punjabi parents representing a mixed socio-economic strata, who lived in the Union Territory of Chandigarh. Infants born to parents who used Punjabi as a language for daily conversation and who traced their ancestral place of origin to any place located in present day Punjab province were considered as Punjabis(15). Infants were included in this longitudinal study, if they fulfilled this given criterion: *(i)* both parents belonged to the Punjabi stock for 3 generations; *(ii)* permanent residence in Chandigarh; *(iii)* gestational age exceeding 37 weeks; *(iv)* birth weight over 2.5 kg; and *(v)* willingness of the parents of child to participate in the longitudinal study. All infants with history of adverse perinatal factors like birth asphyxia, trauma or suspected to be suffering from any other disease of central nervous system or any other congenital anomaly were excluded.

Of these infants, 91.6% were born through normal vaginal deliveries and remaining 8.4% were forceps deliveries, 92.2% of the infants were first borns. None of these infants experienced any serious illness during the entire period of study. All but one infant were breast-fed from birth to six months; however, under 5% of the mothers continued breast-feeding their infants to one year of age(16,17).

Greatest circumference of the head of each child was measured by placing a steel tape firmly around the frontal bones just superior to eye brows, above the glabella, passing around the head at the same level on each side, crossing over the maximum prominence of the occiput at the back(18). Every subject was examined at monthly ages with a time tolerance of ± 3 days on the day of measurement. The babies who failed to reach in the clinics on appointed dates were examined in their homes. The measurement was recorded up to the nearest 0.1 cm. Intra-observer error ranged from 0 to 0.2 cm. The average of two measurements was regarded as the final value. While taking measurements, the infant's hands were restrained by the mother.

Distance percentiles (3rd, 10th, 25th, 50th, 75th, 90th and 97th) were computed from the basic longitudial data on head circumference presented elsewhere(15), by using the following modified formulae

given by Tanner *et al.*(19):

3rd and 97th percentile = $\bar{x} \pm 1.881$ corrected SD

10th and 90th percentile = $\bar{x} \pm 1.282$ corrected SD

25th and 75th percentile = $\bar{x} \pm 0.675$ corrected SD

where $\bar{x}$, is mean and SD, standard deviation

Healy's(20) correction was applied to the standard deviation (SD) to minimize the effect of time tolerance period on the variance of measurements so as to obtain corrected SD, so that:

$$\text{Corrected SD} = \sqrt{SD^2 - \frac{b^2}{12}}$$

where b is the rate of growth of the variable (head circumference) in question.

The corrected SD was used to compute different percentile values at each monthly age level during infancy.

Results

Percentile growth charts for head circumference of both Punjabi male

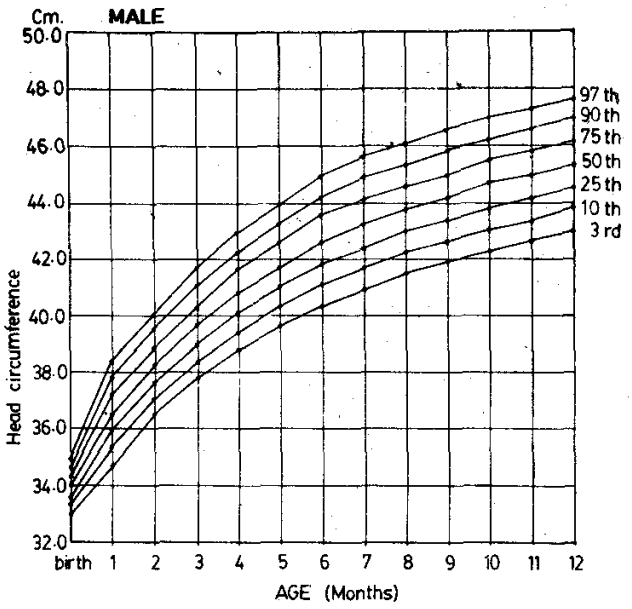

Fig. 1. Head circumference by age percentiles for Punjabi male infants.

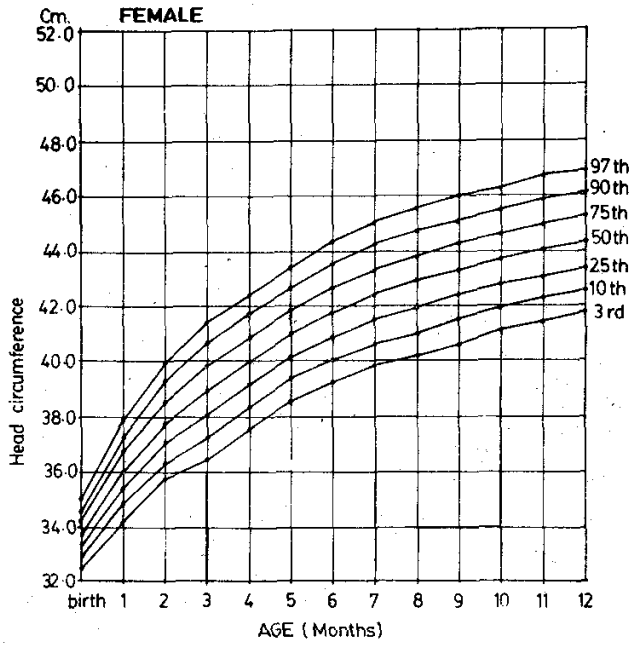

Fig. 2. Head circumference by age percentiles for Punjabi female infants.

(Fig. 1) and female *(Fig. 2)* infants are derived from values presented in *Table I.* The course of mean curve (50th percentile) shows a sharp initial increase during the first half of infancy followed by slower gain during second half. All the seven percentiles for head circumference depict a smooth course among both male and female infants of Punjabi origin. This is a unique feature of the study and no attempts were made to smoothen up these further. Issues relating to sex differences, have already been published(21).

Discussion

Percentile growth charts for head circumference were constructed from monthly longitudinal observations carried out on 86 male and 68 female infants who were normal by birth weight and gestational age(22). The parabolic nature of the mean distance curves for both male and female infants is characterized by initial sharp increase followed by a relatively slow gain during latter half of infancy.

The attainments of Punjabi infants for

TABLE 1– *Head Circumference (cm) by Age Percentile Among Punjabi Male and Female Infants.*

Age (mo)	Percentiles							
	3rd	10th	25th	50th	75th	90th	97th	SD
				Male				
Birth	33.05	33.35	33.65	33.98	34.31	34.61	34.91	1.02
1	34.68	35.29	35.88	36.54	37.21	37.81	38.40	1.11
2	36.48	37.04	37.62	38.26	38.90	39.47	40.04	1.03
3	37.68	38.31	38.94	39.64	40.34	40.97	41.60	1.09
4	38.78	39.44	40.10	40.84	41.57	42.23	42.89	1.12
5	39.60	40.29	40.98	41.75	42.51	43.21	43.89	1.17
6	40.35	41.08	41.82	42.64	43.46	44.19	44.92	1.23
7	40.93	41.68	42.43	43.28	44.12	44.88	45.62	1.26
8	41.48	42.21	42.96	43.78	44.61	45.35	46.08	1.23
9	41.88	42.62	43.37	44.20	45.03	45.78	46.52	1.24
10	42.35	43.09	43.84	44.67	45.50	46.25	46.99	1.24
11	42.71	43.45	44.20	45.03	45.86	46.61	47.35	1.24
12	43.08	43.82	44.56	45.39	46.22	46.96	47.69	1.22
				Female				
Birth	32.45	32.86	33.27	33.72	34.18	34.59	34.99	0.93
1	34.18	34.79	35.31	35.94	36.58	37.14	37.71	1.07
2	36.66	36.32	36.98	37.72	38.45	39.11	39.77	1.15
3	36.45	37.24	38.05	38.94	39.84	40.65	41.44	1.36
4	37.53	38.29	39.07	39.93	40.79	41.57	42.33	1.31
5	38.49	39.28	40.07	40.96	41.84	42.64	43.42	1.33
6	39.16	39.98	40.81	41.74	42.66	43.50	44.32	1.38
7	39.80	40.63	41.47	42.40	43.33	44.17	45.00	1.39
8	40.21	41.05	41.91	42.86	43.81	44.67	45.51	1.42
9	40.64	41.49	42.36	43.32	44.29	45.15	46.01	1.43
10	41.08	41.91	42.76	43.69	44.63	45.47	46.30	1.39
11	41.44	42.28	43.13	44.08	45.03	46.10	46.92	1.36
12	41.80	42.61	43.44	44.36	45.27	46.10	46.92	1.36

head circumference, in general, were higher than those studied in other parts of India(23,24). This reflected a more satisfactory nutritional status enjoyed by Punjabi infants in contrast to their other counterparts. Satisfactory health status of Punjabi infants was also evident from the fact that none of the infants suffered from any serious sickness during the entire study span.

The smooth nature of the percentile grid throughout infancy could be attributed to several quality control measures instituted during the collection and analysis of data. This helped in controlling several confounding factors which are known to contribute towards higher variability. Careful sampling techniques were employed(17) to select Punjabi infants normal by gestational age and birth weight as per the WHO criterion(22). Every effort was made to maintain the constancy of sample size and all the observations pertain to 86 male and 68 female infants at each age

level. Homogeneity of the sub-racial stock was maintained by selecting subjects from Punjabi households. All the measurements were taken by the same investigator (AKB) thus eliminating inter-observer errors.

Time tolerance limit of ±3 days were strictly adhered to on the day of monthly measurements, yet Healy's correction(20) was applied to absolute SD to further reduce the quantum of age related variability so as to obtain corrected SD, which was used to compute different percentiles. Application of Healy's correction gave instantaneous variance by resurrecting Boa's(25) adjustment(26) of sample variance to obtain a value corresponding exactly to the mid point of an age group(27), which came into existence, in the present context, by using specified time tolerance limit (3± days) on the day of monthly measurement.

Besides the aforementioned factors which contributed to the smooth course of this percentile grid, basic nature of the measurement involved, *i.e.*, head circumference in itself is an important factor, which exhibited least variability(28) in contrast to other measurements studied for the subjects of present series. This may be explained by the well accepted fact, dynamics of head growth is controlled more by genetic factors than the environmental ones.

The natural smooth course of the percentile grid is the main strength of this longitudinal study which is not commonly observed amongst representatives of other populations. The reference population in this study may be regarded as normal and healthy as can be. Normality in its operational terms can be equated with 'good health', which was enjoyed by all the sample subjects during study span. In this context, the values depicted at the different age levels in percentile grids may be used to compare and evaluate growth of head circumference or Punjabi infants residing in Chandigarh. The values obtained after measuring head circumference of a child should be plotted against subject's known age in the respective sex specific centile chart, so as to judge his/her growth status with respect to head circumference. Any infant with head circumference outside the 3rd or 97th percentile of the values presented has a 94% chance of being abnormal.

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