

CEPHALOMETRIC NORMS FROM POSTEROANTERIOR RICKETTS' CEPHALOGRAMS FROM HISPANIC AMERICANS PERUVIAN NON ADULT PATIENTS

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ABSTRACT

Aim: The purpose of the present study was to describe the posteroanterior cephalometric norm values from Hispanic Americans Peruvian non adults patients between years 2009 to 2010, identify possible differences between sexes and compare our results with similar studies in the literature.

Material and methods: Data from posteroanterior cephalograms from 318 patients (177 females and 141 males) between 9 and 18 years old were collected from our database; mean and standard deviation were calculated for each gender and age group.

Results: Independent samples T-test found statistically significant differences between males and females results in the intermolar width, right molar to maxillae distance, nasal width, nasal height, maxillary width, mandibular width and facial width.

Conclusions: statistically differences between sexes were found in seven from twelve transversal measurements. The norm values found in this study are similar to those reported by Ricketts'.

Keywords: Cephalometry; Reference values; Radiography, Dental; Orthodontics; Population characteristics.

VALORES PROMEDIO DE LA CEFALOMETRÍA POSTEROANTERIOR DE RICKETTS EN PACIENTES NO ADULTOS PERUANOS HISPANO AMERICANOS

RESUMEN

El propósito del presente estudio fue de establecer valores promedio de las medidas transversales del análisis posteroanterior de Ricketts en pacientes Peruanos Hispano Americanos no adultos que asistieron a nuestro centro de radiología entre los años 2009 y 2010, identificar posibles diferencias entre géneros y contrastar nuestros hallazgos con estudios similares en la literatura.

Materiales y método: Se recolectaron los valores de 12 medidas transversales 318 análisis de cefalometría posteroanterior de Ricketts (177 mujeres y 141 hombres) de nuestra base de datos; para cada medida se calculó el promedio y la desviación estándar de cada género y cada grupo etáreo.

Resultados: La prueba estadística T encontró diferencias estadísticamente significativas entre las medidas de los géneros masculino y femenino en el ancho intermolar, distancia del molar derecho al maxilar; ancho nasal, altura nasal, ancho maxilar; ancho mandibular y ancho facial.

Conclusiones: Se encontraron diferencias estadísticamente significativas en las medidas ancho interpolar (IM), distancia del molar derecho al maxilar (RMMD), ancho nasal (NC-CN), altura nasal (NH), ancho maxilar (JL-JR), ancho mandibular (AG-GA) y ancho facial (ZA-AZ). Los valores encontrados en la población estudiada son similares a los valores promedio reportados por Ricketts.

Palabras clave: Cefalometría; Valores de referencia; Radiografía, dental; Ortodoncia; Características de población.

INTRODUCTION

Cephalometric norms have been developed for the different ethnic and racial groups and it has been concluded that there are significant differences between them. Different racial groups must be treated according to their own characteristics¹. Posteroanterior (PA) cephalometric analysis is

used to: evaluate the vertical, transverse and sagittal dimensions¹, diagnose and quantify facial asymmetries and skeletal abnormalities², assess the transverse changes induced by maxillary expansions³, and diagnose functional, dentoalveolar, and/or facial asymmetries⁴. The relationship between the widths of the maxillary and mandibu-

lar skeletal bases is the most critical information from the posteroanterior cephalometric analysis¹. Most of the normative data have been based on lateral cephalometric radiographs and provides information on sagittal aspects of dentofacial structures⁵. Facial asymmetries and the oronasal area development can be assessed with the transverse analysis of PA cephalometric radiographs⁵.

The use of PA cephalometry is not standardized like lateral cephalometry². Researchers have been reluctant to use PA cephalometry for a variety of reasons such as: difficulties in reproducing head posture and landmark identification due superimposition or poor radiographic technique^{3,4}. Some of those difficulties could be overcome by careful attention to radiographic technique and selection of skeletal and dental landmarks with acceptable reliability³. Transverse measurements or widths from PA cephalograms are least affected by positional errors³. Cephalometric analysis errors are classified in: radiographic projection, landmark identification, tracing and measurement errors⁴. Cephalometric points located on a sharp curve or at the intersection of two curves are, generally, easier to identify than those located on a flat or broad curve⁴, and, cephalometric points located in high contrast areas are easier to identify than the low contrast ones⁴.

In the PA cephalometry, vertical and transverse measurements of dentofacial structures are taken relative to reference lines and the asymmetry are calculated by comparing the measurements of corresponding structures from the left and right sides⁸. The midline structures can also be used to assess the asymmetry as deviation toward the right or left side from the chosen line of reference⁸.

The Ricketts' PA cephalometric analysis seems to be the most widely used because it provides normative values for different ages.^{1,9}

The aim of this study was to describe the cephalometric mean values from Ricketts' PA cephalograms from Hispanic Americans Peruvian non adult patients, identify possible differences between both genres and compare our results with similar design studies in the scientific literature.

MATERIAL AND METHOD

Data was collected from PA cephalograms of Hispanic Americans patients between 9 to 18 years old from Lima – Peru, who attended our radiology center (CIDENT) for radiographic assessment prior to orthodontics between years 2009 - 2010. PA radiographs were taken in an Odontorama PC 100 panoramic machine (Trophy - France) in maximum intercuspation and the Frankfurt plane parallel to the floor. The cephalometric radiographs were traced on acetate cephalometric tracing sheet (GAC - cephalometric tracing paper) by a trained professional not associated to the present study.

From the 429 PA cephalograms selected, 111 were excluded because they met the following exclusion criteria: data absence, error in data entry, craniofacial syndromes, cleft palate (any type), and absence of first molars, lower canines, or incisors. As a result, 318 PA cephalograms were available to perform this study. We collected data from 12 skeletal and dental linear measurements from Ricketts' PA cephalometric analysis in millimeters (Tables 1, 2; Figures 1, 2).

Data was grouped in MS Office Excel 97 and statistical analyses were performed on IBM SPSS Statistics 15. For the 12 selected linear measurements of Ricketts' PA analysis mean, standard deviation and variance were calculated.

Ten PA radiographs were selected randomly and were traced twice in a one week interval. We used the method of error formula found in the study of Ishiguro et al⁶, the result was less than 1 mm.

Table 1: Posteroanterior cephalometric landmarks.

Landmark	Description
ZL/ZR	The most internal point of the frontozygomatic suture
ZA/AZ	The most external (lateral) border of the zygomatic arch
ANS	Anterior nasal spine
JL/JR	Deepest point of the alveolar maxillary process
AG/GA	Deepest point of the antegonial notch
ME	The most inferior point of mandibular symphysis

Table 2: Posteroanterior cephalometric reference planes.

Reference Plane	Description
JL/AG, JL/GA	Frontal face planes or maxilomandibular
Occlusal plane	Occlusal line in the molar teeth
Z plane	Reference line in the horizontal plane

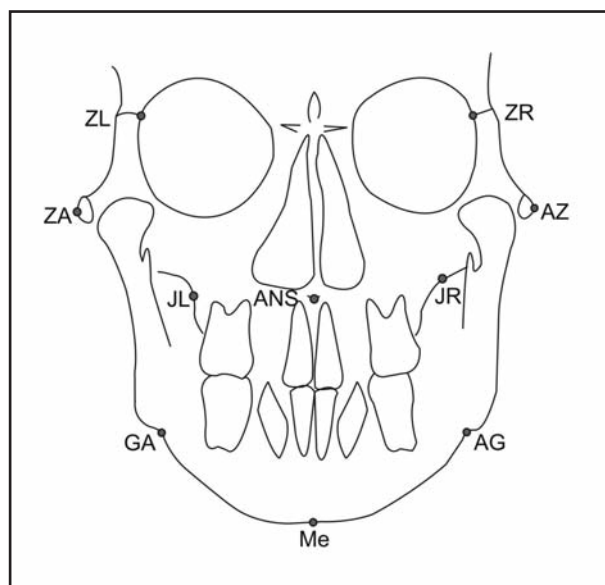


Fig. 1: Posteroanterior cephalometric landmarks.

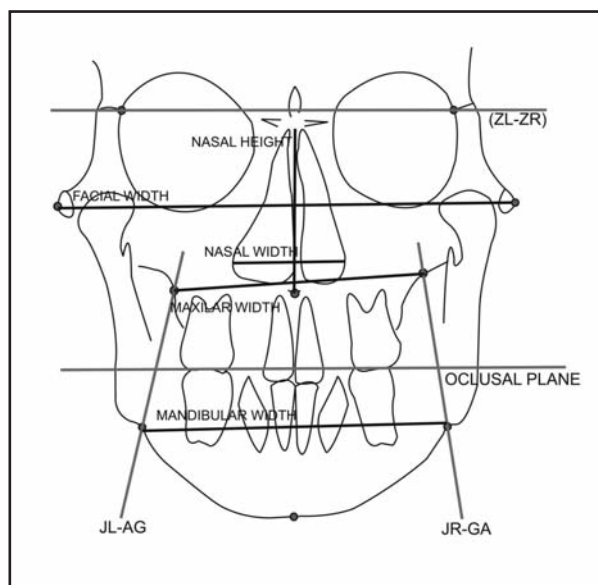


Fig. 2: Posteroanterior cephalometric reference planes.

RESULTS

The data was comprised of PA cephalometric analysis of 318 PA cephalograms, 177 females and 141 males between 9 and 18 years of age. The mean age value was 12.60 +/- 2.18 years old; the female mean age value was 12.28 +/- 2.17 years old and the male mean age value was 12.99 +/- 2.14 years old. (Tables 3-8)

The independent samples t-test was used to compare differences between sexes, the results found statistically significant differences in the intermolar width ($P < 0.000$), right molar to maxillae distance ($P < 0.017$), nasal width ($p < 0.046$), nasal

height ($p < 0.000$), maxillar width ($p < 0.000$), mandibular width ($p < 0.000$) and facial width ($P < 0.000$). (Table 9)

To study the correlation between each of the 12 PA measurements, Pearson correlation coefficients were calculated. The highest coefficient value was found between left and right maxillomandibular width ($r = 0.68$), the lowest correlation was found between maxillar width and right maxillomandibular width ($r = -0.36$). (Table 10)

Table 3: Population age and gender distribution.

Age	Female	Male	Total
9	14	7	21
10	25	6	31
11	31	25	56
12	32	26	58
13	34	21	55
14	16	23	39
15	7	16	23
16	8	7	15
17	6	15	22
18	4	3	7
TOTAL	177	141	318

Table 4: Descriptive statistics of posteroanterior cephalometric measurements (in millimeters) for non adults Hispano American Peruvians.

Measurement (mm.)	MEAN	SD
Intermolar width (IM)	57.71	4.20
Inter canine width (IC)	29.62	3.44
Left maxillomandibular width (LMM)	10.46	2.05
Right maxillomandibular width (RMM)	11.08	2.18
Left molar to maxillae distance (LMMD)	10.01	2.39
Right molar to maxillae distance (RMMD)	10.36	2.28
Lower midline deviation (LMD)	1.07	1.14
Nasal width (NC-CN)	30.18	2.89
Nasal height (NH)	52.51	3.94
Maxillary width (JL-JR)	67.90	3.87
Mandibular width (AG-GA)	86.17	5.11
Facial width (ZA-AZ)	132.36	6.57

Table 5: Descriptive statistics of posteroanterior cephalometric measurements (in millimeters) for a non adult Peruvian women.

Measurement (mm.)	MEAN	SD
Intermolar width (IM)	56.90	3.88
Inter canine width (IC)	26.29	3.36
Left maxilomandibular width (LMM)	10.46	1.83
Right maxilomandibular width (RMM)	11.05	2.15
Left molar to maxillae distance (LMMD)	9.8	2.29
Right molar to maxillae distance (RMMD)	10.08	2.33
Lower midline deviation (LMD)	1.04	1.17
Nasal width (NC-CN)	29.89	2.85
Nasal height (NH)	51.26	3.61
Maxillary width (JL-JR)	66.81	3.57
Mandibular width (AG-GA)	84.72	4.65
Facial width (ZA-AZ)	130.12	5.71

Table 6: Descriptive statistics of posteroanterior cephalometric measurements (in millimeters) for a non adult Peruvian men.

Measurement (mm.)	MEAN	SD
Intermolar width (IM)	58.72	4.39
Inter canine width (IC)	30.03	3.51
Left maxilomandibular width (LMM)	10.47	2.30
Right maxilomandibular width (RMM)	11.13	2.22
Left molar to maxillae distance (LMMD)	10.27	2.49
Right molar to maxillae distance (RMMD)	10.70	2.17
Lower midline deviation (LMD)	1.12	1.10
Nasal width (NC-CN)	30.54	2.92
Nasal height (NH)	54.07	3.78
Maxillary width (JL-JR)	69.27	3.82
Mandibular width (AG-GA)	87.99	5.09
Facial width (ZA-AZ)	135.16	6.52

Table 7: Descriptive statistics of posteroanterior cephalometric measurements (in millimeters) for a non adult Peruvian by age.

Age	IM Mean	IC Mean	LMM Mean	RMM Mean	LMMD Mean	RMMD Mean	LMD Mean	NC-CN Mean	NH Mean	JL-JR Mean	AG-GA Mean	ZA-AZ Mean
9	57.43	28.86	8.86	9.52	8.95	9.48	1.38	28.90	49.19	68.10	82.05	128.24
10	59.58	29.87	9.65	10.13	8.29	9.13	1.19	29.32	51.03	67.45	84.23	128.90
11	57.89	29.75	9.46	10.05	9.27	9.59	1.05	29.23	50.79	67.57	83.61	129.04
12	58.52	29.57	10.12	10.67	9.79	10.16	1.01	30.12	52.28	68.09	86.29	132.12
13	56.84	29.82	11.04	11.60	10.55	10.93	1.04	30.76	53.67	68.40	87.36	133.78
14	57.10	29.26	11.33	11.90	11.18	11.38	0.96	30.51	53.97	67.62	87.95	135.79
15	57.27	28.41	11.32	12.32	11.59	11.45	1.30	31.68	54.36	68.86	89.32	134.64
16	57.60	29.20	12.27	13.20	10.27	11.27	0.60	30.73	54.60	66.93	88.47	135.87
17	56.21	32.64	11.29	11.79	10.57	10.86	1.21	31.93	53.29	68.71	88.86	136.00
18	57.00	29.29	12.14	13.29	11.00	9.57	1.21	29.86	55.43	65.43	87.14	136.14

Table 8: Descriptive statistics of posteroanterior cephalometric measurements (in millimeters) for a non adult Peruvian by gender and age.

Gen	Age	IM Mean	IC Mean	LMM Mean	RMM Mean	LMMD Mean	RMMD Mean	LMD Mean	NC-CN Mean	NH Mean	JL-JR Mean	AG-GA Mean
	9	56.64	29.07	9.29	10.00	9.14	9.71	29.36	48.29	67.07	82.21	127.07
F	10	59.08	29.80	10.08	10.32	8.52	8.88	29.12	50.72	66.60	84.24	128.24
e	11	57.10	29.71	9.19	9.71	9.10	9.29	29.58	49.84	66.97	81.81	127.77
m	12	57.19	28.78	10.50	10.78	10.09	10.03	29.69	51.16	66.44	85.34	129.59
a	13	56.29	29.12	11.18	11.68	10.56	11.24	30.18	52.88	67.79	86.68	132.12
l	14	55.94	28.38	11.25	12.13	10.81	11.00	30.63	52.06	65.69	84.81	130.75
e	15	55.57	27.00	11.43	12.86	11.43	10.71	30.86	51.43	66.29	86.86	130.86
	16	58.38	29.75	11.88	13.75	9.38	10.50	31.63	54.50	66.88	88.50	136.88
	17	52.67	34.50	11.00	11.33	10.17	10.17	31.17	50.67	68.00	86.00	134.50
	18	55.25	28.25	11.75	13.00	10.00	10.00	28.00	54.00	64.00	84.00	134.25

Table 8: Cont.

Gen	Age	IM Mean	IC Mean	LMM Mean	RMM Mean	LMMD Mean	RMMD Mean	LMD Mean	NC-CN Mean	NH Mean	JL-JR Mean	AG-GA Mean
	9	59.00	28.43	8.00	8.57	8.57	9.00	28.00	51.00	70.14	81.71	130.57
	10	61.67	30.17	7.83	9.33	7.33	10.17	30.17	52.33	71.00	84.17	131.67
M	11	58.88	29.80	9.80	10.48	9.48	9.96	28.80	51.96	68.32	85.84	130.60
a	12	60.15	30.54	9.65	10.54	9.42	10.31	30.65	53.65	70.12	87.46	135.23
l	13	57.71	30.95	10.81	11.48	10.52	10.43	31.71	54.95	69.38	88.48	136.48
e	14	57.91	29.87	11.39	11.74	11.43	11.65	30.43	55.30	68.96	90.13	139.30
	15	58.07	29.07	11.27	12.07	11.67	11.80	32.07	55.73	70.07	90.47	136.40
	16	56.71	28.57	12.71	12.57	11.29	12.14	29.71	54.71	67.00	88.43	134.71
	17	58.88	31.25	11.50	12.13	10.88	11.38	32.50	55.25	69.25	91.00	137.13
	18	59.33	30.67	12.67	13.67	12.33	9.00	32.33	57.33	67.33	91.33	138.67

Table 9: T test results of posteroanterior cephalometric measurements (in millimeters) between men and women.

	GEN	N	MEAN	SD	P		GEN	N	MEAN	SD	P
IM	Male	141.00	58.72	4.39	0.000	LMD	Male	141.00	1.12	1.10	0.533
	Female	177.00	56.90	3.88			Female	177.00	1.04	1.17	
IC	Male	141.00	30.03	3.51	0.059	NC-CN	Male	141.00	30.54	2.92	0.046
	Female	177.00	29.29	3.36			Female	177.00	29.89	2.85	
LMM	Male	141.00	10.47	2.30	0.964	NH	Male	141.00	54.07	3.78	0.000
	Female	177.00	10.46	1.83			Female	177.00	51.26	3.61	
RMM	Male	141.00	11.13	2.22	0.716	JL-JR	Male	141.00	69.27	3.82	0.000
	Female	177.00	11.05	2.15			Female	177.00	66.81	3.57	
LMMD	Male	141.00	10.27	2.49	0.079	AG-GA	Male	141.00	87.99	5.09	0.000
	Female	177.00	9.80	2.29			Female	177.00	84.72	4.65	
RMMD	Male	141.00	10.70	2.17	0.017	ZA-AZ	Male	141.00	135.16	6.52	0.000
	Female	177.00	10.08	2.33			Female	177.00	130.12	5.71	

Table 10: Pearson's correlation coefficient of posteroanterior cephalometric measurements.

	AIM	AIC	AMMI	AMMD	MAAMI	MAAMD	LMDI	AN	ALTN	ANMAX	ANMAND	ANFAC
IM		-0.16	-0.10	-0.08	-0.29	-0.29	0.04	0.18	0.09	0.36	0.23	0.25
IC	-0.16		-0.09	-0.01	-0.02	-0.06	-0.06	0.14	0.04	0.22	0.13	0.17
LMM	-0.10	-0.09		0.68	0.28	0.21	-0.03	0.15	0.11	-0.34	0.38	0.19
RMM	-0.08	-0.01	0.68		0.18	0.20	-0.03	0.07	0.12	-0.36	0.40	0.20
LMMD	-0.29	-0.02	0.28	0.18		0.63	0.03	0.22	0.25	0.29	0.51	0.27
RMMD	-0.29	-0.06	0.21	0.20	0.63		0.01	0.20	0.28	0.32	0.50	0.26
LMD	0.04	-0.06	-0.03	-0.03	0.03	0.01		0.05	-0.05	0.06	0.01	0.02
NC-CN	0.18	0.14	0.15	0.07	0.22	0.20	0.05		0.11	0.37	0.37	0.45
NH	0.09	0.04	0.11	0.12	0.25	0.28	-0.05	0.11		0.30	0.43	0.44
JL-JR	0.36	0.22	-0.34	-0.36	0.29	0.32	0.06	0.37	0.30		0.42	0.53
AG-GA	0.23	0.13	0.38	0.40	0.51	0.50	0.01	0.37	0.43	0.42		0.57
ZA-AZ	0.25	0.17	0.19	0.20	0.27	0.26	0.02	0.45	0.44	0.53	0.57	

DISCUSSION

The importance of the transverse dimension becomes apparent when the potential and limits of certain treatment options, such as palatal expansion, have

to be explored, or when deciding between the extraction or non extraction in borderline cases⁹.

Transverse and vertical distances demonstrated a progressive increase between 10 and 14 years in

both genres, with vertical growth greater than the transverse facial growth⁵. Facial growth finishes first in width, then in length and finally in height^{5,7}. Publications concerning normative data related to PA cephalometry in different non adult populations were made by Athanasiou¹² (Austria), Moyers (USA), Ricketts (USA), Cortella⁷ (USA); studies in adult population were conducted by Wey (China), Uysal and Zafer¹ (Turkey) and Altaki¹³ (Palestine). Intermolar width (IM) mean value found in this study was 57.71 ± 4.2 mm, the female population mean value was 56.9 ± 3.88 mm and the male population mean value was 58.72 ± 4.39 mm. Our results are similar to those reported by Ricketts, Zafer and Uysal¹ in the Turkish adult population and Altaki¹³ in the Palestinian adult population¹³. The mandibular canine width (IC) mean value found in this study was 26.92 ± 3.44 mm, the female population mean value was 26.29 ± 3.36 mm and the male mean value was 30.3 ± 3.51 mm. Our results are similar to Ricketts norm value and to those reported, in the general population and female population, by Uysal and Zafer¹ in the Turkish population, the male mean value found in this study was higher when compared to Uysal and Zafer¹ findings in the Turkish male adult population.

Maxilomandibular width (LMM and RMM) mean value found in this study for the left side was 10.46 ± 2.05 mm; the female population mean value was 10.46 ± 1.83 mm and the male population mean value was 10.46 ± 2.30 mm. The right side the mean value was 11.08 ± 2.18 mm, the female population was 11.05 ± 2.15 mm and the male population mean value was 11.13 ± 2.22 mm. Our results are similar to those reported by Ricketts and lower to those reported by Uysal and Zafer¹ in the Turkish male adult population. The molar to maxillae distance (LMM) mean value found in this study for the left side was 10.01 ± 2.39 mm; the female population mean value was 9.8 ± 2.29 mm and the male population mean value was 27.10 ± 2.49 mm. The right side mean value was 10.36 ± 2.28 mm; the female population mean value was 10.08 ± 2.33 mm and the male population mean value was 10.7 ± 2.17 mm. Our results are higher to those reported by Ricketts and similar to those reported by Uysal and Zafer¹ in the Turkish adult population.

The nasal width (NC-CN) mean value found in this study was 30.18 ± 2.89 mm; the female population mean value was 29.89 ± 2.85 mm and the male population mean value was 30.54 ± 2.92 mm. Our

results are lower than those reported by Uysal and Zafer¹ in the Turkish adult population, Altaki¹³ in the Palestinian adult population and similar to those reported by Wei¹⁴ in the Chinese adult population. In Ricketts' PA analysis, the nasal width norm value varies between 25 to 31.3mm among 9 to 18 years old, our results found range values between 28 to 31mm, which are similar to those reported by Ricketts.

The maxillary width (JL-JR) mean value found in this study was 67.9 ± 3.87 mm; the female population mean value was 66.81 ± 3.57 mm and the male population mean value was 69.27 ± 3.82 mm. Our results are similar to those reported by Uysal and Zafer¹ in the Turkish adult population and Altaki¹³ in the Palestinian adult population; our results for the female population are higher than those reported by Uysal and Zafer¹. In the Ricketts' PA analysis, the norm value varies between 62 to 67.4mm among 9 to 18 years old, our results found range values between 65 to 68mm, similar to those reported by Ricketts.

The mandibular width (AG-GA) mean value found in this study was 86.17 ± 5.11 mm; the female population mean value was 84.72 ± 4.65 mm and the male population mean value was 87.99 ± 5.09 mm. Our results are lower than those reported by Uysal and Zafer¹ for the Turkish adult population and similar to those reported by Altaki¹³ for the Palestinian adult population, Cortella⁷ and Ricketts.

Facial width (ZA-AZ) mean value found in this study was 132.36 ± 6.57 mm; the female population norm value was 130.12 ± 5.71 mm and the male population value was 135.16 ± 6.52 mm. Our results are higher than those reported by Wei¹⁴ in the Chinese adult population, lower than those reported by Uysal and Zafer¹ in the Turkish adult population and similar to those reported by Altaki¹³ in the Palestinian adult population and the Ricketts' PA analysis. Statistically significant differences between male and female genres was found in the intermolar width (IM), right molar to maxillae distance (RMMD), nasal width (NC-CN), nasal height (NH), maxillary width (JL-JR), mandibular width (AG-GA), facial width (AZ-ZA). Uysal and Zafer¹, Wei¹⁴, Yavuz⁵ and Altaki¹³ found differences between genres in facial width, nasal width and maxillary width respectively. Wei¹⁴ and Uysal⁵ found differences in the intercanine width. Uysal and Zafer¹ and Altaki¹³ found differences in the intermolar width and mandibular width.

Our study population consisted of cephalograms from the Hispanic American Peruvians ethnic group; ethnic line studies can be developed to collect data from two previous generations to make comparisons and establish so microevolutionary changes.

The real cephalometric norm values for our ethnic group can be found with similar design studies in the three geographical regions of our country.

Differences between male and female genres found in our study can be supplemented with other cephalometric measurements for a better description of secondary sex characteristics.

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CONCLUSIONS

Differences between sexes were demonstrated in seven from twelve transversal measurements, especially in the internal structural field of the Ricketts analysis.

The mean values found in this study are similar to those reported by Ricketts, with exception bilateral molar to maxillae distance (MMD); so it is advisable to use the Rickett's PA cephalometric norm values.

Differences between populations were found by comparing studies of similar design.