CLINICAL APPLICATION FORMS FOR POSTERO-ANTERIOR CEPHALOMETRIC ANALYSIS

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أجرى هذا البحث لاستنباط معايير قياسية للبعد العرضي من مرحلة الطفولة حتى سن البلوغ حيث أجديت هذه الدراسة الطولية على الأشعة الأمامية الخلفية السيفالومترية التي أخذت عند عمر ٦، ١٢، ١٨ عاما. شملت الدراسة ستون طفلا قوقازيا من أصل أوروبي في مركز أبحاث الطفولة بمدينة دينفر بولاية كولورادو الأمريكية. تم عمل رسم تخطيطي لعظام الوجه والرأس على الإشعاعات وقياس الأبعاد العرضية للوجه. بعد التحليل الأحصائي لهذه المعلومات يبين هذا البحث النتائج الآتية :

١ – معايير قياسية للبعد العرضي للوجه عند عمر ٦، ١٢، ١٨ عاما لكلا الجنسين للتطبيق الإكلينيكي.

٢ – وصف طريقة لتحديد مكان ومقدار العيب في حالة عدم التماثل في جانبي الوجه.

٣ – يوجد فروق واضحة بين الذكور والإناث في الأبعاد العرضية في أغلب الأعمار فيما عدا فتحة الأنف لا يوجد فروق واضحة بين الجنسين.

٤ – لا يوجد فروق واضحة للبعد العرضي بين جانبي الوجه الأيمن والأيسر.

٥ – إستحداث أشكال للتطبيق الإكلينيكي للتحليل السيفالومتري للأشعة الأمامية الخلفية للرأس.

The purpose of this study was to develop standard norms for the transverse dimension of the face from childhood to adulthood. The sample consisted of P-A cephalometric radiographs for 30 males and 30 females at each age-level of 6, 12 and 18 years. All subjects were Caucasian of northern European descent. The poster-anterior cephalograms were traced and digitized. Six Bi-width dimensions, i.e., Bi-lateroorbitale, Bi-zygomatic, Bi-maxillary, Bi-lateronasal, Bi-condylar and Bi-gonial widths were recorded. Also, horizontal and vertical distances from these landmarks Lo, Zyg, Mx, Ln, Cd, and Go to mid-sagittal and FH planes were determined in both the right and left sides of the face. Standard norms were provided for each dimension at each age-level. Further, forms for clinical application were generated. It was observed that the boys measurements were larger than the girls at all ages from 6 to 18 years in all dimensions, except the Bi-lateronasal width where there was no significant differences. Also, the right and left side differences were not significant. The present study provides normative data for comparison of the individual subject with population norms forming a basis for discriminating normal from abnormal. Also, the data are of value for diagnosis of maxillofacial anomalies and for monitoring the growth of persons and their corresponding age and race.

Introduction

There are billions of us and yet no people are completely alike. Every face is uniquely different from every other face, much like the fingerprints. However, the face changes its dimensions and proportions throughout life.

As the facial bones grow in three dimensions, the face should then be studied in three dimensions. The transverse dimension of the face affects the overall determination of the dentofacial proportions as well its balance and harmony.

Most of the common cephalometric standards used for orthodontic diagnosis[1,2,3] were derived from cross-sectional data analyzed by cross-sectional methods. These data provide measures of central tendency and dispersion and are used to describe the characteristics of a population in general order to establish trends. Population trends are often regarded as erepresenting the normal and used as standard for evaluation of the individual. Standard norms are used to describe every one in general and no one in particular.

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Several studies[4–9] were carried out to measure the morphological changes of the human craniofacial skeleton during its development. Asymmetry and variability of the skull's dimensional changes were also taken. Investigations[10–12] on the development of the human face from infancy to adulthood and its orthodontic implications were also performed. Later on, cephalometric and radiographic studies were conducted relative to orthodontic treatment necessary to correct facial deformities.[13–16]

In 1931, Todd[17] found out that measurement of dead skulls was largely a record of defective growth. He concluded that if measurement of the normal growth had to be done, then measurement should be conducted on healthy children.

Direct measurements of the living head during growth has the advantage of observing the same individual repeatedly over a period of time and will reveal any variation. However, it has the disadvantage of the error introduced by measuring through the overlying soft tissues. Further, facial bones are not accessible to precise direct measurements.

Broadbent[13] described a standard technique for lateral and frontal radiographs. Radiographic cephalometry facilitated

accurate measurements of the skeletal components of the face in a growing child.

Since none of the previous studies had described a definitive method for facial asymmetry, it is clear that a technique must be devised to accurately define and assess the area of asymmetry in the craniofacial region that would provide limitations useful for future comparison. Standard norms will contribute normative data for comparison of the individual subject, with population norms forming a basis for discriminating normal from abnormal. Further, clinical application form will be generated.

Materials and Methods

The subjects utilized for this cephalometric investigation consisted of 30 male and 30 female participants in a growth study at the Child Research Council in Denver. All subjects were Caucasian and of northern European descent. The postero-anterior cephalometric radiographs were taken according to a standardized technique identical in principle to that used by Broadbent[11] at the Western Reserve University.

The postero-anterior cephalometric radiographs were taken for each subject at 6, 12 and 18 years of age. These radiographs were traced and all measurements were double checked and recorded by one investigator.

Cephalometric Landmarks:

Several studies[18,19] were performed to locate, design and define all cephalometric landmarks. The landmarks used [Fig. 1] were neck of crista galli (Nc), latero-orbitale (Lo), orbitale (Or), zygomatic (Zyg), maxillare (Mx), latero-nasal (Ln), condylion (Cd), gonion (Go) and menton (Me).

Reference System:

The Frankfort horizontal (FH) was used as the horizontal plane of the head. From the neck of the crista galli (Nc), a perpendicular plane was constructed on the FH and was used as the midsagittal plane [Fig. 1]. Reference planes were established on the postero-anterior tracings. The measurement of a distance along perpendiculars to reference planes is known as orthogonal measurement used to represent its distance and position relative to a reference system.[20]

Cephalometric Measurements:

The P-A cephalogram was traced to record pertinent structures in linear measurements. The following linear measurements were used [Fig. 2] :

1. *Bi-Latero orbitale width (Bi-Lo) :* taken as a transverse measurement between the bilatero-orbitale points.
2. *Bi-Zygomatic width (Bi-Zyg)* : the distance between the most laterally situated points on the zygomatic arches.
3. *Bi-Maxillary width (Bi-Mx)* : the horizontal distance between both right and left maxillaries.
4. *Bi-Lateronasal width (Bi-Ln)* : the greatest distance between the lateral walls of the anterior nasal aperture measured at the front of the face,
5. *Bi-Condylar width (Bi-Cond)* : the transverse distance between the bi-Condylions.
6. *Bi-Gonial width (Bi-Go)* : the distance between the right and left gonia.

Also, both the horizontal and vertical distances from these landmarks (Lo, Zyg, Mx, Ln, Cond and Go) to those planes (midsagittal and Frankfort horizontal planes) were determined

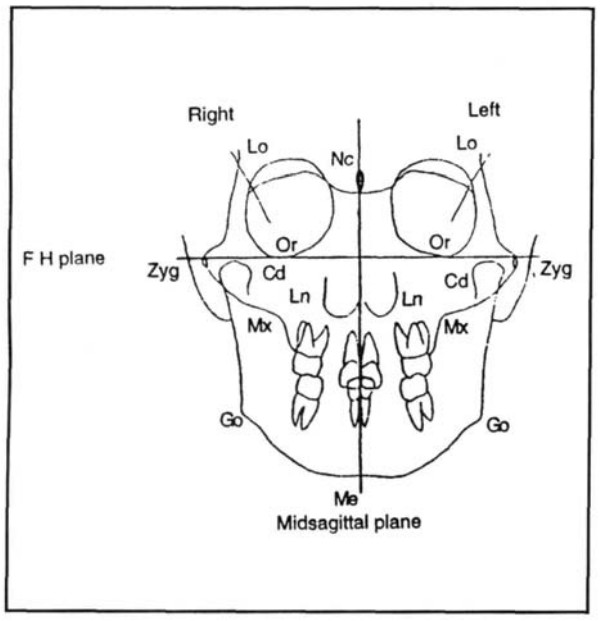

Figure (1) : A schematic showing the cephalometric landmarks and reference planes.

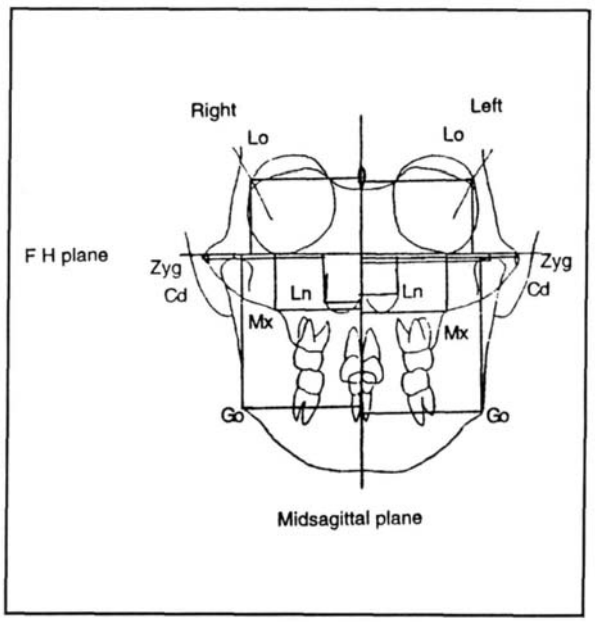

Figure (2) : A schematic showing the cephalometric measurements.

for both right and left sides of the face. This was used 1 localize the site and determine the amount of facial asymmeti as follows:

1. *Lo-H*: the horizontal distance from Lo to the midsagitt; plane.
2. *Lo-V*: the vertical distance from Lo to the FH plane.
3. *Zyg-H* : the horizontal distance from Zyg to tr midsagittal plane.
4. *Zyg-V*: the vertical distance from Zyg to the FH plane.
5. *Mx-H* : the horizontal distance from Mx to tf midsagittalplane.
6. *Mx-V*: the vertical distance from Mx to the FH plane.
7. *Ln-H*: the horizontal distance from Ln to the midsagitt; plane.
8. *Ln-V*: the vertical distance from Ln to the FH plane.
9. *Cd-H* : the horizontal distance from Cond to th midsagittal plane.
10. *Cd-V*: the vertical distance from Cond to the FH plane.
11. *Go-H*: the horizontal distance from Go to the midsagittal plane.
12. *Go-V*: the vertical distance from Go to the FH plane.

Statistical Methods

Descriptive statistics including mean, standard deviation, minimum and maximum were calculated for each variable at each age level. A paired /-test was conducted on the difference between the means of the right and lef sides of the face to identify significant differences.

As bi-lateral width measurements do not clarify where the asymmetry is located, i.e. on the right, the left or whether both sides are affected. Furthermore, is transverse asymmetry accompanied by vertical asymmetry or not ? To obtain an accurate assessment of amount, site and type of asymmetry, perpendiculars from each cephalometric landmark to the reference planes (midsagittal and Frankfort horizontal planes) were constructed.

Clinical application form for P-A cephalometric analysis.

Measurements	6 years old Mean (SD)		12 years old Mean (SD)		18 years old Mean (SD)	
	Boys	Girls	Boys	Girls	Boys	Girls
Bi-Lo	85(4)	83(3)	91(4)	89(3)	96(5)	93(3)
Bi-Zyg	111 (3)	108 (4)	122 (4)	121 (5)	134 (7)	128 (6)
Bi-Mx	61(3)	58(4)	70(3)	66(4)	76(4)	72(5)
Bi-Ln	23(1)	22(2)	27(2)	27(2)	31(2)	30(2)
Bi-Cd	90(3)	88(3)	100 (3)	98(4)	107 (5)	104 (4)
Bi-Go	79(4)	76(3)	90(5)	87(4)	101 (6)	94(5)
			Right Side			
Lo-H	43(2)	42(2)	46(2)	45(2)	48(2)	46(2)
Lo-V	28(2)	29(2)	32(2)	33(2)	36(2)	37(2)
Zyg-H	56(2)	54(2)	61(3)	61(2)	68(4)	64(3)
Zyg-V	2(2)	2(2)	5(2)	5(2)	9(4)	9(3)
Mx-H	30(2)	29(2)	35(2)	33(2)	38(2)	36(2)
Mx-V	16(3)	16(2)	20(3)	19(2)	25(3)	22(3)
Ln-H	11(1)	11(1)	14(1)	13(1)	16(1)	15(1)
Ln-V	10(2)	10(2)	14(2)	13(2)	19(2)	16(3)
Cd-H	45(2)	44(2)	50(2)	49(2)	54(2)	52(2)
Cd-V	1(2)	Id)	4(1)	3(1)	7(3)	7(2)
Go-H	40(2)	38(2)	46(3)	44(3)	51(3)	47(3)
Go-V	46(2)	44(2)	54(4)	52(4)	65(4)	58(4)
			Right Side			
Lo-H	43(2)	42(2)	46(2)	44(2)	48(2)	46(2)
Lo-V	29(2)	29(2)	32(2)	33(2)	36(3)	37(1)
Zyg-H	55(2)	54(2)	61(2)	60(3)	66(3)	63(3)
Zyg-V	2(2)	2(2)	5(2)	5(2)	9(4)	10(3)
Mx-H	30(2)	29(2)	35(2)	33(2)	38(3)	36(2)
Mx-V	16(2)	16(2)	19(2)	19(2)	24(3)	21(3)
Ln-H	11(1)	11(1)	13(1)	13(1)	15(1)	15(1)
Ln-V	11(2)	10(2)	14(2)	13(2)	19(2)	16(3)
Cd-H	45(2)	44(2)	50(2)	49(2)	53(2)	52(2)
Cd-V	1(2)	KD	4(1)	3(1)	7(3)	7(2)
Go-H	40(2)	38(2)	45(3)	43(2)	50(3)	47(2)
Go-V	46(4)	43(3)	54(4)	51(4)	65(5)	58(5)

Measurements are in millimeters.

Results

Size Changes

A. Bi-Latero Orbitale Width :

Overall increase in width from 6 to 18 years of age was 10.28 mm in males and 9.67 mm in females as shown in Table 1 (a). The absolute mean values were greater in males at each age with statistically significant differences (P<0.05).

Tables lb and lc show the mean values and standard deviations for the horizontal distances from right and left latero-orbitales to the midsagittal plane in both male and female groups. There was no significant difference between the right and left sides in both the male and female groups at all ages.

Table 1 (a). Norms for bilatero-orbitale width

	6 years **old**		12 years old		18 years **old**	
	Boys	Girls	Boys	Girls	Boys	Girls
N	25	28	26	22	14	17
Mean	85.49	83.13	91.32	89.02	95.77	92.80
S.D.	3.90	3.21	3.66	3.05	4.52	3.32
Minimum	76.84	78.25	83.61	84.34	87.00	86.30
Maximum	94.19	89.25	99.82	96.00	103.18	98.00
P-value	0.02		0.02		0.04	

Table 1 (b). Norms for horizontal distance from latero-orbitale to midsagittal plane.

			Boys Group							
			Right Side				Left Side			P-Value
Age	N	Mean	S.D.	Min.	**Max.**	Mean	S.D.	Min.	Max.	
6	25	42.86	1.90	38.80	46.75	42.60	2.10	38.05	47.44	0.10
12	26	45.79	1.73	42.12	49.74	45.54	2.01	41.49	50.32	0.06
18	14	47.95	2.18	43.50	51.15	47.81	2.38	43.50	52.00	0.46
			Girls Group							
6	28	41.53	1.58	38.83	44.63	41.60	1.72	39.03	45.00	0.63
12	22	44.57	1.49	42.00	48.00	44.45	1.61	42.34	48.00	0.32
18	17	46.40	1.75	43.00	49.00	46.40	1.60	43.30	49.00	0.98

Table 1 (c). Norms for vertical distance from latero-orbitale to FH plane.

			Boys **Group**							
			Right Side				Left Side			P-Value
Age	N	Mean	S.D.	Min.	Max.	Mean	S.D.	Min.	Max.	
6	25	28.37	1.99	23.50	31.82	28.61	2.16	24.05	33.23	0.35
12	26	32.08	2.01	25.73	36.00	32.42	2,05	25.53	35.67	0.09
18	14	35.50	2.46	28.30	38.50	36.29	2.97	28.28	41.00	0.10
			Girls Group							
6	28	28.73	2.03	25.72	34.02	29.11	2.11	23.97	33.05	0.27
12	22	32.62	1.82	29.74	35.34	32.84	1.75	29.39	35.96	0.32
18	17	36.58	1.60	33.00	39.00	36.80	1.06	35.00	38.50	0.39

B. Bi-Zygomatic Width:

The absolute mean values of bi-zygomatic (Bi-Zyg) width in male and female groups are presented in Table 2a. The total increase in width from 6 to 18 years was 23.16 mm in males at each age. However, there were significant differences observed at ages 6 and 18.

Tables 2b and 2c show the mean values and standard deviations for the horizontal distances from right and left zygomatic points to the midsagittal plane in both male and female groups. There was no statistically significant differences between the right and left sides in the male group at all ages except at the age of 18, where the right was larger than the left side ($P<0.05$). However, in female group, differences were not significant at all ages.

The means and standard deviations of vertical distances from right and left Zyg to the FH plane in both sexes were shown in Tables 2d and 2e. In the male group, the differences between the right and left sides were statistically insignificant at all ages. Whereas in the female group, there was no statistically significant difference observed except at the age of 12 years where the left was larger than the right side ($P<0.001$).

Table 2 (a). Norms for zygomatic width

	6 years old		**12 years old**		**18 years old**	
	Boys	**Girls**	Boys	**Girls**	**Boys**	**Girls**
N	25	28	26	22	14	17
Mean	110.70	108.30	122.46	120.91	133.86	127.58
S.D.	3.46	4.40	4.49	4.82	6.50	5.80
Minimum	103.60	99.72	114.98	114.50	124.20	118.00
Maximum	116.19	115.80	129.20	134.00	144.27	140.00
P-value	**0.03**		**0.25**		**0.01**	

Table 2 (b). Norms for horizontal distance from zygomatic to midsagittal plane.

		Boys Group								
		Right Side				**Left Side**				**P-Value**
Age	**N**	**Mean**	**S.D.**	**Min.**	Max.	**Mean**	**S.D.**	**Min.**	Max.	
6	25	55.64	2.07	51.30	60.23	55.03	1.94	49.18	58.79	0.15
12	26	61.72	2.61	56.95	65.50	60.75	2.30	56.90	66.00	0.02
18	14	67.68	3.53	62.60	73.98	66.11	3.25	61.00	70.24	0.01
				Girls Group						
6	28	54.43	2.45	49.53	57.81	53.89	2.43	49.61	58.70	0.20
12	22	60.72	2.41	57.38	66.00	60.19	2.85	56.16	68.00	0.26
18	17	64.09	3.13	58.00	70.00	63.49	2.89	59.00	70.00	0.16

Table 2 (c). Norms for vertical distance from zygomatic to FH plane.

		Boys Group								
		Right Side				**Left Side**				**P-Value**
Age	**N**	**Mean**	**S.D.**	**Min.**	Max.	Mean	**S.D.**	**Min.**	**Max.**	
6	25	2,17	1.81	-2.85	4.00	1.91	1.68	-2.96	4.00	0.17
12	26	5.32	2.21	1.18	12.45	5.31	1.98	1.41	10.36	0.94
18	14	8.83	3.86	3.86	15.50	9.38	4.11	3.80	18.50	0.26
				Girls	G	**roup**				
6	28	1.69	1.63	-1.57	6.000	1.88	1.56	-1.68	5.83	0.13
12	22	5.00	1.81	1.69	8.888	5.37	1.75	2.56	10.13	0.00
18	17	**9.48**	3.02	3.78	16.00	9.64	3.16	5.14	17.50	0.43

C. Bi-Maxillary Width:

The absolute mean values of bi-maxillary width (Bi-Mx) in male and female groups are presented in Table 3a. The total increase in width from 6 to 18 years was 15.45 mm in males and 13.78 mm in females, the absolute mean values were larger in emales than females with statistically differences at all ages.

Tables 3b and 3c show the mean values and standard deviations for the horizontal distances from right and left Mx to the midsagittal plane in both male and female groups. There was no statistically difference observed between the right and left sides of both male and female groups at all ages.

The means and standard deviations of vertical distances from the right and left Mx to the FH plane in both males and females are shown in Tables 3d and 3e. In the male group, difference between the right and left sides was statistically insignificant except at ages 12 and 18 years, where the right was larger than the left side ($P<0.05$). In the female group, no significant difference was observed at all ages.

Table 3 (a). Norms for bi-maxillary width

	6 years old		12 years old		18 years old	
	Boys	**Girls**	Boys	**Girls**	Boys	**Girls**
N	25	28	26	22	14	17
Mean	60.61	58.02	69.86	66.30	76.06	71.80
S.D.	2.82	3.76	3.37	4.19	4.12	4.74
Minimum	56.11	51.87	63.97	59.25	69.50	63.60
Maximum	65.50	65.65	76.75	75.27	82.17	80.00
P-value	**0.01**		**0.00**		**0.01**	

Table 3 (b). Norms for horizontal distance from maxillary to midsagittal plane.

				Boys Group						
		Right Side				**Left Side**				**P-Value**
Age	**N**	**Mean**	**S.D.**	**Min.**	Max.	**Mean**	**S.D.**	**Min.**	Max.	
6	25	30.24	1.56	27.54	32.98	30.36	1.54	27.85	33.63	0.62
12	26	34.87	1.63	32.12	38.43	34.99	1.90	31.85	38.80	0.57
18	14	38.02	1.83	34.00	40.84	38.02	2.50	34.00	41/34	0.99
				Girls Group						
6	28	28.98	2.09	25.81	32.78	29.03	1.86	25.60	32.88	0.83
12	22	33.09	2.28	29.30	38.29	33.21	2.00	29.60	36.98	0.56
18	17	35.91	2.37	31.80	40.00	35.90	2.46	31.80	40.00	0.97

Table 3 (c). Norms for vertical distance from maxillary to FH plane.

				Boys Group						
		Right Side				**Left Side**				**P-Value**
Age	**N**	**Mean**	**S.D.**	**Min.**	Max.	**Mean**	**S.D.**	**Min.**	Max.	
6	25	16.33	2.86	11.95	21,76	16.19	2.47	12.00	20.83	0.38
12	26	19.79	2.63	15.83	24.95	19.43	2.17	15.48	24.05	0.04
18	14	24.53	2.91	20.00	29.78	23.51	2.67	19.00	29.68	0.03
				Girls Group						
6	28	15.56	1.95	12.13	19.17	15.50	1.88	11.75	19.17	0.60
12	22	18.60	2.48	15.00	24.50	18.82	2.25	15.67	25.00	0.12
18	17	21.53	2.56	17.00	26.50	21.37	2.65	16.50	26.50	0.21

D. Bi-Lateronasal Width :

The absolute mean values of bi-lateronasal width (Bi-Ln) in male and female groups are demonstrated in Table 4a. The total increase in width from 6 to 18 years was 8.37 mm in males and 8.35 mm in females. The absolute mean values were slightly greater in males at each age but no significant difference was reached.

Tables 4b and 4c show the mean values and standard deviations for the horizontal distances from right and left Ln to the midsagittal plane in both male and female groups. There were no statistically significant differences between the right and left sides in the male group except at the age of 12 years, where the right was larger than the left side ($P<0.05$). No significant difference was observed in the female group.

The means and standard deviations of vertical distances from the right and left Ln to the FH plane in both groups are shown in Tables 4d and 4e. No statistically significant difference was reached in both groups at all ages.

Table 4 (a). Norms for nasal width

	6 years old		12 years old		18 years old	
	Boys	**Girls**	**Boys**	**Girls**	**Boys**	**Girls**
N	25	28	26	22	14	17
Mean	22.67	22.12	27.18	26.69	31.04	30.47
S.D.	1.05	1.66	1.70	1.87	2.15	2.20
Minimum	20.09	18.43	24.09	23.25	27.00	26.00
Maximum	25.60	25.25	31.89	31.00	34.26	33.00
P-value	**0.16**		**0.34**		**0.48**	

Table 4 (b). Norms for horizontal distance from Ln. to midsagittal plane.

		Boys Group								
		Right Side				Left Side				**P-Value**
Age	**N**	**Mean**	S.D.	**Min.**	**Max.**	**Mean**	S.D.	**Min.**	**Max.**	
6	25	11.49	0.59	10.35	12.34	11.17	0.74	9.67	12.95	0.06
12	26	13.79	0-.94	12.00	16.59	13.40	0.96	11.55	15.67	0.03
18	14	15.71	0.97 .	14.00	17.15	15.32	1.34	13.00	17.70	0.15
				Girls Group						
6	28	11.05	0.95	8.78	12.63	11.08	0.79	9.56	12.63	0.78
12	22	13.37	1.04	11.63	15.50	13.32	0.93	11.63	15.50	0.68
18	17	15.24	1.10	13.00	16.50	15.23	1.26	13.00	17.00	0.97

Table 4 (c). Norms for vertical distance from Ln. to FH plane.

		Boys Group								
		Right Side				Left Side				**P-Value**
Age	**N**	**Mean**	S.D.	**Min.**	**Max.**	**Mean**	S.D.	**Min.**	Max.	
6	25	10.46	2.09	7.37	17.00	10.52	2.05	7.47	16.75	0.62
12	26	14.44	2.31	10.95	22.00	14.24	2.05	10.97	20.08	0.11
18	14	18.60	2.43	16.00	25.40	18.54	1.95	16.00	23.80	0.77
				Girls Group						
6	28	9,78	1.90	5.31	13.13	9.85	1.72	7.12	13.13	0.59
12	22	13.27	2.15	8.20	16.48	13.36	1.88	9.97	16.48	0.62
18	17	16.22	2.70	12.14	22.08	16.08	2.68	12.36	22.08	0.21

E. Bi-Condylar Width :

The absolute mean values of bi-condylar with (Bi-Cd) in male and female groups are shown in Table 5a. The total increase in width from 6 to 18 years was 17.48 mm in males and 16.24 mm in females. The absolute mean values were greater in males at each age level with significant differences at ages 6 and 18 years (P<0.05).

Tables 5b and 5c show the mean values and standard deviations for the horizontal distances from the right and left Cd to the midsagittal plane in both male and female groups. There were no statistically significant differences between the eright and left sides in the male group except at ages 6 and 18 years where P<0.01 and P<0.05, respectively. In the female group, no significant difference was reached at all ages.

The means and standard deviations of the vertical distance from the right and left Cd to the FH plane on both groups are shown in Tables 5d and 5e. In the male group, no significant difference between the right and left sides was reached. In the female group, a significant difference at all ages was observed except at the age of 6 years. It was observed that at ages 12 and 18 years, the left side was larger with highly significant difference of 5% and 1%, respectively. In general, the left side eshowed greater mean value than the right side.

Table 5 (a). Norms for bi-condylar width

	6 years old		12 years old		18 years old	
	Boys	**Girls**	**Boys**	**Girls**	Boys	**Girls**
N	25	28	26	22	14	17
Mean	88.90	87.83	99.69	97.72	107.38	104.07
S.D.	2.78	3.30	3.27	3.62	4.52	3.84
Minimum	89 Q4 97.51	81.50	92.20	92.25	99.00	98.00
Maximum		94.16	106.84	103.50	115.40	110.00
P-value	**0.02**		**0.05**		**0.04**	

Table 5 (b). Norms for horizontal distance from condylar to midsagittal plane.

			Boys Group							
Age	N	Mean	**Right Side**		Max.	Mean	**Left Side**		Max.	**P-Value**
			S.D.	**Min.**			**S.D.**	**Min.**		
6	25	45.44	1.60	42.47	48.76	44.51	1.69	39.47	48.76	0.02
12	26	50.19	1.87	47.05	53.67	49.50	2.12	44.03	54.00	0.14
18	14	54.43	2.38	51.00	58.60	52.95	2.38	48.00	56.80	0.00
			Girls Group							
6	28	43.97	2.07	40.74	47.25	43.86	1.59	40.69	47.08	0.73
12	22	49.00	2.08	44.58	52.83	48.72	2.13	44.26	52.00	0.55
18	17	52.19	2.08	48.78	57.00	51.88	2.02	48.00	54.76	0.37

Table 5 (c). Norms for vertical distance from condylar to FH plane.

			Boys Group							
Age	**N**	**Mean**	**Right Side**		**Max.**	**Mean**	**Left Side**		**Max.**	**P-Value**
			S.D.	**Min.**			**S.D.**	**Min.**		
6	25	1.07	2.36	-7.99	3.19	1.06	2.29	-8.35	2.66	0.91
12	26	3.53	1.19	1.27	6.12	3.70	1.19	1.53	6.02	0.22
18	14	6.97	3.41	3.04	13.30	7.18	3.41	2.50	15.50	0.49
			Girls Group							
6	28	1.21	1.13	-1.57	2.63	1.34	1.31	-2.34	3.00	0.15
12	22	3.04	0.79	1.93	4.44	3.30	1.01	1.96	5.95	0.02
18	17	6.65	2.14	3.50	10.50	7.20	2.43	3.50	11.30	0.01

F. Bi-Gonial Width :

The absolute mean values of Bi-gonial width (Bi-Go) in male and female groups are presented in Table 6a. The total increase in width from 6 to 18 years was 21.64 mm in males and 18.29 mm in females. The absolute mean values were greater in males than females at each age (P<0.01).

Tables 6b and 6c show the mean values and standard deviations for the horizontal distances from the right and left Go to the midsagittal plane in both male and female groups. There were no statistically significant differences between right and left sides in the male group except at the age of 18 where the right side was greater than the left (P<0.01). Whereas, the female group showed statistically insignificant differences at all ages.

The means and standard deviations of vertical distances from the right and left Go to the FH plane in both male and female groups are shown in Tables 6d and 6e. In both male and female groups, the differences between the right and left sides were statistically insignificant at all ages.

Table 6 (a). Norms for bi-gonial width

	6 years old		12 years old		18 years old	
	Boys	**Girls**	Boys	**Girls**	Boys	**Girls**
N	25	28	26	22	14	17
Mean	79.32	75.84	90.42	86.79	100.96	94.13
S.D.	4.19	3.46	4.70	4.32	6.01	4.58
Minimum	70.74	71.16	82.59	78.16	90.00	84.56
Maximum	88.28	83.16	101.90	96.00	112.00	102.61
P-value	**0.00**		**0.01**		**0.00**	

Table 6 (b). Norms for horizontal distance from gonion to midsagittal plane.

			Boys Group							
Age	N	**Mean**	Right Side		Max.	Mean	**Left Side**		Max.	**P-Value**
			S.D.	**Min.**			**S.D.**	**Min.**		
6	25	39.71	2.90	35.17	46.45	39.64	2.20	35.02	43.30	0.91
12	26	45.50	2.70	41.43	50.16	44.91	2.64	40.81	52.00	0.24
18	14	50.99	3.01	46.00	57.00	50.03	2.97	45.00	55.00	0.01
			Girls Group							
6	28	38.04	2.13	34.84	42.16	37.79	1.76	35.00	41.00	0.46
12	22	43.52	2.58	39.34	48.50	43.26	2.27	38.81	47.50	0.59
18	17	47.04	2.51	42.00	51.61	47.10	2.32	42.50	51.00	0.88

Table 6 (c). Norms for vertical distance from gonion to FH plane.

			Boys Group							
Age	**N**	**Mean**	Right Side		Max.	Mean	Left Side		Max.	**P-Value**
			S.D.	**Min.**			S.D.	**Min.**		
6	25	46.08	3.84	37.28	54.16	45.59	3.85	37.84	52.85	0.10
12	26	53.92	3.68	47.79	63.80	53.86	3.64	46.47	63.16	0.87
18	14	65.35	3.97	59.35	71.82	65.33	4.59	60.35	75.00	0.97
			Girls Group							
6	28	43.67	3.02	37.97	52.50	42.99	3.37	37.00	51.18	0.07
12	22	51.77	3.71	46.05	60.51	51.21	4.21	44.61	62.00	0.06
18	17	58.09	3.75	51.00	66.00	58.08	4.61	51.00	71.00	0.99

Discussion

It is difficult to directly compare the findings of the present study with most of the published anthropological studies based on skulls. This is due to differences in methods and samples used for each study. The previous investigations must be compared to the present data with caution because of several major differences. The greatest drawback inherent in the study of the skeletal record is that all the data must be cross-sectional and the age and gender are speculative in nature. Many of these studies were conducted on ancient and geographical diverse population. Further, Todd[17] emphasized the keynote of progress in 1931 when he advised that the measure of dead skulls was largely a record of defective growth and that measurement must be done on healthy living children in order to measure its normal growth.

A. Bi-Latero-orbitale Width :

The findings of the present study regarding the absolute size of the Bi-Lo width inmales and females were not in agreement with those obtained by Ingerslev and Solow[21] in 1975. This is possibly because their samples were derived from the different population. Sexual dimorphism identified in this study was consistent with the findings of many investigators.[21-23] Males exhibited a greater increase in width over a longer period of time than the females resulting in a greater facial dimension. This was in contrast with the study of Chebib and Chamma[24], who concluded that there was no significant gender differences in a sample of adult Caucasian subjects.

The difference between the right and left sides in the horizontal distance of LO to the midsagittal plane was generally insignificant in males and females. This reflects the differential growth occurred between the right and left Lo. Also, the vertical distance from the right and left Lo to the FH plane showed no significant differences at all ages in both male and female groups. Hence, asymmetry is a temporary phenomenon exhibited at some specific ages which are most oftenly improved by growth in the subsequent time intervals. These findings are in agreement with Robinson[25] but differ from that of the other investigators[5,26] who found that the right side was significantly larger than the left. The latter were cross-sectional studies far less sensitive to small dimensional changes which occur with age. Also, the findings of the present study differ from that of the other studies[24,27] for which the left side was significantly larger than the right. These differences may, again, be due to the cross-sectional nature of the last two studies.

B. Bi-Lateronasal Width:

The absolute size of the Bi-zygomatic width in males and females were in agreement with the longitudinal cephalometric study done by Woods[14] but differ from those obtained by other investigators[4,9-12]. This was possibly because some of these studies[4,9] were done on skull while others[11,12] did their measurements directly on the living subjects including the soft tissue thickness. The gender differences between males and females found in this study were concurrent with the findings of many investigations[14-23] where the bi-zygomatic width in males was significantly larger.

The difference between the right and left zygomatic to the midsagittal plane was insignificant except at 18 years in males. This manifests the different growth rates of both the right and left sides. Also, the vertical distances from the right and left zygomatic to the FH plane showed insignificant differences at all ages in males. However, in females, there was no significant differences except at the age of 12 years. These findings indicate the possibility of the self-correction of asymmetry through growth over a period of time which is in consistent with the study of Robinson[25]. However, it was not in agreement with the other investigations where the right was larger than the left side.[5,26] This was possibly because both the latter studies were had cross-sectional samples and could only demonstrate facial form at discrete periods of time. Further, findings of the present study differ from others[24,27] who found the left side was significantly larger than the right. Furthermore, the differences may be directly related to the cross-sectional approach.

C. Bi-Maxillary Width :

Findings of the present study on the absolute size of the bi-maxillary width were not in agreement with other studies[9,21,28,29]. These differences reflect the heterogeneity in population and landmarks utilized in these studies, i.e. Scottish, Danish.

The gender differences between males and females found in this study were consistent with the findings of other investigators[21-23] where the bi-maxillary width in males were significantly larger.

The right and left side differences in the horizontal distance of Mx to the midsagittal plane were insignificant at all ages in both males and females. Also, the vertical distances from the right and left Mx to the FH plane showed insignificant edifferences except at ages 12 and 18 years where the right MX was significantly larger, however, less than 0.5 mm. Whereas, the female group showed insignificant differences at all ages. This may be explained by the differential rates of growth between the right and left sides of the face. However, this was different from that of other investigators[9,26] who found the right side was significantly larger than the left and different from those[24,27] who found that the left side was significantly larger. These studies were based on cross-sectional samples which are less sensitive to growth investigations.

D. Bi-Lateronasal Width :

In the present study, the absolute size of the Bi-lateronasal width in males and females were consistent with that of Ricketts[30] and inconsistent with those of tollman's[4,10,11]. This was possibly because the latter study utilized dry skulls whereas the former used living patients.

Gender differences between males and females were insignificant at all ages. This was consistent with the study conducted by Chebib and Chamma[24] in 1981 but contradicted with that of Wei's[22] which can be attributed to populational differences.

The right and left side differences in the horizontal distance from Ln to the midsagittal plane were insignificant except at 12 years in males where the right side was insignificantly larger. This was mostly due to different rates of growth between right and left which may be improved by further growth. While the vertical distances from right and left Ln to the FH plane showed insignificant differences in females at all ages. This data demonstrated that asymmetry could be temporary at specific period of time and will be improved by further growth in the subsequent time intervals. These findings were different from other investigators' who found the right side was significantly larger and from those[24,27] who found the left side was significantly larger than the right side. Further, these studies were based on cross-sectional samples which describe facial form at specific period of time.

E. Bi-Condylar Width :

In the present study, the absolute size of the Bi-condylar width in males and females were in disagreement with the results obtained by other investigations[4,1011]. This was possibly because measurement in the first study was done on dry skulls, while mesurements in the next two studies were performed directly on living subjects including soft tissue thickness. The findings of the present study were similar to the longitudinal cephalometric studies carried out by Savara and Tracy[31,32].

The gender differences between males and females found in this study were consistent with the findings of other investigators[22,23,31,32] where the Bi-condylar width in males was significantly larger.

The right and left side differences in the horizontal distance from Cd to the midsagittal plane were insignificant except at 6 and 18 years in males where the right side was significantly larger. However, in the female group there was no significant differences at all ages. Also, the vertical distances from right and left Cd to the FH plane showed insignificant differences in the male group. Whereas in the female group, there were significant differences except at he age of 6 years. This data supports the contention that there are different growth rates between right and left sides of the face. However, this was in disagreement with investigators[9,26] who found the right side was significantly larger. Also, this study differs from others[24,25] who stated that the left side was significantly larger. These studies were limited because of their cross-sectional nature describing facial form at specific period of time.

F. Bi-Gonial Width :

The findings of the present study regarding the absolute size of the Bi-gonial width in males and females were consistent with some studies[14,15,31,32] and inconsistent with others[4,1011]. The Hellman's first study was carried out on dry skulls and the latter ewere performed directly on living subjects including soft tissue thickness.

The gender differences between males and females found in this study were consistent with the findings of many investigators[21,23,31,32]. In this study, the Bi-Go width in males was significantly greater. This was in disagreement with Chebib and Chamma[24] who found no significant gender differences.

The right and left side differences in the horizontal distance from Go to the midsagittal plane were insignificant except at the age of 18 years in males where the right side was significantly larger. Also, the vertical distance from the right and left Go to the FH plane showed insignificant differences at all ages in both males and females.

Clinical Implications

The results of the present study provide normative data for the transverse dimensions of the face of the study subjects at ages 6, 12 and 18 years. Further, forms for clinical application were generated at these ages for both sexes. These norms are very important for comparison of the individual subject with population norms, forming a basis for discriminating normal from abnormal and for monitoring growth of persons for corresponding age and race.

This study provided a simple way for frontal cephalometric analysis by setting perpendiculars from the cephalometric landmarks to the midsagittal and FH planes. By this way accurate assessment of site and amount of asymmetry could be determined.

Conclusions

The following conclusions have been drawn from this investigation :

1. Normative data for the transverse dimension of the face in a selected population were provided for each age (from 6, 12 and 18 years) and in both sexes for clinical use and research.

2. A method of identifying, describing and evaluating facial asymmetry was illustrated. Simply, by setting perpendiculars from each cephalometric landmarks to the midsagittal and FH planes. Thus, asymmetry in both horizontal and vertical dimensions will be identified on both sides of the face.
3. A sexual dimorphism was observed at most ages for all transverse dimensions, except the Bi-Ln width where there was no significant differences. Males exhibited greater increase over a longer period of time than females resulting in greater final dimension.
4. Right-left side differences were not significant in general except at few specific ages where the right side was significantly greater. This reflects the differential growth occurred between the right and left. This was most often improved by growth in the subsequent time intervals.
5. Forms for clinical application at ages 6, 12 and 18 years were provided for both sexes.

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