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Anatomical Characteristics, Relations, and Clinical Considerations of the Facial Index and Cephalic Index in Young Chileans Aged Between 18 and 21 Years

Características Anatómicas, Relaciones y Consideraciones Clínicas del Índice Facial e Índice Cefálico en Jóvenes Chilenos entre 18 y 21 Años

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SUMMARY: Humans throughout history have shown similarities between both their cephalic and facial complexion, among certain ethnic groups, due to genetic and demographic factors. Several studies have demonstrated the different constitutions of specific groups of people in order to generate data of a certain population or group. The present research aims to preliminarily study the existence of possible relations between Cephalic Index and Facial Index among categories of individuals in an odontology student population from a private university in Santiago, Chile. Empirical, descriptive, and cross-sectional study. In this study, 129 students with age range 18-21 were taken as subjects in a non-probabilistic way. Regarding Cephalic Index (CI), the Retzius classification was used, and the Facial Index (FI) was measured considering the maximum height of the face, from nasion to gnathion (Na-Gn), and the maximum width, from right zygion to left zygion (Zr-Zl). In this study, 129 people were taken as sample, 82 females and 47 males. Among women, the most predominant cephalic biotype was brachycephalic (59.8 %), followed by mesocephalic (37.8 %), and dolichocephalic (2.4 %). On the other hand, men's most common biotype was mesocephalic (57.5 %), followed by brachycephalic (36.2 %), and dolichocephalic (6.4 %). Regarding facial biotype, both in female and male subjects the following pattern was shown: euryprosopic (F: 59.7 %, M: 59.6 %), mesoprosopic (F: 26.8 %, M: 29.8 %), and leptoprosopic (F: 13.4 %, M: 10.6 %). Facial parameters of the subjects (odontology students from a Chilean university) tend to be mostly euryprosopic, followed by mesoprosopic and leptoprosopic. Additionally, mesocephalic biotypes tend to be similar to other studies conducted in Chile.

KEY WORDS: Facial Index; Cephalic Index; Young Chileans.

INTRODUCTION

Humans throughout history have shown similarities between both their cephalic and facial complexion, among certain ethnic groups, due to genetic and demographic factors. Several studies have demonstrated the different constitutions of specific groups of people in order to generate data of a certain population or group (del Sol, 2006; Bustamante *et al*., 2011; Shetti *et al*, 2011; Staka *et al*., 2013; Lakshmi *et al*., 2015; Bustamante *et al*., 2016). Settlements in the Americas suffered changes due to several migration waves throughout history, as Pucciarelli (2004) describes.

One of the most influential authors contributing to the study of cephalometry has been anthropologist Anders Retzius (1796-1860) because, in his studies related to human skull morphology, he introduced the term Cephalic Index (CI), besides new classification inside this index such as dolichocephalic and brachycephalic (Triarhou, 2013).

CI is calculated by measuring the maximum length of the head and the maximum width of living individuals (Fig. 1). CI is calculated with these measurements using the

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following Retzius equation. Once the result is obtained, the CI is classified as the following: brachycephalic, mesocephalic, and dolichocephalic (Aguila, 1996; del Sol, 2006; Shetti *et al*., 2011; Staka *et al*., 2013; Lakshmi *et al*., 2015). On the other hand, Facial Index (FI) is calculated by measuring the maximum height and the maximum width of the anatomical face (Fig. 1). FI is calculated with these measurements using the Martin equation (Martin & Saller, 1957). Once the result is obtained, the FI can be classified in two different ways. First, according to Martin & Saller (1957), they can be grouped as euryprosopic (<85), mesoprosopic (85-89), and leptoprosopic (>90), this also includes categories in both opposite ends, such as hypereuryprosopic and hyperleptoprosopic respectively. The second classification, used by Companioni *et al*. (2010), is as follows: euryprosopic (<97), mesoprosopic (97-104) and leptoprosopic (>104).

Both cephalic and facial craniometric measurements have been exhaustively studied by several authors, allowing different relationships and indices to be made between each of these measurements (del Sol, 2006; Bustamante *et al*., 2011; Shetti *et al*., 2011; Staka *et al*., 2013; Lakshmi *et al*., 2015; Bustamante *et al*., 2016). Facial measurements have been exhaustively detailed due to the quantity of bone structures and landmarks that the anatomical face has. In addition, these measurements provide a huge variety of information that can be used in different medical-surgical specialisations. However, the lack of literature that links facial biotype and cephalic biotype makes it possible to carry out this study, mainly based on different biotypes of individuals in distinct demographic areas. In accordance with the above, the present research aims to study observationally and descriptively the CI and FI between categories of individuals in a population of dental students from a private university in Santiago de Chile.

MATERIAL AND METHOD

The sample was randomly selected and in a non-probabilistic way. It included 129 students, 82 females and 47 males, from the Universidad Andrés Bello Faculty of Dentistry in Santiago, Chile, between 2021 and 2022. The participants met the inclusion criterion suggested by the investigation group. This empirical, descriptive, and cross-sectional study was approved by the Universidad Andrés Bello Ethics Committee. Prior to the participation in this study, participants voluntarily and without any type of incentive or conflict of interest signed an informed consent validated by the investigation group and the Ethics Committee.

Inclusion criterion were, being a student at Universidad Andrés Bello, being between 18 and 21 years of age, male or female. Participants with congenital craniofacial anomalies and/or with pathological craniofacial alterations, caused by trauma or surgery, were excluded because this could lead to alterations in the reported data from measurements and possible comparisons. CI was calculated in millimetres by measuring the maximum length of the head in the axial plane, from the craniometric point glabella to inion (Gb-In), specifically, the space between the eyebrows to external occipital protuberance was used as reference, with a breadth caliper. A Vernier caliper was used to obtain the maximum width, from left eurion to right eurion (El-Er), i.e., from one parietal eminence to the other, With these measurements CI was calculated using the following equation: CI = El-Er/Gb-In × 100, and the results were classified according to Retzius as follows: brachycephalic (>80), mesocephalic (75-80), and dolichocephalic (<75). FI was calculated in millimetres by measuring the maximum height of the anatomical face, from nasion to gnathion (Na-Gn), and the maximum width, from right zygion to left zygion (Zr-Zl), both measured with a vernier caliper. With these measurements FI was calculated using the following equation: FI = Na-Gn/Zr-Zl × 100, and the results were classified according to Companioni *et al*. (2010) as follows: euryprosopic (<97), mesoprosopic (97-104) and leptoprosopic (>104) (Fig. 1), all this measurement was taken by one observer.

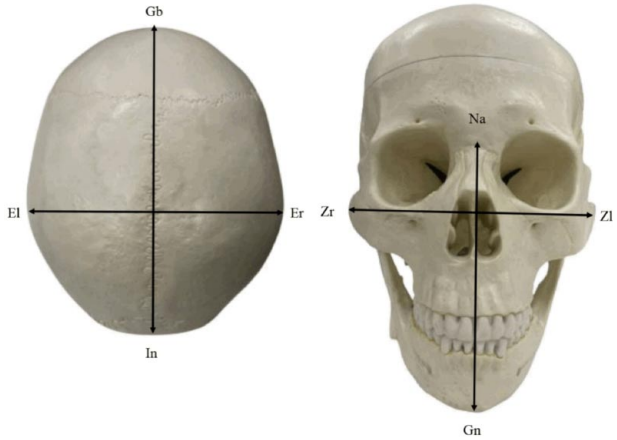

Fig. 1. Left: Top view of the craniometric points used to calculate CI in a plastic cranium for easy recognition of the measurements. Cranium length measured anteroposteriorly from glabella (Gb) to inion (In), and width measured laterolaterally from left eurion (El) to right eurion (Er). Right: Front view of the craniometric points used to calculate FI in a plastic cranium. Facial height measured from gnathion (Gn) to nasion (Na), and width from right zygion (Zr) to left zygion (Zl).

The data was tabulated in STATA and distributed according to participant's sex. Through frequency tables the distribution of cephalic and facial indices was observed. Information was stratified by sex. Chi-squared test was used to value the relation between both indices, which will indicate if the relation exists or not. Whereas to evaluate the degree of association, considering a statistical significance level of 0.05 ($p<0.05$).

RESULTS

The sample of this study included 129 participants who met the inclusion criterion defined by the investigation group, aged between 18 and 21 years old (mean = 19.13 years old; SD = 0.995). Regarding measurements for females, obtained CI data showed that, from a total of 82 students, 2 individuals were classified as dolichocephalic (2.44 %), 32 individuals as mesocephalic (39.02 %), and 48 individuals as brachycephalic (58.54 %) **(Fig. 2)**. Females mean CI was 81.49 corresponding to a brachycephalic classification (Table I). Whereas for female FI, 11 individuals were classified as leptoprosopic (13.41 %), 22 individuals as mesoprosopic (26.83 %), and 49 individuals as euryprosopic (59.76 %) (Fig. 2). Females mean FI was 95.86, corresponding to euryprosopic (Table II).

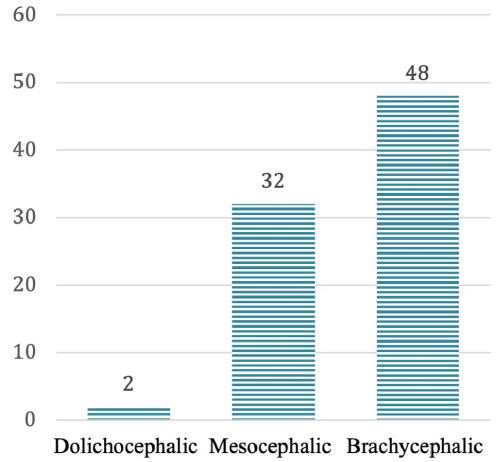

Fig. 2. Comparison between CI (left) and FI (right) results in females.

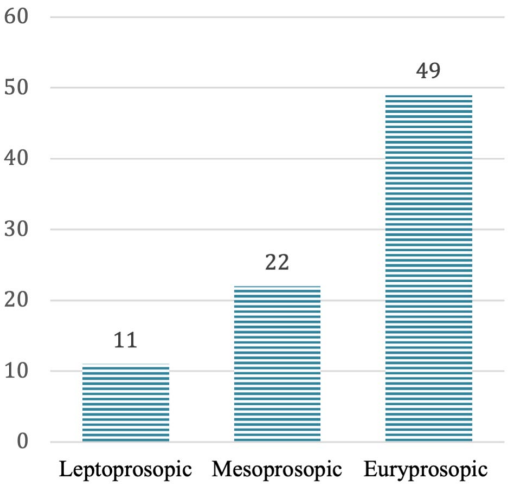

Fig. 3. Comparison between CI (left) and FI (right) results in males.

Regarding males, registered CI data showed that, from a total of 47 students, 3 individuals were classified as dolichocephalic (6.38 %), 27 individuals as mesocephalic (57.45 %), and 17 individuals as brachycephalic (36.17 %) (Fig. 3). Males mean CI was 79.56, corresponding to a mesocephalic classification, but close enough to brachycephalic (Table I). Whereas for male FI, 5 individuals were classified as leptoprosopic (10.64 %), 14 individuals as mesoprosopic (29.79 %), and 28 individuals as euryprosopic (59.57 %) (Fig. 3). Males mean FI was 95.46, corresponding to euryprosopic (Table II).

Table I. Numeric distribution of Cephalic Index.

Sex	Mean	Median	SD	Minimum	Maximum
Female	81.49	81.16	3.82	72.58	88.82
Male	79.55	79.48	3.88	72.05	91.32

Table II. Numeric distribution of Facial Index.

Sex	Mean	Median	SD	Minimum	Maximum
Female	95.86	94.78	7.69	78.51	115.88
Male	95.46	94.21	7.50	78.78	116.34

The box plot indicates that regarding female CI, only 1 participant was classified as an outlier, with a value of 93.41. Outliers are individuals who are not outside the average, but outside the three categories we used in our study: brachiocephalic, mesocephalic and dolichocephalic. This was not the case for FI in which all samples were within the expected range; therefore, no outliers were found. On the other hand, regarding male CI, 2 participants were classified as outliners, with values of 89.20 and 91.33. Likewise, all the samples for male FI were within the expected range; therefore, no outliers were found (Fig. 4).

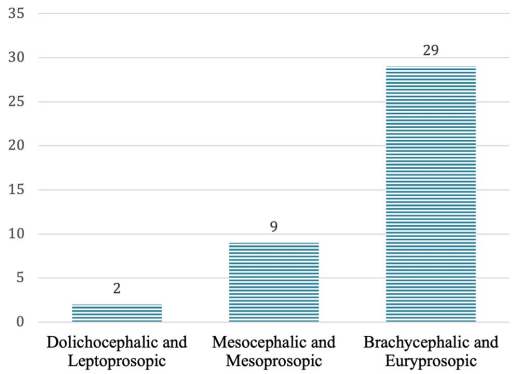

Fig. 4. Box plot of obtained values grouped in quartiles showing outliers. CI is coloured blue, and FI is coloured green for both sexes. Circles symbolise outliers for each index.

In the individual analysis for each female participant, from a total of 82 individuals, only 40 of them (48.8 %) presented a concordance between CI and FI, i.e., mesocephalic corresponded to mesoprosopic, and the same with all the other categories (Fig. 5). Hence, chi-squared test result was 0.007 (lower than 0.05), which indicates the existence of relation between both indices (Table III). No concordance was found between the characteristics of facial and cephalic indices of the rest of the female participants. Likewise, in the individual analysis for each male participant, from a total of 47 individuals, only 17 of them (36.17 %) presented a concordance between CI and FI (Fig. 6). This means that 63.83 % of male individuals, i.e., almost two thirds, no concordance was found between CI and FI characteristics. Regarding chi-squared test, values were 0.69 (higher than 0.05), which indicates there is no relation between both indices (Table III). Additionally, the total of the studied population, males, and females, were analysed, where chi-squared test was 0.233 (higher than 0.05) demonstrating that there is no relation between both indices in the total population studied.

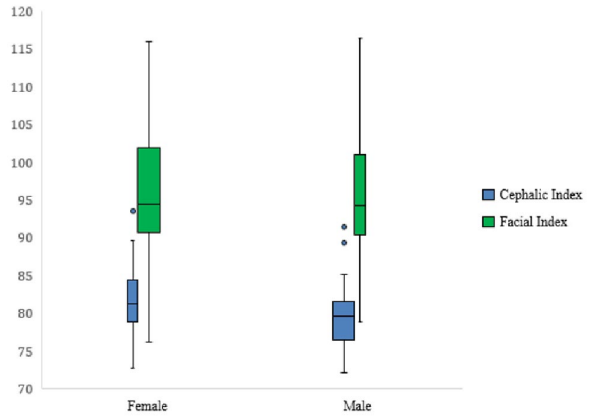

Fig. 5. Female students with concordance between CI and FI.

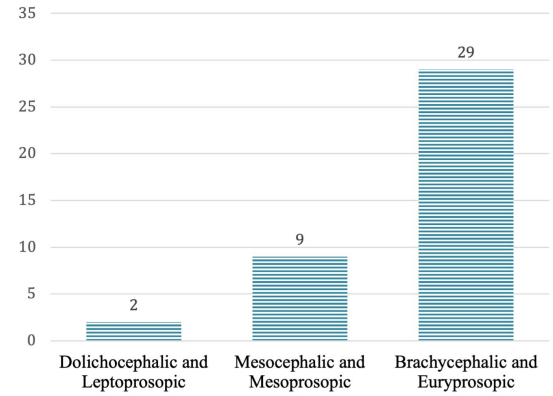

Fig. 6. Male students with concordance between CI and FI.

DISCUSSION

The data obtained in this investigation showed that the prevalence in both male and female IF is euryprosopic classification. Regarding CI, the most prevailing category for females was brachycephalic and for males was mesocephalic. If we compare these results with the ones from Bustamante *et al*. (2011), we can only find concordance between the percentages of the individuals classified as mesocephalic. Concerning the differences between males and females, this study was not exactly conclusive since our sample was heterogenic in relation to the distribution of sex of the included individuals. Clinical and anthropometric implications of these cranial measurements have been studied and associated in different conditions. It is reported that knowing the cranial index is useful for craniosynostosis surgeries, which affects the right close of the sutures in children because it does not allow the encephalon to expand correctly within the cranial vault. Regarding this condition, it is important to know the craniometrical and facial

Table III. Relation between Cephalic Index and Facial Index.

		Facial classification				Chi-squared
Sex		Euryprosopic	Leptoprosopic	Mesoprosopic	Total	
Female	Brachycephalic	28	7	13	48	
	Dolichocephali	0	2	0	2	
	Mesocephalic	21	2	9	32	
	Total	49	11	22	82	0.007
Male	Brachycephalic	10	2	5	17	0.69
	Dolichocephali	1	0	2	3	
	Mesocephalic	17	3	7	27	
	Total	28	5	14	47	
Total	Brachycephalic	38	9	18	65	0.233
	Dolichocephali	1	2	2	5	
	Mesocephalic	38	5	16	59	
	Total	77	16	36	129	

characteristics of an individual because children's cranium shape differ from adult's developed skulls. Also, it is recommended to know the anthropometric characteristics of parents to better address distances and proportions of surgical joining and positioning. Literature suggests conducting this type of surgery at a young age to avoid ossification problems, so knowing these characteristics is important for decision making or careful handling of surgeries or for conservative handling of the pathology (Al-Shaqsi *et al*., 2019; Zhou *et al*., 2020; Frostell *et al*., 2021).

Cephalometry is also useful for forensic and anthropometric measurements in the processes of corpse identification, bodies that have suffered some type of traumatic death, or death by burning causing calcination and alteration in face recognition (Priyadharshini *et al*., 2018). Other important considerations are aesthetic or reconstructive facial surgeries due to congenital malformations or certain type of trauma that could disrupt the joint position or the shape of certain bone structures of the viscerocranium or neurocranium. As a result, these measurements are important for an early diagnosis or for a conservative or surgical treatment planning. Besides, knowing these craniometric characteristics is important to conduct zygomatic bone surgeries or malarplasty since this bone can be partially removed or, on the contrary, augmented in size. Post-operative measurements are needed to evince changes in the facial proportions proposed before surgery (Li *et al*., 2015). The modifications in the aesthetic parameters of facial proportions may vary according to ethnicity and the patient's personal desire of the wanted aesthetic result. However, it is difficult to predict the reactions soft tissue may have in the treated areas due to the procedure (Kolte *et al*., 2020). Therefore, facial plastic surgeons must recognise these indices and name which are the best alternatives for the patient according to his or her congenital and ethnical facial characteristics (Dhir *et al*., 2013; Yang *et al*., 2020). The present study carried out with dentistry students from private universities is a mestizo group. Nevertheless, the study carried out by del Sol (2006) with individuals belonging to the Mapuche ethnic group, our data are similar, therefore, the mestizo population studied is consistent with the Mapuche population. Finally, it is important for dental surgeons to know these craniometric characteristics because there is a relation between FI, gingival thickness and anterior teeth angulation, in both the maxilla and the mandible, which is crucial for repair surgeries or extractions of dental pieces (Kolte *et al*., 2020).

Within the limitations we stated, although it is reported that these examinations in vivo are useful to characterise cranial anthropometric measurements, it is tedious to perform them regularly in clinic due to time and instrument costs for each examined individual. With regard to the foregoing, the literature describes other more effective methods related to both aforementioned variables, for example, 3D anthropometric examination through Cone Beam (CBCT), which has demonstrated to be efficient and to have almost no margin of error in its measurements (Wang *et al*., 2020; Oz *et al*., 2011; Van Vlijmen *et al*., 2009), so this opens the door to new research on 3D cephalometry. Regarding other studies, which analysed anthropometric characteristics in the facial and cranial area, our study differs from others mainly because the facial and cephalic characteristics were analysed individually to demonstrate the existence of a relation between both variables. In addition, sample variation can be directly associated to miscegenation between native people and colonists during the 18th century, which differs from the following studies: Khatun's study showed that the prevailing characteristic was dolichocephalic (Khatun, 2018); in the study of Muralidhar *et al*. (2021), dolichocephalic was the prevailing FI characteristic, and Koizumi *et al*. (2010) showed that brachycephalic was the prevailing characteristic of its population. It should be noted that all these studies had samples of Japanese or pure indigenous ancestry. In the study of Muralidhar *et al*. (2021), leptoprosopic was the prevailing characteristic for FI. In del Sol (2006) study, concluded that the total mean FI had mesoprosopic characteristics with a tendency towards euryprosopic. In our study, mean FI was classified as euryprosopic, which, even though conducted within Chilean population, differs from the aforementioned study because our sample was not from native people, but from a mixed-ancestry population. The previous classifications may be influenced by the type of classification used, leading to a bias in their description (Shetti *et al*., 2011; Staka *et al*., 2013; Lakshmi *et al*., 2015). This article shows Cephalic and Facial Indices, which in the aforementioned studies were individually and exhaustively described. It is important to individually know these indices, but it is also useful to compare them because in some cases an individual may have concordance between his or her CI and FI, i.e., mesocephalic corresponds to mesoprosopic. Nevertheless, the obtained data in the present investigation evinced that there is concordance between both indices only in females, but not in males nor in the total population studied.

CONCLUSIONS

The present study analysed the relation between FI and CI individually for each participant. Although there are several studies showing the measurements for these indices in different populations, we couldn't find studies relating

both indices individually to establish concordance between them. The established differences between studies conducted within Chilean population are caused by miscegenation due to several migration waves in the continent throughout history. In most studies, people who declared themselves to be from specific ethnicities and not from mixed-ancestry population were analysed. It is important to know these craniofacial characteristics to conduct different reconstructive or aesthetic surgeries or dental treatments, and to plan pre- and post-operative procedures always considering patient's requirements depending on desire, beliefs, and ethnicity.

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RESUMEN: Los seres humanos a lo largo de la historia han mostrado similitudes tanto entre su complexión cefálica como facial, entre ciertos grupos étnicos, debido a factores genéticos y demográficos. Varios estudios han demostrado las diferentes constituciones de grupos específicos de personas para poder generar datos de una determinada población o grupo. La presente investigación tiene como objetivo estudiar preliminarmente la existencia de posibles relaciones entre el Índice Cefálico y el Índice Facial entre categorías de individuos en una población de estudiantes de odontología de una universidad privada de Santiago, Chile, en un estudio empírico, descriptivo y transversal. En este estudio, se tomó como sujetos de forma no probabilística a 129 estudiantes con edades comprendidas entre 18 y 21 años. Respecto al Índice Cefálico (IC), se utilizó la clasificación de Retzius, y el Índice Facial (FI) se midió considerando la altura máxima de la cara, desde nasión hasta gnatión (Na-Gn), y el ancho máximo, desde cigio derecho a izquierdo. cigio (Zr-Zl). En este estudio se tomó como muestra 129 personas, 82 mujeres y 47 hombres. Entre las mujeres, el biotipo cefálico más predominante fue el braquicéfalo (59,8 %), seguido del mesocefálico (37,8 %) y el dolicocéfalo (2,4 %). Por otro lado, el biotipo más común en los hombres fue el mesocefálico (57,5 %), seguido del braquicéfalo (36,2 %) y el dolicocéfalo (6,4 %). Respecto al biotipo facial, tanto en sujetos femeninos como masculinos se mostró el siguiente patrón: euriprosópico (F: 59,7 %, M: 59,6 %), mesoprosópico (F: 26,8 %, M: 29,8 %) y leptoprosópico (F: 13,4 %, M: 10,6 %). Los parámetros faciales de los sujetos (estudiantes de odontología de una universidad chilena) tienden a ser en su mayoría euriprosópicos, seguidos de mesoprosópicos y leptoprosópicos. Además, los biotipos mesocefálicos tienden a ser similares a otros estudios realizados en Chile.

PALABRAS CLAVE: Índice facial; Índice cefálico; Jóvenes chilenos.

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