Detection of ocular hypertelorism among Indian children

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Background & objectives: Ocular hypertelorism constitutes an important component of many clinical syndromes. It is typically recommended to use inter-pupillary distance (IPD) for objective evaluation of ocular hypo/hypertelorism. Barring infancy, there is a scarcity of data on this anthropometric parameter relating to the ocular apparatus. This study aims to study auxological dynamics of IPD in children of Indian origin.

Methods: A total of 3622 (2239 males and, 1383 females) normal, healthy Indian children of North-western origin, aged one month to 14 yr comprised the sample for this study. Inner and outer-canthal distance were measured using standardized anthropometric techniques. None of the children who participated in this study had craniofacial dysmorphism or any body deformity. Mean (standard deviation SD) and percentiles were calculated for IPD in male and female subjects at different age levels.

Results: IPD increased from 4.68±0.21 to 6.19±0.36 cm in males and from 4.59±0.26 to 6.08±0.25 cm in females between one month and 14 yr of age. Boys in general, possessed larger IPD than girls, however, the gender differences became significant (P≤0.05) at 10, 11, 16-18 and 22-24 months, respectively, and five and 10 yr of age, respectively.

Interpretation & conclusions: The results of this study suggest that the patients having IPD less than the 3rd percentile should be treated as cases of hypotelorism while, those exceeding 97th percentile as cases of hypertelorism. The use of percentile grids presented for IPD may be used to detect ocular hypotelorism and hypertelorism in male and female children to corroborate diagnosis of different syndromes.

Key words Growth percentiles - hypertelorism - hypotelorism - Indian children - inter-pupillary distance

Irregularities of growth and shape in craniofacial region disturb the harmonious structural relationship between the cranium and face of the growing children1. Therefore, for the detection of aberrant growth patterns in the facial region of children beyond normal variation, understanding of the auxological dynamics of the ocular apparatus becomes important. Ocular hypertelorism (representing an increased distance between centres of both the pupils) is known to be constituent of many clinical syndromes including, Crouzan’s disease, Cleidocranial dysostosis, Apert, Hurler’s, Cri-du-chat, Oto-palato-digital and Basal Cell Nevus syndromes, etc2,3. While, ocular hypotelorism (depicting decreased distance between centres of the pupils of two eyes) is associated with Mechel, Cofin-Siris and, William’s syndromes, and chromosomal disorders involving some partial trisomy etc3. It may present as an unusual morphologic feature without any
medical or cosmetic consequence\textsuperscript{1}. An optical illusion produced by a flat nasal bridge, lateral displacement of inner canthi or short palpebral fissures, epicanthal folds, widely spaced eyebrows, often makes evaluation of ocular hypertelorism imprecise and misleading. To diagnose true ocular hypertelorism accurately, the distance between both inner and outer canthi should be increased. Furthermore, hypertelorism must be differentiated from telecanthus or pseudohypertelorism in which the lateral displacement of the inner canthi may give a false impression of widely spaced eyes\textsuperscript{4}. Therefore, a need to objectively evaluate hypertelorism becomes obvious.

Inter-pupillary distance (IPD) is considered to be the most accurate and reliable measure for the quantification of ocular hypertelorism as the centre of the pupil remains unaffected by the soft tissues surrounding the eye\textsuperscript{5}. Available anthropological evidence confirms the existence of significant differences in the craniofacial growth patterns of children representing various ethnic and racial groups. Available data on IPD of Turkish\textsuperscript{6}, Nigerian\textsuperscript{7}, American\textsuperscript{8,9}, Iranian\textsuperscript{10}, Ghanaian\textsuperscript{11} populations exhibit substantial inter-population variation and hence, cannot be used to evaluate and compare the growth of IPD among children of Indian origin. However, detection of ocular hypo/hypertelorism in terms of inter-pupillary index derived from IPD and fronto-occipital circumference is another method suggested by Evereklioglu et al\textsuperscript{12}. Furthermore, different methodologies employed previously to measure and calculate IPD not only make inter-population comparison difficult but are also scientifically imprecise\textsuperscript{13}. It was, therefore, emphasized that for the purpose of making a precise comparison, norms derived from homogenous racial stocks should be available\textsuperscript{6}. To pick any possible anomaly, understanding of the growth dynamics of the craniofacial region, particularly affecting ocular apparatus becomes important.

Available anthropometric data sets on IPD of Indian children were either drawn from a small sample size\textsuperscript{14,15} or the values were merely presented for the first year of life\textsuperscript{2}. Owing to the absence of any authentic age and gender-specific anthropometric data on the pattern of growth of IPD, the present study aimed to check for the auxological dynamics of IPD among normal, healthy children residing in northwestern parts of India.

Material & Methods

A total of 3622 (2239 males and 1383 females) normal, healthy children aged one month to 14 yr who were born to parents from mixed socioeconomic strata, and residing in northwestern parts of India constituted sample for this cross-sectional study. These children were consecutively enrolled over a period of 24 years between April 1994 and September 2018 from the Growth Clinic/Growth Laboratory of the Advanced Paediatrics Centre, Postgraduate Institute of Medical Education & Research (PGIMER), Chandigarh, where they visited for either scheduled immunization, routine health check-up, or nutritional growth assessment etc. Children suspected with any disease of the central nervous system or any chronic disease or congenital anomalies were excluded from the study. Furthermore, severe under-nutrition, physical or craniofacial anomalies were also factors for exclusion. Informed written consent from parents of the participating children was obtained. The study protocol was approved by the Institutional Ethics Committee.

The direct measurement of IPD in awake and unco-operative infants and young children is difficult, which often yields faulty data. To overcome difficulties encountered in the measurement of this dimension, the formula by Feingold and Bossert (1974)\textsuperscript{13} was used to derive IPD from outer canthal distance (OCD) and inner canthal distance (ICD). All children were measured for ICD (i.e. distance between the two endocanthion points) and OCD (i.e. distance between the two ectocanthion points) using the digimatic sliding caliper (least count: 0.01 mm, Mitutoyo, Japan) in the study centre following standardized anthropometric measurements\textsuperscript{2}. The measurement in children less than two years was taken with the caliper on a supine child, with and head arms restrained by an attendant.

All anthropometric measurements were taken by the well-trained staff of the unit for whom intraclass correlation coefficient to check reliability of different measurements were periodically calculated on a sub-sample of 50 subjects and were found to be 0.795 for OCD (excellent agreement) and 0.816 for ICD (almost perfect agreement).

The IPD (i.e. distance between the centre of pupils of the two eyes) for each individual at each age was then calculated in centimetres from the ICD and OCD measured in each child by using the following formula:

\[
\text{IPD (cm)} = 0.7 + 0.41 \times \text{OCD} + 0.59 \times \text{ICD}
\]

Statistical analysis: The normality of data was checked using Kolmogorov–Smirnov tests of normality. Since the data were normally distributed mean in the present

\[
\text{IPD (cm)} = 0.7 + 0.41 \times \text{OCD} + 0.59 \times \text{ICD}
\]
| Age           | Male Mean±SD | Female Mean±SD | Gender differences (t test, P) |
|---------------|--------------|----------------|--------------------------------|
|               | n | OCD (mm) | ICD (mm) | IPD (mm) | n | OCD (mm) | ICD (mm) | IPD (mm) | OCD (mm) | ICD (cm) | IPD (mm) |
| One month     | 57 | 65.8±4.25 | 21.6±1.79 | 4.68±0.21 | 39 | 63.9±4.65 | 21.5±2.04 | 4.59±0.26 | 0.395 | 0.212 | 0.147 |
| Two months    | 56 | 69.1±5.28 | 22.6±2.28 | 4.87±0.28 | 35 | 68.1±4.86 | 22.4±2.08 | 4.84±0.26 | 0.320 | 0.526 | 0.351 |
| Three months  | 56 | 70.5±5.06 | 23.2±2.69 | 4.96±0.30 | 38 | 68.1±5.62 | 22.7±2.18 | 4.83±0.32 | 0.312 | 0.116 | 0.650 |
| Four months   | 42 | 71.2±5.24 | 24.2±2.34 | 5.05±0.29 | 34 | 69.1±4.69 | 23.1±2.11 | 4.90±0.27 | 0.361 | 0.505 | 0.593 |
| Five months   | 38 | 72.6±5.46 | 24.3±2.78 | 5.12±0.31 | 27 | 69.3±3.68 | 23.3±2.19 | 4.91±0.25 | 0.116 | 0.441 | 0.593 |
| Six months    | 41 | 72.7±4.50 | 24.5±2.65 | 5.13±0.29 | 31 | 69.9±4.34 | 23.4±2.09 | 4.95±0.28 | 0.472 | 0.183 | 0.467 |
| Seven months  | 45 | 73.1±4.96 | 24.5±3.03 | 5.15±0.33 | 41 | 70.7±4.09 | 24.3±2.27 | 5.03±0.25 | 0.609 | 0.351 | 0.360 |
| Eight months  | 35 | 73.2±4.79 | 24.9±2.45 | 5.18±0.28 | 23 | 71.5±4.67 | 24.4±2.30 | 5.07±0.29 | 0.839 | 0.611 | 0.676 |
| Nine months   | 40 | 73.3±4.49 | 25.1±2.93 | 5.18±0.33 | 34 | 71.6±4.99 | 24.5±2.35 | 5.09±0.30 | 0.184 | 0.297 | 0.864 |
| 10 months     | 29 | 73.4±2.97 | 25.2±1.61 | 5.20±0.17 | 37 | 71.8±4.08 | 24.5±2.41 | 5.09±0.27 | 0.071 | 0.020* | 0.003** |
| 11 months     | 31 | 75.0±3.48 | 25.3±2.16 | 5.27±0.22 | 28 | 72.9±2.41 | 24.5±1.46 | 5.14±0.15 | 0.047* | 0.011* | 0.024* |
| 12 months     | 35 | 75.1±3.12 | 25.4±1.67 | 5.28±0.20 | 36 | 74.6±4.57 | 25.5±2.08 | 5.26±0.25 | 0.026* | 0.339 | 0.265 |
| 13-15 months  | 54 | 74.2±2.99 | 25.5±2.38 | 5.30±0.20 | 35 | 74.9±4.05 | 25.4±2.22 | 5.27±0.25 | 0.023* | 0.484 | 0.388 |
| 16-18 months  | 36 | 75.4±4.37 | 25.6±2.75 | 5.31±0.29 | 39 | 75.0±2.96 | 25.6±2.15 | 5.30±0.22 | 0.015* | 0.084 | 0.033* |
| 19-21 months  | 44 | 76.1±4.03 | 25.8±2.11 | 5.34±0.26 | 35 | 75.2±3.96 | 25.6±2.93 | 5.29±0.26 | 0.813 | 0.040* | 0.804 |
| 22-24 months  | 52 | 77.5±4.26 | 25.8±2.64 | 5.40±0.27 | 42 | 75.7±2.50 | 25.6±2.16 | 5.31±0.18 | 0.000** | 0.375 | 0.004** |
| 2.5 yr        | 54 | 77.6±3.68 | 26.0±1.82 | 5.42±0.22 | 38 | 75.8±3.55 | 25.9±2.39 | 5.34±0.25 | 0.413 | 0.181 | 0.877 |
| 3.0 yr        | 109 | 78.4±3.10 | 26.2±2.46 | 5.45±0.25 | 64 | 76.6±3.56 | 25.9±2.41 | 5.37±0.23 | 0.379 | 0.627 | 0.488 |
| 3.5 yr        | 106 | 78.4±3.81 | 26.5±2.76 | 5.47±0.26 | 83 | 77.4±4.08 | 26.0±2.38 | 5.41±0.26 | 0.297 | 0.263 | 0.602 |
| 4.0 yr        | 113 | 79.5±3.95 | 27.1±2.67 | 5.56±0.27 | 92 | 77.5±3.89 | 26.4±2.51 | 5.44±0.26 | 0.801 | 0.511 | 0.954 |
| 4.5 yr        | 132 | 80.3±3.78 | 27.4±2.21 | 5.60±0.23 | 66 | 78.9±3.47 | 26.9±2.68 | 5.52±0.25 | 0.257 | 0.050* | 0.452 |
| 5.0 yr        | 133 | 80.6±3.59 | 27.4±2.48 | 5.62±0.24 | 89 | 78.9±3.02 | 26.9±1.89 | 5.53±0.18 | 0.197 | 0.004** | 0.036* |
| 5.5 yr        | 114 | 81.3±3.36 | 27.8±2.57 | 5.67±0.24 | 81 | 79.6±3.57 | 26.9±2.48 | 5.56±0.24 | 0.476 | 0.633 | 0.331 |
| 6.0 yr        | 132 | 82.3±3.79 | 28.1±2.37 | 5.73±0.26 | 66 | 80.4±3.94 | 27.2±2.43 | 5.60±0.27 | 0.890 | 0.746 | 0.559 |
| 7.0 yr        | 189 | 83.2±4.23 | 28.4±2.97 | 5.79±0.28 | 131 | 81.4±4.08 | 27.9±2.79 | 5.69±0.27 | 0.713 | 0.660 | 0.927 |
| 8.0 yr        | 187 | 83.9±4.50 | 28.7±2.76 | 5.84±0.29 | 125 | 82.3±4.26 | 28.2±2.36 | 5.74±0.26 | 0.568 | 0.008** | 0.113 |

*Contd...*
For precise detection of ocular hyper/hypotelorism, the use of authentic population-specific growth reference data becomes a paramount necessity as besides IPD, ICD and OCD are also known to exhibit age-related changes. For this study, standard deviation (SD) were computed for the parameters, namely IPD, ICD and OCD at each age level.

### Results

The mean (SD) for IPD, ICD, OCD are presented in Table I. Percentile grids for IPD among male and female children are depicted in Table II and III while, mean increase for OCD, ICD and IPD is shown in Table IV. A regular increase in IPD, ICD and OCD was observed throughout the period of the study. The corresponding figures for the girls measured 65.9 (4.63) mm for OCD, 21.5 (2.04) mm for ICD, 4.59 (0.26) cm for IPD at one month, respectively. These increased to 89.8 (4.91) mm, 30.7 (2.61) mm, 6.19 (0.36) cm by 14 yr, respectively. While, for ICD, significance (P ≤ 0.05) in terms of gender differences was observed at 10, 11, 16-18 and 22-24 months, five and 10 yr of age, respectively.

### Discussion

Correlation of ICD and OCD with IPD was calculated using Pearson correlation-coefficient at each age level. The inter-population difference for mean IPD among children representing different population groups was calculated using online GraphPad calculator. A P < 0.05 was considered as significant.

### Table I

| Age (yr) | Male | | Female | | Gender differences (t test, P) |
|---|---|---|---|---|---|
| | n | OCD (mm) | ICD (mm) | IPD (mm) | n | OCD (mm) | ICD (mm) | IPD (mm) | OCD (mm) | ICD (cm) | IPD |
| 9.0 | 136 | 84.8±4.23 | 29.0±2.79 | 5.89±0.29 | | 120 | 83.7±3.68 | 28.8±2.67 | 5.84±0.26 | | 0.492 | 0.848 | 0.659 |
| 10.0 | 151 | 86.6±5.21 | 29.7±2.65 | 6.00±0.30 | | 110 | 84.6±4.22 | 29.4±2.63 | 5.99±0.28 | | 0.016 | 0.611 | 0.027 |
| 11.0 | 153 | 86.9±4.52 | 29.8±3.03 | 6.02±0.31 | | 92 | 85.0±4.01 | 29.5±2.60 | 5.93±0.26 | | 0.266 | 0.240 | 0.124 |
| 12.0 | 106 | 88.1±4.71 | 29.9±2.71 | 6.08±0.29 | | 56 | 86.3±4.37 | 29.8±2.93 | 5.99±0.28 | | 0.527 | 0.595 | 0.607 |
| 13.0 | 57 | 88.3±4.14 | 30.5±2.06 | 6.12±0.21 | | 26 | 87.2±4.86 | 29.6±2.80 | 6.02±0.29 | | 0.246 | 0.137 | 0.123 |
| 14.0 | 35 | 89.8±4.91 | 30.7±3.62 | 6.19±0.36 | | 10 | 88.6±4.14 | 29.6±1.93 | 6.08±0.25 | | 0.762 | 0.137 | 0.392 |

*P ≤ 0.05; **P ≤ 0.01; ***P ≤ 0.001; df=n-2. SD, standard deviation
substantial degree of racial and ethnic variation. This study presents cross-sectional reference data for IPD which has been derived from OCD and ICD measured among apparently normal healthy male and female children inhabiting northwestern parts of India over the last two decades.

IPD among the study participants demonstrated a regular increase throughout the study period. This can be attributed to the sustained increase recorded for both inner canthal and OCD which were used to calculate IPD. The mean increase in OCD, ICD and IPD in male subjects (24.0 mm, 9.1 mm, 1.51 cm) was marginally higher than for females (24.7 mm, 8.1 mm, 1.49 mm). The net per cent increase for IPD from one month to 14 yr was almost similar among male (32.3%) and female (32.5%) children. The per cent increase for OCD measured lesser in males (36.47%) as compared to females (38.6%). While, for ICD, it remained higher in male (42.1%) than the

| Table II. Percentiles for inter-pupillary distance (cm) in male children |
|-----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|
| Age             | 3rd            | 5th            | 10th           | 25th           | 50th           | 75th           | 90th           | 95th           | 97th           |
| One month       | 4.28           | 4.33           | 4.41           | 4.53           | 4.68           | 4.82           | 4.94           | 5.02           | 5.07           |
| Two months      | 4.34           | 4.40           | 4.51           | 4.68           | 4.87           | 5.06           | 5.23           | 5.33           | 5.40           |
| Three months    | 4.40           | 4.47           | 4.58           | 4.76           | 4.96           | 5.16           | 5.35           | 5.46           | 5.53           |
| Four months     | 4.50           | 4.56           | 4.67           | 4.85           | 5.05           | 5.25           | 5.43           | 5.54           | 5.61           |
| Five months     | 4.53           | 4.60           | 4.72           | 4.91           | 5.12           | 5.33           | 5.52           | 5.63           | 5.71           |
| Six months      | 4.58           | 4.65           | 4.75           | 4.93           | 5.13           | 5.32           | 5.50           | 5.60           | 5.67           |
| Seven months    | 4.53           | 4.60           | 4.72           | 4.92           | 5.15           | 5.37           | 5.57           | 5.69           | 5.77           |
| Eight months    | 4.65           | 4.71           | 4.82           | 4.99           | 5.18           | 5.37           | 5.54           | 5.64           | 5.71           |
| Nine months     | 4.56           | 4.64           | 4.76           | 4.96           | 5.18           | 5.41           | 5.61           | 5.73           | 5.80           |
| 10 months       | 4.88           | 4.92           | 4.98           | 5.08           | 5.20**         | 5.31           | 5.41           | 5.48           | 5.51           |
| 11 months       | 4.86           | 4.91           | 4.99           | 5.12           | 5.27           | 5.42           | 5.55           | 5.63           | 5.68           |
| 12 months       | 4.90           | 4.94           | 5.02           | 5.14           | 5.28           | 5.42           | 5.54           | 5.62           | 5.66           |
| 13-15 months    | 4.91           | 4.96           | 5.04           | 5.16           | 5.30           | 5.43           | 5.56           | 5.63           | 5.68           |
| 16-18 months    | 4.75           | 4.82           | 4.93           | 5.11           | 5.31           | 5.50           | 5.68           | 5.79           | 5.86           |
| 19-21 months    | 4.85           | 4.91           | 5.01           | 5.17           | 5.34           | 5.52           | 5.67           | 5.77           | 5.83           |
| 22-24 months    | 4.88           | 4.95           | 5.05           | 5.22           | 5.40**         | 5.59           | 5.76           | 5.86           | 5.92           |
| 2.5 yr          | 5.01           | 5.06           | 5.14           | 5.27           | 5.42           | 5.56           | 5.70           | 5.78           | 5.83           |
| 3.0 yr          | 4.97           | 5.03           | 5.13           | 5.28           | 5.45           | 5.62           | 5.77           | 5.86           | 5.92           |
| 3.5 yr          | 4.98           | 5.04           | 5.14           | 5.30           | 5.47           | 5.65           | 5.81           | 5.91           | 5.97           |
| 4.0 yr          | 5.04           | 5.10           | 5.21           | 5.37           | 5.56           | 5.74           | 5.91           | 6.01           | 6.07           |
| 4.5 yr          | 5.16           | 5.21           | 5.30           | 5.44           | 5.60           | 5.75           | 5.89           | 5.98           | 6.03           |
| 5.0 yr          | 5.18           | 5.23           | 5.32           | 5.46           | 5.62‘*         | 5.78           | 5.93           | 6.02           | 6.07           |
| 5.5 yr          | 5.21           | 5.27           | 5.36           | 5.51           | 5.67           | 5.83           | 5.98           | 6.07           | 6.13           |
| 6.0 yr          | 5.25           | 5.31           | 5.40           | 5.56           | 5.73           | 5.91           | 6.07           | 6.16           | 6.22           |
| 7.0 yr          | 5.26           | 5.33           | 5.43           | 5.60           | 5.79           | 5.98           | 6.15           | 6.25           | 6.31           |
| 8.0 yr          | 5.29           | 5.36           | 5.47           | 5.64           | 5.84           | 6.04           | 6.21           | 6.32           | 6.39           |
| 9.0 yr          | 5.34           | 5.41           | 5.52           | 5.69           | 5.89           | 6.08           | 6.26           | 6.36           | 6.43           |
| 10.0 yr         | 5.43           | 5.50           | 5.62           | 5.80           | 6.00‘*         | 6.21           | 6.39           | 6.50           | 6.57           |
| 11.0 yr         | 5.43           | 5.50           | 5.62           | 5.81           | 6.02           | 6.24           | 6.43           | 6.54           | 6.62           |
| 12.0 yr         | 5.52           | 5.59           | 5.70           | 5.88           | 6.08           | 6.28           | 6.46           | 6.57           | 6.63           |
| 13.0 yr         | 5.71           | 5.76           | 5.84           | 5.97           | 6.12           | 6.26           | 6.47           | 6.47           | 6.52           |
| 14.0 yr         | 5.52           | 5.61           | 5.74           | 5.95           | 6.19           | 6.44           | 6.65           | 6.78           | 6.87           |

*P < 0.05, **P < 0.01, ***P < 0.001
female children (37.7%). Around 48 per cent of the adult OCD, ICD and IPD were attained by two years of age and around 85 per cent by 10 yr.

The co-relation coefficient calculated among our study subjects confirmed a strong inter dependency of IPD on both OCD and ICD as the values were statistically significant throughout the age range. However, the magnitude of this correlation was found to be slightly more with OCD than ICD. A strong correlation of IPD with inner-outer ICD in Iranian individuals younger than 20 yr has also been reported.\textsuperscript{18}

Relatively larger OCD, ICD and IPD noticed among the male children than females of same age depicted almost a similar pattern of gender differences reported earlier among Black children,\textsuperscript{8,19} as also with those with Chinese\textsuperscript{20}, Nigerian\textsuperscript{6} and American\textsuperscript{7} ancestry. However, Gupta et al\textsuperscript{21} reported no gender difference between male and female children.

| Age         | 3rd | 5th | 10th | 25th | 50th | 75th | 90th | 95th | 97th |
|-------------|-----|-----|------|------|------|------|------|------|------|
| One month   | 4.10| 4.16| 4.25 | 4.41 | 4.59 | 4.76 | 4.92 | 5.01 | 5.07 |
| Two months  | 4.36| 4.42| 4.51 | 4.67 | 4.80 | 5.01 | 5.16 | 5.25 | 5.31 |
| Three months| 4.24| 4.31| 4.43 | 4.62 | 4.83 | 5.05 | 5.24 | 5.36 | 5.43 |
| Four months | 4.39| 4.45| 4.55 | 4.72 | 4.90 | 5.08 | 5.25 | 5.35 | 5.41 |
| Five months | 4.45| 4.50| 4.60 | 4.75 | 4.91 | 5.08 | 5.23 | 5.33 | 5.38 |
| Six months  | 4.42| 4.49| 4.59 | 4.76 | 4.95 | 5.14 | 5.31 | 5.41 | 5.47 |
| Seven months| 4.56| 4.61| 4.71 | 4.86 | 5.03 | 5.20 | 5.36 | 5.45 | 5.51 |
| Eight months| 4.53| 4.60| 4.70 | 4.88 | 5.07 | 5.26 | 5.43 | 5.54 | 5.61 |
| Nine months | 4.52| 4.59| 4.70 | 4.89 | 5.09 | 5.29 | 5.47 | 5.58 | 5.65 |
| 10 months   | 4.58| 4.65| 4.74 | 4.91 | 5.09 | 5.26 | 5.43 | 5.52 | 5.59 |
| 11 months   | 4.85| 4.89| 4.94 | 5.04 | 5.14 | 5.24 | 5.34 | 5.39 | 5.43 |
| 12 months   | 4.80| 4.86| 4.95 | 5.10 | 5.26 | 5.43 | 5.58 | 5.67 | 5.72 |
| 13-15 months| 4.81| 4.87| 4.96 | 5.11 | 5.27 | 5.44 | 5.59 | 5.68 | 5.74 |
| 16-18 months| 4.87| 4.92| 5.01 | 5.14 | 5.30 | 5.45 | 5.58 | 5.67 | 5.72 |
| 19-21 months| 4.81| 4.87| 4.96 | 5.12 | 5.29 | 5.47 | 5.62 | 5.72 | 5.78 |
| 22-24 months| 4.97| 5.01| 5.08 | 5.19 | 5.31 | 5.44 | 5.55 | 5.62 | 5.66 |
| 2.5 yr      | 4.86| 4.92| 5.01 | 5.17 | 5.34 | 5.51 | 5.66 | 5.76 | 5.81 |
| 3.0 yr      | 4.93| 4.98| 5.07 | 5.21 | 5.37 | 5.53 | 5.67 | 5.76 | 5.81 |
| 3.5 yr      | 4.93| 4.99| 5.08 | 5.24 | 5.41 | 5.59 | 5.74 | 5.84 | 5.90 |
| 4.0 yr      | 4.95| 5.01| 5.11 | 5.26 | 5.44 | 5.61 | 5.77 | 5.86 | 5.92 |
| 4.5 yr      | 5.05| 5.10| 5.20 | 5.35 | 5.52 | 5.69 | 5.84 | 5.94 | 6.00 |
| 5.0 yr      | 5.18| 5.23| 5.29 | 5.41 | 5.53 | 5.65 | 5.76 | 5.83 | 5.87 |
| 5.5 yr      | 5.10| 5.15| 5.24 | 5.39 | 5.56 | 5.72 | 5.87 | 5.96 | 6.01 |
| 6.0 yr      | 5.09| 5.15| 5.25 | 5.42 | 5.60 | 5.79 | 5.95 | 6.05 | 6.12 |
| 7.0 yr      | 5.17| 5.23| 5.33 | 5.50 | 5.69 | 5.88 | 6.05 | 6.15 | 6.21 |
| 8.0 yr      | 5.25| 5.31| 5.40 | 5.56 | 5.74 | 5.92 | 6.07 | 6.17 | 6.23 |
| 9.0 yr      | 5.34| 5.40| 5.50 | 5.66 | 5.84 | 6.01 | 6.17 | 6.27 | 6.33 |
| 10.0 yr     | 5.49| 5.54| 5.62 | 5.76 | 5.90 | 6.05 | 6.19 | 6.27 | 6.32 |
| 11.0 yr     | 5.43| 5.49| 5.59 | 5.75 | 5.93 | 6.11 | 6.27 | 6.37 | 6.43 |
| 12.0 yr     | 5.47| 5.54| 5.64 | 5.81 | 5.99 | 6.18 | 6.35 | 6.45 | 6.52 |
| 13.0 yr     | 5.47| 5.54| 5.65 | 5.82 | 6.02 | 6.22 | 6.40 | 6.51 | 6.58 |
| 14.0 yr     | 5.60| 5.66| 5.76 | 5.91 | 6.08 | 6.25 | 6.40 | 6.49 | 6.55 |
influence (children as well as adults) on OCD, ICD and IPD values in the normal Indian population.

IPD of the children in the present study measured larger than infants and children of American origin\(^7,14\), White males\(^12\) as well as those representing central\(^22\) and north India\(^23\). The magnitude of this interpopulation differential between the present study and American\(^7\) children, however, remained significant only during infancy. As compared to their central\(^22\) Indian counterparts, this measure was significantly larger (\(P \leq 0.05\)) beyond three years of age and at 14 yr (\(P \leq 0.001\)) when compared with those from Amritsar, Punjab\(^23\). On the contrary, IPD in children measured significantly (\(P \leq 0.01\)) shorter in this study than Black children\(^8\), throughout. Since shape and cranial proportions affect the orbits, Pryor\(^12\) suggested that patients should preferably be compared with their own age, gender and racial norms for evaluating deviations from normal. These norms were reported for IPD

| Age                  | OCD (mm) | ICD (mm) | IPD (cm) | OCD (mm) | ICD (mm) | IPD (cm) |
|----------------------|----------|----------|----------|----------|----------|----------|
| Mean Increase (Male) |          |          |          | Mean Increase (Female) |          |          |
| 1-2 months           | 3.3      | 1.0      | 0.19     | 4.2      | 0.9      | 0.25     |
| 2-3 months           | 1.4      | 0.6      | 0.09     | 0.0      | 0.3      | −0.01    |
| 3-4 months           | 0.7      | 1.0      | 0.09     | 1.0      | 0.4      | 0.07     |
| 4-5 months           | 1.4      | 0.1      | 0.07     | 0.2      | 0.2      | 0.01     |
| 5-6 months           | 0.1      | 0.2      | 0.01     | 0.6      | 0.1      | 0.04     |
| 6-7 months           | 0.4      | 0.0      | 0.02     | 0.8      | 0.9      | 0.08     |
| 7-8 months           | 0.1      | 0.4      | 0.03     | 0.8      | 0.1      | 0.04     |
| 8-9 months           | 0.1      | 0.2      | 0.00     | 0.1      | 0.1      | 0.02     |
| 9-10 months          | 0.1      | 0.1      | 0.02     | 0.2      | 0.0      | 0.00     |
| 10-11 months         | 1.6      | 0.1      | 0.07     | 1.1      | 0.0      | 0.05     |
| 11-12 months         | 0.1      | 0.1      | 0.01     | 1.7      | 1.0      | 0.12     |
| 12 to 13-15 months   | 0.3      | 0.1      | 0.02     | 0.3      | −0.1     | 0.01     |
| 13-15 to 16-18 months| 0.0      | 0.1      | 0.01     | 0.1      | 0.2      | 0.03     |
| 16-18 to 19- months  | 0.7      | 0.2      | 0.03     | 0.2      | 0.0      | −0.01    |
| 19-21 to 22-24 months| 1.4      | 0.0      | 0.06     | 0.5      | 0.0      | 0.02     |
| 22-24 months to 2.5 yr| 0.1    | 0.2      | 0.02     | 0.1      | 0.3      | 0.03     |
| 2.5-3.0 yr           | 0.6      | 0.2      | 0.03     | 0.8      | 0.0      | 0.03     |
| 3.0-3.5 yr           | 0.2      | 0.3      | 0.02     | 0.8      | 0.1      | 0.04     |
| 3.5-4.0 yr           | 1.1      | 0.6      | 0.09     | 0.1      | 0.4      | 0.03     |
| 4.0-4.5 yr           | 0.5      | 0.3      | 0.04     | 1.4      | 0.5      | 0.08     |
| 4.5-5.0 yr           | 0.6      | 0.0      | 0.02     | 0.0      | 0.0      | 0.01     |
| 5.0-5.5 yr           | 0.7      | 0.4      | 0.05     | 0.7      | 0.0      | 0.03     |
| 5.5-6.0 yr           | 1.0      | 0.3      | 0.06     | 0.8      | 0.3      | 0.04     |
| 6.0-7.0 yr           | 0.9      | 0.3      | 0.06     | 1.0      | 0.7      | 0.09     |
| 7.0-8.0 yr           | 0.7      | 0.3      | 0.05     | 0.9      | 0.3      | 0.05     |
| 8.0-9.0 yr           | 0.9      | 0.3      | 0.05     | 1.4      | 0.6      | 0.1      |
| 9.0-10.0 yr          | 1.8      | 0.7      | 0.11     | 0.9      | 0.6      | 0.06     |
| 10.0-11.0 yr         | 0.3      | 0.1      | 0.02     | 0.4      | 0.1      | 0.03     |
| 11.0-12.0 yr         | 1.2      | 0.1      | 0.06     | 1.3      | 0.3      | 0.06     |
| 12.0-13.0 yr         | 0.2      | 0.6      | 0.04     | 0.9      | −0.2     | 0.03     |
| 13.0-14.0 yr         | 1.5      | 0.2      | 0.07     | 1.4      | 0.0      | 0.06     |
among Whites, Asians and Mexican-Americans; however, their mean IPD values are lesser than that reported in the present study. This aforementioned size-related differential confirms the existence of a substantial degree of racial/ethnic variation in the growth of IPD among children belonging to different population stocks. Existence of ethnic variation for OCD, ICD and IPD in different parts of the
world among Black\textsuperscript{8} individuals in contrast to those belonging to White, Asian, Mexican and American racial stocks has also been reported\textsuperscript{12}. However, no racial differences were observed while comparing subjects of Chinese ancestry\textsuperscript{23} with those representing Caucasian\textsuperscript{25} population.

In view of the existence of substantial degree of inter-population variability, there is a need to establish age, gender, geographic, racial, ethnicity specific data sets of male and female individuals to arrive at precise and accurate clinical inferences. Therefore, it is suggested that the percentile grids presented from two months to 14 yr among male and female children of north-western India (Table II & III) may be used for comparative purposes to detect ocular hypertelorism and hypertelorism to corroborate diagnosis of suitable syndromic conditions. The patients having IPD less than 3\textsuperscript{rd} percentile should be treated as cases of hypertelorism while those exceeding 97\textsuperscript{th} percentile as cases of hypertelorism.

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