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Original Article

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Standards of facial growth in children using anthropometric method and its correlation with somatic growth

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ABSTRACT

BACKGROUND & OBJECTIVE: Craniofacial anthropometry involves the measurement of various soft and hard tissue characteristics of the head and face and is considered an important pre-clinical record for the diagnosis of growth and development and for orthodontic treatment planning. This study aims to determine the means of facial growth parameters and their correlation with somatic growth in a sample of growing children of the Pakistani population. **METHODOLOGY:** This cross-sectional study was conducted at various schools of Lahore, Pakistan, with an age range of 3-14 years. Data was collected by taking facial measurements with a digital vernier caliper and a geometric divider to the nearest 1mm. To measure height and weight, a Martin anthropometer and an electronic scale were used. Data were entered and analyzed for description using SPSS version 25. A post-stratification Pearson correlation test was applied to general body growth and facial parameters. **RESULTS:** Mean upper face height, lower face height, total face height, and face width for the sample were 53.08±5.561 mm, 53.05±5.407 mm, 106.25±9.022 mm, and 118.07±9.281 mm, respectively. Mean weight and height for ages 3–14 years were 31.61±13.1 kg and 133.22±17.3 cm. Facial parameters correlated significantly with height and weight. **CONCLUSION:** A stronger correlation was seen between facial width and weight in both genders (r = 0.737-0.739), whereas the correlation between height and total facial height was observed only in girls (r = 0.710).

KEYWORDS: Anthropometry, Body Height, Body Weight, Growth Charts, Growth and Development.

INTRODUCTION

The human face does not grow evenly over time. Facial structures develop along distinct directions and dimensions [1]. The growth of children can be evaluated through medical history, physical examination, and anthropometric measurements [2,3]. Somatic growth, including stature and body weight, is the most reliable indicator of craniofacial development [4].

Enlow outlined the biological principles that account for variations in facial features, considering: 1) differences in the development and form of the head, producing distinct facial types; 2) gender-related developmental variations; and 3) facial distinctions between children and adults [5]. Facial growth, comprising both soft tissue and skeletal development, is coordinated with somatic growth [5]. Body growth is steady during the prepubertal period and is readily assessed [4]. According to Scammon's Curve, jaw growth tracks between neural and general body curves, with the mandible more closely following the general curve than the maxilla. The accelerated facial growth during puberty is synchronized with increases in body height. Incremental and proportional facial growth follows the body's rhythmic and periodic developmental pattern, known as the cephalocaudal gradient [6,7].

Craniofacial anthropometry is a balanced approach based on a set of angular and linear measurements that enables the classification of phenotypic differences and assessment of dimensional variability and dysmorphology during growth [8]. It is a 3-D technique that provides data which is crucial for the craniofacial growth studies as well as for the orthodontic diagnosis. Craniofacial anthropometry involves the measurement of various soft and hard tissue characteristics of the head and face and is considered an important preclinical record for the diagnosis of growth and development and the treatment of orthodontic matters [9].

Orthodontists are able to suppress or enhance the facial growth for patient well-being, since their domain involves the development of dentition as well as the craniofacial complex [5]. The goal of orthodontic treatment is to improve

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oral function and dentofacial esthetics [10]. Accurate facial analysis is crucial for orthodontic diagnosis and the study of typical and atypical facial growth [5,11]. Therefore, one of the essential keys in orthodontic treatment planning is soft-tissue evaluation [12].

Facial contours and conformity of the vertical proportions are imperative for soft-tissue assessment. Modification of dentofacial structure in growing children demands the use of functional jaw orthopaedics (FJO). Orthopaedic or functional appliances are more effective when used circumpubertally [13]. Determination of skeletal developmental status and growth prediction is mandatory before embarking on the journey of FJO. Once the patient's growth is over, orthognathic surgery in conjunction with contemporary orthodontics is the only option for modification of dentofacial parameters.

The objective of this epidemiological study was to determine the means of facial growth parameters in growing children from a sample of the Pakistani population and to assess their correlation with somatic growth. Every day, orthodontic practice commonly uses Caucasian standards that differ significantly from Pakistani facial features. Basic anthropometric techniques allow orthodontists to conveniently measure dentofacial parameters and add information to the local database.

METHODOLOGY

This cross-sectional study was conducted after approval of the Sharif Medical Research Centre (SMRC) and the Ethics Committee SMDC vide letter no. SMDC/SMRC/227-21 Dated 21-02-24 in a duration of 6 months (22-02-24 to 22-08-24). Prior permission was taken from the heads of schools of various areas of Lahore, Pakistan. Inclusion Criteria: School children (boys & girls) with an age range of 3-14 years of Pakistani origin were included in the study. Exclusion Criteria: Children with a history of craniofacial surgery, facial trauma, congenital craniofacial anomalies (such as cleft lip) and children who were under orthodontic treatment or had orthodontic treatment in the past were excluded.

Measurement procedures were explained verbally to each participant, and consent was obtained. Each child was seated in a chair in a relaxed, natural head position (NHP). Data was collected by taking facial measurements with the help of a digital vernier caliper and geometric divider to the nearest 1mm. To measure height and weight, a Martin anthropometer and an electronic scale were used. Data was collected by two orthodontic faculty members and two trained post-graduate residents. Two house officers helped with coordination and management in the field. All measurements, along with demographic data, were recorded on a predesigned proforma.

The following landmarks were identified on the children's faces during extraoral examination:
Nasion (N): The point in the midline of both the nasal root and the nasofrontal suture.
Subnasale (Sn): The midpoint of the angle at the columella base where the lower border of the nasal septum and the surface of the upper lip meet.
Gnathion (Gn): the midpoint on the lower border of the mandible.
Zygion (Zy): lateral-most point of the zygomatic bone (cheek bone).

The following facial measurements were taken in mm:
Upper face height: distance between nasion (N) and subnasale (Sn).
Lower face height: distance between subnasale (Sn) and gnathion (Gn).
Total face height: measured as a straight distance between nasion (N) and gnathion (Gn)
Facial width: measured as the distance between both zygions (Zy).

The data was analyzed using SPSS version 25. Basic descriptive statistics were calculated for all variables, i.e. mean/standard deviation for quantitative variables, and frequency/percentage for qualitative variables. Data was stratified for age and gender. The Pearson correlation test was applied to general body growth and facial parameters. One-way ANOVA was applied, and post-hoc Tukey test was applied to determine inter-group comparisons. An independent sample t-test was used to compare the means of height & weight of both genders. P-value <0.05 was considered to be statistically significant.

RESULTS

Our sample included 1082 school children (546 females and 536 males), out of which 350 (32.3%) were in the age group 3-6 years, 424 (39.27%) were in the 7-10 years age group, and 308(28.5%) were in the 11-14 years age group. The mean age of the sample was 8.4 ± 2.9 years, and the mean weight and height were 31.61 ± 13.1 kg and 133.22 ± 17.3 cm, respectively. Mean values for each facial parameter in different age groups and the total sample (N) are shown in Table-I.The results of the one-way ANOVA indicate significant differences among all three age groups. Results of Post-hoc Analysis with Tukey's Test for comparison of facial parameters across age groups show statistically significant differences (Table-II). Mean height and weight in both genders of different age groups, along with statistically insignificant differences via an independent sample t-test, are shown in Table-III. Stratification of data was done for facial parameters and somatic growth (height & weight), and correlation was found to be statistically significant (Table -IV). Stratification of data was done for facial parameters and somatic growth with respect to gender, and their correlation was found to be statistically significant (Table-V).

Table-II: Post- Hoc Analysis with Tukey's Test for comparison of facial parameters in different age groups.

Age Groups Years	Upper Face Height P-value	Lower Face Height P-value	Total Face Height P-value	Face Width P-value
3-6 vs 7-10	≤0.001*	≤0.001*	0.000*	≤0.001*
3-6 vs 11-14	≤0.001*	≤0.001*	0.000*	≤0.001*
7-10 vs 11-14	≤0.001*	.051*	0.000*	≤0.001*

* The mean difference is significant at the 0.05 level.

Table-I: Comparison of facial anthropometric parameters of different age groups using one-way ANOVA.

Anthropometric Parameter (mm)	Age Group 3-6 years n=350 Mean ± SD (Min-Max)	Age Group 7-10 years n=424 Mean ± SD (Min-Max)	Age Group 11-14 years n=308 Mean ± SD (Min-Max)	P-value	Total Children (N=1082) Mean ± SD (Min-Max)
Upper Face Height (N-Sn)	48.58± 4.86 (32-58)	53.91 ± 4.09 (44-65)	57.05 ± 4.36 (45-68)	0.001*	53.08±5.56 (32-68)
LowerFace Height (Sn-Gn)	50.17 ± 5.08 (30-60)	54.03 ± 4.91 (30-65)	54.97 ± 5.08 (40-67)	0.001*	53.05±5.40 (30-67)
Total Face Height (N-Gn)	98.73 ± 7.79 (79-126)	108.26 ± 6.27 (92-124)	111.99 ± 7.70 (85-156)	0.001*	106.25±9.02 (79-156)
Face Width (Zy-Zy)	109.76 ± 6.66 (95-130)	120.19 ± 6.99 (103-139)	124.63 ± 7.61 (109-147)	0.001*	118.07±9.28 (95-147)

*Statistically significant difference p<0.05 (one way ANOVA) .

Table-III: Comparison of mean height & weight of both genders in different age groups.

Age Group (Years)	Height(cm) (Mean ± SD)			Weight (kg) (Mean ± SD)		
	Females n=546	Males n=536	P-value	Females n=546	Males n=536	P-value
3-6	113.81 ± 7.59 n=180	114.59 ± 8.59 n=170	0.363	19.50 ± 4.78 n=180	20.27 ± 4.45 n=170	0.119
7-10	135.02 ±9.16 n=190	134.56 ± 8.16 n=234	0.581	31.44 ± 8.43 n=190	31.04 ± 8.55 n=234	0.629
11-14	153.11 ± 8.47 n=176	152.20 ± 9.19 n=132	0.366	45.79 ± 10.45 n=176	45.07 ± 12.94 n=132	0.594

*Statistically significant difference p<0.05(independent sample t-test).

Table-IV: Correlation between facial & general body growth parameters.

Facial Growth Parameters	Height (cm)		Weight (kg)	
	Correlation Coefficient	P-value	Correlation Coefficient	P-value
Upper Face Height (N-Sn)	.655**	0.001*	0.587**	0.001*
Lower Face Height (Sn-Gn)	.445**	0.001*	0.434**	0.001*
Total Face Height (N-Gn)	.684**	0.001*	0.633**	0.001*
Face Width (Zy-Zy)	.672**	0.001*	0.730**	0.001*

*Statistically significant difference p<0.05
**Statistically significant correlation.

Table-V: Correlation between facial & general body growth parameters with respect to gender.

Facial Parameters	Females				Males			
	Height (cm)		Weight (kg)		Height (cm)		Weight (kg)	
	Correlation Coefficient	P-value	Correlation Coefficient	P-value	Correlation Coefficient	P-value	Correlation Coefficient	P-value
Upper Face Height (N-Sn)	.673**	0.001*	.619**	0.001*	.634**	0.001*	.551**	0.001*
Lower Face Height (Sn-Gn)	.436**	0.001*	.438**	0.001*	.493**	0.001*	.466**	0.001*
Total Face Height (N-Gn)	.710**	0.001*	.665**	0.001*	.670**	0.001*	.615**	0.001*
Face Width (Zy-Zy)	.684**	0.001*	.739**	0.001*	.676**	0.001*	.737**	0.001*

*Statistically significant difference p<0.05.
**Statistically significant correlation.

DISCUSSION

Anthropometric facial evaluation is the systematic, empirical analysis of the morphology of the human face and is fundamental across various fields, including orthodontics, paediatrics, and craniofacial surgery. These parameters can be evaluated directly from clinical measurements of physical dimensions in living individuals or obtained from cephalograms or photographs [14-16].

Craniofacial anthropometry is used for the evaluation of morphological differences of the face and head. Many factors determine the face shape, for example, nutrition, socioeconomic status,ethnicity,gender, and genetic factors. Facial measurements are also used to identify the congenital abnormalities and traumatic facial deformities [11].

Facial form is controlled genetically by the amalgamation of complex morphological traits. Various ethnicities exhibit significantly different craniofacial characteristics pertinent to human migration and evolution [17]. Multiple anthropometric studies also concluded that facial measurements for one ethnic group should not be taken as normal for other groups. Therefore, it is important to determine anthropometric data for every ethnicity [18]. More benefits of the anthropometric approach include simplicity, non-invasiveness, and cost-effectiveness, with the least risk [19,20].

The mean total face height of Pakistani children in the the current study ranged from 79 to 156mm, lower face height ranged from 30 to 67mm, and face width ranged from 95 to 147mm in the age group 8-14 years. Minawi et al conducted a study on Egyptian females with the age range of 18 -50 years and found that face height ranged from 103-125 mm, the lower face height was 58-77 mm, while the face width was 96-140 mm [18]. Yadav et al. reported the mean facial height and bizygomatic facial width of males to be 109.6 mm and 136.4 mm, respectively. In females, the means were 101.3 mm and 127.5 mm, respectively [20]. The difference in values probably owes to a change of ethnicity.

The average age of the sample in the current study was 8.4 ± 2.9 years, and the mean height and weight were 133.2 cm and 31.61 kg, respectively. Zhong et al conducted a study on the Tibetan population aged 18 to 24 years. He found median heights and weights of 171 cm and 58.64 kg in males, whereas 165cm and 51.02 kg in females [21]. Yadav et al conducted a study on medical and nursing students of Nepal with an age range of 18-26 years and found the mean height and weight to be 166.66 cm ±6.22 cm and 58.59 kg ±7.01 kg in males and 154.05 cm ± 5.81 cm and 47.79 kg ± 6.77 kg in females respectively [20]. The variation may be due to age-group differences in both studies.

The present study concluded that somatic growth and facial parameters have a direct, significant correlation in the total sample, but stronger correlations were observed for facial width and weight in both genders (r = 0.737-0.739) and for height and total facial height in girls (r = 0.710).

Kulkarni et al. conducted a study of a sample of Managundi people and found that all facial measurements were higher in males than in females. There was a significant positive correlation between facial height and stature measurements, and a negative correlation between stature and bizygomatic breadth in both genders [22].

The results of this study are in accordance with Ogodescu et al., who found a significant, strong, and direct correlation between stature and the the following parameters: Zy-Zy, N-Gn, and N-Sn in Romanian children & adolescents. However, he did not find the correlation of Sn-Gn [5]. Alam et al. measured the mean body and facial heights to be 167.54cm and 10.77cm, respectively [23]. He found a significant positive correlation between both of them, similar to the study conducted by Yadav et al. [20].

The current study had some limitations, such as a smaller sample size and the inclusion of only Lahore and nearby areas. At the provincial level, insufficient data is available, which cannot be used to represent the growth parameters of the Pakistani Population as a whole. Therefore, more studies should be conducted at the regional level to establish reliable Pakistani facial norms for reference in orthodontic diagnosis and treatment planning.

CONCLUSION

The mean weight and height were 31.61 ± 13.1 kg and 133.22 ± 17.3 cm, respectively, for the whole sample aged 3-14 years. Correlation of facial parameters and somatic growth (height & weight) was found to be statistically significant. Facial parameters and somatic growth showed a statistically significant correlation by gender. Strong correlations were found between facial width and weight in both genders, and between height and total face height in girls only.

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Faiza Malik: Conception and design of the work, Reviewing it critically for important intellectual content.
Faiza Rana: Data collection, Analysis of data for the work.
Muhammad Noman: Interpretation of data for the work.
Hooria Haq : Data collection, Interpretation of data for the work.
Mazhar Hussain: Drafting the work.
Fiza Khan : Data collection.

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