Original Article

Evaluation of the facial soft tissue thickness in a Brazilian *in vivo* population "facial soft tissue thickness in Brazilians"

Avaliação da espessura de tecido mole facial em uma população brasileira in vivo "a espessura do tecido mole facial em Brasileiros"

MARÍLIA MOURA FREITAS DA-SILVA [1]
GABRIELA GRANJA PORTO [1*]
ANTÔNIO AZOUBEL ANTUNES [1]
EVELYNE PESSOA SORIANO [1]
MARCUS VITOR DINIZ DE-CARVALHO [1]
RAFAEL DE SOUSA CARVALHO SABOIA [1]

Institution: Universidade de Pernambuco, Camaragibe, PE, Brazil.

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■ ABSTRACT

Introduction: Nowadays there is a huge demand for individual identification in both civil and criminal justice fields. There are several ways to identify individuals, depending on whether he is alive or dead (cadaver or skeleton). This research aimed to create a database for facial soft tissue thickness in living individuals of a specific Brazilian population, according to age, sex and body mass index. **Methods:** Measurements of facial soft tissues thickness were done in 101 patients (62 men and 39 women, aged 18 to 106 years). CT scans were performed taking into account 20 craniometric points previously selected. The soft tissue thickness in these points were initially found and compared with age, sex and nutritional status, and with another populations data worldwide. **Results:** According about sex was no significant difierence in points: nasion, rhinion, midphiltrum, supradentale and lateral orbit. Distances with significant difference for both sexes between the diferent populations were: supradentale; infradentale; supramentale; lateral orbit; zygomatic arch and occlusal line. Some anthropometric points showed significant differences between sex, age groups and nutritional status. Between sexes, men had greater means. Among age groups, there was also significant differences in some distances. In relation to nutritional status, the distances were lower among normal weight and higher among the obese. **Conclusion:** When considering various populations, soft tissue thickness had significant differences in many craniometric points highlighting how distinct they might be.

Keywords: Forensic anthropology; Forensic medicine; Tomography; Ethnic groups; Image processing, computer- assisted.

[1] Universidade de Pernambuco, Camaragibe, PE, Brazil.

■ **RESUMO**

Introdução: Hoje em dia há uma enorme demanda para identificação individual tanto no campo da justiça civil e criminal. Existem várias maneiras de identificar indivíduos, dependendo se ele está vivo ou morto (cadáver ou esqueleto). Esta pesquisa teve o objetivo de criar um banco de dados para a espessura do tecido mole facial em indivíduos vivos de uma determinada população brasileira, de acordo com idade, sexo e índice de massa corporal. **Métodos:** medições da espessura de tecidos moles faciais foram realizadas em 101 pacientes (62 homens e 39 mulheres, com idade entre 18 e 106 anos). TC foi realizado tendo em conta 20 pontos craniométricos selecionados previamente. A espessura dos tecidos moles nestes pontos foram inicialmente medida e comparada com a idade, sexo e estado nutricional e com dados de outras populações em todo o mundo. **Resultados:** De acordo com o sexo não houve diferenças significativas nos pontos: násio, rínion, meio do filtro labial midphiltrum , supradentale, e órbita lateral. Distâncias com diferenças significativa para ambos os sexos entre as diferentes populações foram: supradentale; infradentale; supramentale; órbita lateral; arco zigomático e linha oclusal. Alguns pontos antropométricos mostraram diferenças significativas entre sexo, faixa etária e estado nutricional. Entre os sexos, os homens apresentaram médias maiores. Entre os grupos etários, houve também diferenças significativas em algumas distâncias. Em relação ao estado nutricional, as distâncias foram menores entre peso normal e maior entre os obesos. **Conclusão:** Ao considerar várias populações, a espessura do tecido mole mostrou diferenças significativas em muitos pontos craniométricos destacando como eles podem ser distintas.

Descritores: Antropologia forense; Medicina legal; Tomografia computadorizada; Grupos étnicos; Processamento de imagem assistida por computador.

INTRODUCTION

There are many ways to identify an individual, depending on whether he is dead or alive. Thus, more specifically for the identification of human skeletal remains, a variety of methods can be used such as DNA analysis and teeth X- rays[1,2]. Although these methods provide valuable information for forensic scientists in relation to age, sex and body size of the dead, many of them may not be useful.

They depend on the availability of a comparative material, either from police database, dentists or relatives, which can make identification impossible[1,3]. Facial reconstruction is the last process when identification methods have failed[2]. Based on average values of facial soft tissue thickness obtained in particular populations is possible to obtain an image of an unknown dead, that may allow recognition of an individual.

Detailed information obtained from physiological and osteological analysis of remains such as sex, age, and thickness of soft tissue in a specific population can promote the success of an identification. Data on the soft tissue thickness represent an integral part of the paths to obtain similarity of a face[4], assuming that cranial morphology is sufficiently distinct and provides an efficient framework for a single facial appearance even when applying average values of soft tissue thickness.

Recently, the number of studies on this subject has increased. Many established methods measure thickness of soft tissues. To this end, some studies used cadavers inserting a calibrated needle in distinct points of the face[5-8]. Some imaging techniques, used in living people, can minimize the error caused by the soft tissue post-mortem changes when these studies are in cadavers. Taking into consideration that each of these techniques have their own advantages and disadvantages, it can be cited the following: radiography[9-13], ultrasound[3,14-19], magnetic resonance imaging[2,20,21], and computed tomography[1,22,23].

Furthermore, previous studies have shown that different groups present significant variation in soft tissue thickness, questioning whether data of a population may be applied in facial reconstruction of another with different ancestry[2,7,10,11,16,24]. For this reason, for obtaining an accurate facial reconstruction, construction of a database on soft tissue thickness of a particular population is required.

There are available data published in literature on soft tissue thickness *in vivo* among Japaneses[25], Portugueses[8], Egyptians[16], Indians[21], Zulus[15], mixing of populations of South Africa[23], African-americans[26] and Greek[14]. Nevertheless, for the Brazilian population there are studies only on cadavers[9].

OBJECTIVE

This study intends to compose a database for determining soft tissue thickness and begins with this pilot study, aiming a future facial three- dimensional reconstruction of Brazilians to apply in recognition of skeletal remains as well as to compare its results with other populations worldwide.

METHODS

The sample was estimated using the PC-SIZE 1.1 program (1990) by making use of data source with variable similar to the article Panenková et al.[1]. The calculation was based on the craniometric point malar lower in females and males. The mean and standard deviation were used for this calculation. This variable had a significant difference in the study and leaded to a larger sample compared to other craniometric points also with significant differences. The total number of patients was 101, with 0.90252 of power analysis and considering a 0.05 significance level.

This cross-sectional pilot research studied in a Brazilian North Eastern Population, most precisely in Recife, state of Pernambuco. The sample comprised of 101 patients' images, who sought the radiological clinic of the University Hospital Oswaldo Cruz/ University of Pernambuco over a period of six months. For this reason, patients have not been exposed to radiation only for research. Exclusion criteria were patients with indications of trauma, congenital facial disorders, skin edema, previous surgery or artifacts in CT. Participation was voluntary.

The variables considered were sex, age, height and weight of each person, they were collected at the same time of CT examination. The following formula calculated body mass index (BMI): weight/height^2 (kg/m^2). According to others studies[3,8,26], four BMI ranges were considered: thin (BMI < 20); normal weight (BMI = 20-25); over weight (BMI > 25). Ages were arranged into age groups 18-39, 40-59 and 60 years old or more.

In this research, measurements of soft tissue were performed on 20 skull anthropometric points (Table 1 and Figure 1). Many of which are standard points most commonly used in the studies found in the literature[22,26-28], ten are in the midline and ten are bilateral. For anthropometric convention, only midline points and the left ones were considered.

A multi-slice computed tomography / GE 4-channel with a thickness of 1.25 mm and slice increment of 1 mm were used in the study, which can provide sectional images in three planes and a three-dimensional object. The images were displayed on InVesalius 3.0 program that provided an adjustment of the position and orientation of head plans and shows skull and surface of the superimposed face.

Measurements were taken perpendicularly to craniometric points according to Vanezi et al.[29]). The length of facial soft tissue thickness was measured by drawing a line perpendicular to a facial skeleton point towards the soft tissue (Figure 2). The measurements were performed on the monitor using a CT console cursor, with an accuracy of 0.01 mm. All data were recorded on appropriate forms. Points' description is presented in Table 1 and Figure 1.

The results were expressed in percentages and statistical measures: mean, standard deviation and median. Categories of independent variables in relation to the means were compared using Student t test with equal variances, t-test with unequal variances or Mann-Whitney test in the case of comparison between two categories. F (ANOVA) or Kruskal-Wallis tests were adopted when comparing more than two groups.

In the event of a difference using F test (ANOVA) it was used the paired LSD type for multiple comparisons. And when it was observed significant difference using the Kruskal-Wallis, test multiple comparisons of that test were performed. T-Student test and F (ANOVA) was chosen when there was normal distribution of data in each category.

Mann-Whitney and Kruskal-Wallis tests were used in cases of normality rejection. Shapiro-Wilk test was used to verify the normality of the hypothesis. The assumption of variances equality was performed using F Levene test. The margin of error used was 5%. Data were entered in EXCEL spreadsheet and programs for statistical calculations such as the SPSS® (Statistical Package for Social Sciences version 21.0) and MedCalc® (in version 12.5.0.0) were used.

After that, the results found in the Brazilian population was compared to others populations worldwide that used the same methodology. The following countries: Colombia[27], Korea[28], Africa[23], China[22] and Slovakia[1] conducted these studies. T-Student test was used in order to compare the data between these populations. The same margin of error was used (5%).

Table 1. Description of craniometric points considered in this study (Tedeschi-Oliveira et al.[8]; Dong et al.[22]).

Medium-sagittal Points	Description
1. Supra-glabella	The most anterior point of the forehead, above the glabella in the midsagittal plane
2. Glabella	The most prominent point between the supra orbital ridges in the midsagittal plane
3. Nasion	Midline point on the internasal suture
4. Rhinion	The anterior tip of the nasal bones
5. Midphiltrum	Midline of the maxilla, placed as high as possible before the curvature of the anterior nasal spine begins
6. Supra dentale	Centered between the maxillary central incisors at the level of the cementum–enamel junction
7. Infra dentale	Centered between the mandibular central incisors at the level of the cementum–enamel junction
8. Supra mentale	Deepest midline point in the groove superior to the mental eminence
9. Pogonion	Most anterior midline point on the mental eminence of the mandible
10. Menton	Most inferior midline point at the mental symphysis of the mandible
Bilateral points	
11. Supra-orbital	Centered upper part of the margin of the orbit
12. Infra-orbital	Centered lower part of the margin of the orbit
13. Lateral orbit	Lined up with the lateral border of the eye on the center of the zygomatic process
14. Inferior Malar	Lower part of the jaw
15. Zygomatic arch	Zygomatic arch the most lateral point of the zygomatic arch
16. Supra-glenoid	Root of the zygomatic arch just before the ear
17. Gonion	Point located on the jaw line at the level of the angle between the posterior and the inferior borders of the mandible
18. Supra M2	Point located on the alveolar process at the level of the middle of the second upper molar (if this tooth loss, the point is placed in the corresponding area)
19. Occlusal line	Point located on anterior margin of the ramus of the mandible, in alignment with the plane of dental occlusion
20. Sub M2	Point located on the alveolar process at the level of the middle of the second lower molar (if this tooth loss, the point is placed in the corresponding area).

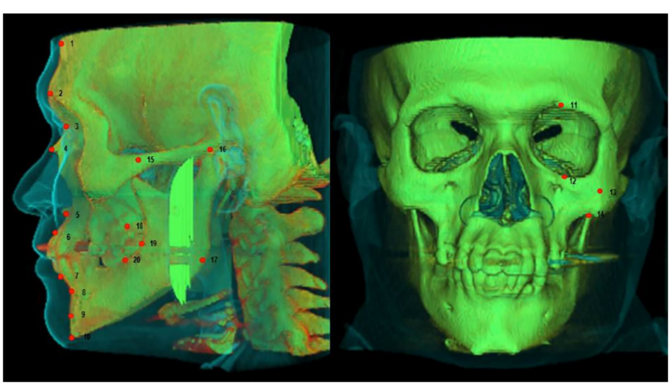

Figure 1. Craniometric points.

RESULTS

Table 2 presents data on sample characteristics. This table stands out that: the mean age was 39,30 years; the distribution by sex with men 61.4% and women 38.6%, the mean weight, height, and BMI were correspondingly 69.90 kg, 1,68 meters and 24,82; the two highest percentages corresponded to those normal weight (57,4%), reported overweight (35.6%) and the lowest to underweight (7%).

With the exception of the distances: lateral orbit, zygomatic arch; supra- glenoid; gonion and supra M2 that had higher averages in females than in males. For the others, the average measures were correspondingly higher in males. However, there is significant differences between the sexes ($p<0.05$) in the distances nasion, rhinion, midphiltrum, supradentale and lateral orbit (Table 3).

There were significant differences between categories of nutritional status for the measures: glabella; nasion; pogonion; menton; supraorbital; lateral orbit; inferior malar; supraglenoid; supra M2; occlusal line; sub M2 (Table 4). Most means grew with the category of nutritional status, with higher measurements among overweighed patients.

Tables 5 and 6 show results found in Brazilians compared to the ones in other populations. Table 5 shows several distances with significant differences ($p < 0.05$) when considering males of each country: Colombians had nine distances; Koreans had

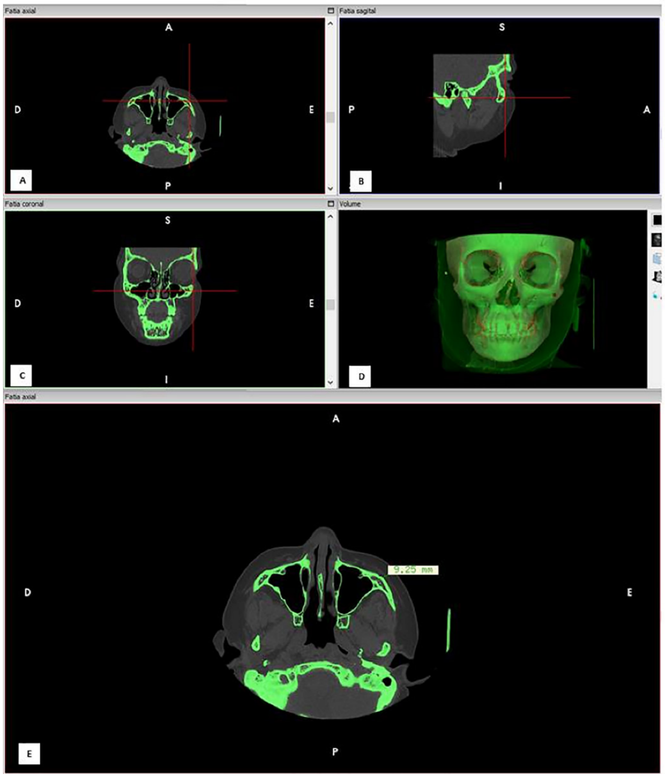

Figure 2. A: Positioning an anatomical landmark: lateral orbit point (D13) in axial axis; **B:**Positioning an anatomical landmark: lateral orbit point in sagittal axis; **C:** Positioning an anatomical landmark: lateral orbit point in coronal axis; **D:** Checking the correct point position; **E:** Making measurement of soft tissue thickness.

Table 2. Sample characterization.

Variable	Total Group
TOTAL	101 (100.0)
• Age: Mean ± SD	39.30 ± 17.61 (36.00)
• Age group: n (%)	
18-39	58 (57.4)
40-59	31 (30.7)
60 or more	12 (11.9)
• Sex: N (%)	
Male	62 (61.4)
Female	39 (38.6)
• Weight: Mean ± SD	69.90 ± 10.78 (69.00)
• Height: Mean ± SD	1.68 ± 0.07 (1.68)
• BMI: Mean ± SD	24.82 ± 3.21 (24.44)
• BMI rated: n (%)	
Normal weight (18.50 a 24.99)	58 (57.4)
Over weight (25.00 a 29.99)	36 (35.6)
Obesity (≥ 30)	7 (7.0)

Sample characterization.

seventeen; Slovaks had thirteen; Africans had sixteen and Chinese had eleven distances. Table 6 shows also many distances with significant differences when considering females: Colombians had ten distances; Koreans had twelve; Slovaks had nine; Africans had eleven and Chinese had eight distances.

Table 7 shows the differences between individuals overweighed of Brazil, China and Colombia. It shows significant differences in 10 points in Chinese males, nine in Colombian males and 4 in Chinese females.

DISCUSSION

Demands in civil and criminal areas involving corpses or skeletons' identification are enormous. For this reason, the process by which it determines a person's identity is crucial in trying to prove that a dead individual is really himself. For this facial reconstruction may be used when other identification methods have failed[2]. An image of the unknown dead is obtained based on average values of facial soft tissue thickness obtained in particular populations that can allow the recognition of an individual.

This study evaluated soft tissue thickness among a Brazilian population, based in predefined craniometric points using CT scans, aiming to create a population data for future facial reconstructions for identification of skeletal remains. This is important because variations between different populations may be found and may interfere in these reconstructions.

This research found three points presenting higher soft tissue thickness: supra M2, occlusal line and sub-M2. The points that showed smaller thickness were located in the frontal bone (supraglabella, glabella, nasion) and the nose region (rhinion). The rhinion point was the thinner. In agreement to the population compared in this study Colombian[27], Korean[28], Slovak[1], African[23] and Chinese[22], the greatest thickness of the soft tissue in these populations were also in the cheek region and the narrowest in the forehead and nasal root area.

Therefore, this is the only agreement in view of finding several distances with significant difference when comparing them. The distances found to be different with a $p < 0.05$ in almost all populations were rhinion; supradentale; infradentale; supra orbital; inferior malar and zygomatic arch. For over weighted individuals the distances found to be different were rhinion; supradentale; infradentale; infra orbital; lateral orbit and oclusal line.

In this study, female's distances in points such as lateral orbit, zygomatic arch; supra-glenoid;

Table 3. Statistics of the averages of the distances according to sex.

Distances (D_i)	Sex			
	Male Mean ± SD (median)	Female Mean ± SD (median)	*p* Value	Distances (D_i)
• Supra-glabella	4.34 ± 1.20 (4.13)	4.10 ± 1.17 (4.17)	4.25 ± 1.19 (4.16)	$p^{(1)} = 0.528$
• Glabella	4.92 ± 1.40 (5.03)	4.82 ± 1.35 (4.61)	4.88 ± 1.38 (4.88)	$p^{(2)} = 0.733$
• Nasion	6.12 ± 1.91 (6.15)	5.19 ± 1.55 (5.09)	5.76 ± 1.83 (5.81)	$p^{(1)} = 0.011$*
• Rhinion	4.73 ± 2.40 (4.12)	3.20 ± 1.96 (2.71)	4.14 ± 2.35 (3.42)	$p^{(1)} < 0.001$*
• Midphiltrum	14.29 ± 2.69 (13.94)	11.32 ± 2.68 (11.46)	13.14 ± 3.04 (13.30)	$p^{(2)} < 0.001$*
• Supradentale	11.81 ± 2.34 (11.94)	9.16 ± 2.26 (8.73)	10.79 ± 2.64 (10.50)	$p^{(2)} < 0.001$*
• Infradentale	10.29 ± 2.70 (10.00)	9.65 ± 2.11 (9.48)	10.05 ± 2.50 (9.72)	$p^{(1)} = 0.178$
• Supramentale	12.33 ± 2.38 (12.25)	11.58 ± 2.45 (11.80)	12.04 ± 2.42 (12.13)	$p^{(2)} = 0.133$
• Pogonion	11.10 ± 2.65 (11.26)	10.44 ± 2.64 (10.00)	10.84 ± 2.65 (10.80)	$p^{(2)} = 0.228$
• Menton	7.23 ± 2.73 (6.75)	6.93 ± 2.72 (6.49)	7.11 ± 2.72 (6.61)	$p^{(1)} = 0.725$
• Supra-orbital	6.34 ± 1.86 (6.19)	6.23 ± 1.77 (6.20)	6.29 ± 1.82 (6.19)	$p^{(2)} = 0.773$
• Infra-orbital	6.38 ± 2.46 (5.80)	5.83 ± 2.18 (5.29)	6.16 ± 2.36 (5.67)	$p^{(1)} = 0.289$
• Lateral orbit	7.20 ± 2.33 (7.06)	8.81 ± 2.99 (8.65)	7.82 ± 2.71 (7.42)	$p^{(3)} = 0.006$*
• Inferior malar	12.66 ± 3.73 (12.11)	12.25 ± 4.71 (11.67)	12.50 ± 4.12 (11.95)	$p^{(1)} = 0.443$
• Zygomatic arch	7.29 ± 2.52 (7.47)	8.53 ± 3.06 (7.64)	7.77 ± 2.79 (7.57)	$p^{(1)} = 0.078$
• Supra-glenoid	10.26 ± 3.84 (10.07)	10.96 ± 3.78 (11.53)	10.53 ± 3.81 (10.36)	$p^{(2)} = 0.377$
• Gonion	16.00 ± 6.38 (15.37)	18.02 ± 6.98 (18.08)	16.78 ± 6.66 (15.85)	$p^{(1)} = 0.198$
• Supra M2	27.32 ± 5.77 (27.30)	28.12 ± 6.24 (28.95)	27.63 ± 5.94 (27.86)	$p^{(2)} = 0.515$
• Occlusal line	23.11 ± 4.42 (23.49)	22.39 ± 4.52 (22.29)	22.83 ± 4.45 (23.03)	$p^{(1)} = 0.220$
• Sub M2	23.12 ± 4.84 (23.38)	22.27 ± 5.46 (21.95)	22.79 ± 5.08 (22.87)	$p^{(2)} = 0.416$

(*): Significant difference at 5.0%; (1): Student's *t* test with unequal variances; (2): Student t-test with equal variances; (3): Mann-Whitney test.

Table 4. Statistics of the average distance according to age.

Distances (D_i)	Age group			*p* value
	up to 39 Mean ± SD (median)	40-59 Mean ± SD (median)	60 or more Mean ± SD (median)	
• Supra-glabella	4.19 ± 1.31 (4.08)	4.37 ± 1.02 (4.40)	4.23 ± 1.07 (4.03)	$p^{(1)} = 0.801$
• Glabella	4.60 ± 1.35 (4.64)	5.29 ± 1.30 (5.49)	5.18 ± 1.50 (4.59)	$p^{(1)} = 0.056$
• Nasion	5.59 ± 1.76 (5.51)	6.22 ± 1.96 (6.06)	5.37 ± 1.74 (5.25)	$p^{(2)} = 0.213$
• Rhinion	3.98 ± 2.37 (3.20)	3.89 ± 1.62 (3.64)	5.56 ± 3.40 (4.19)	$p^{(2)} = 0.225$
• Midphiltrum	13.74 ± 2.86 (13.70)$^{(A)}$	12.64 ± 3.11 (13.00)$^{(AB)}$	11.59 ± 3.20 (10.70)$^{(B)}$	$p^{(3)} = 0.043$*
• Supradentale	11.16 ± 2.47 (11.01)	10.52 ± 2.49 (10.50)	9.68 ± 3.55 (8.66)	$p^{(1)} = 0.165$
• Infradentale	9.74 ± 2.54 (9.51)	10.52 ± 2.31 (10.40)	10.28 ± 2.74 (9.86)	$p^{(2)} = 0.228$
• Supramentale	12.15 ± 2.16 (12.20)	11.91 ± 2.16 (11.95)	11.88 ± 4.04 (11.93)	$p^{(1)} = 0.876$
• Pogonion	10.63 ± 2.57 (10.41)	11.26 ± 2.79 (11.78)	10.77 ± 2.77 (11.03)	$p^{(1)} = 0.566$
• Menton	6.43 ± 2.52 (6.02)$^{(A)}$	8.19 ± 2.68 (8.37)$^{(B)}$	7.61 ± 2.93 (7.67)$^{(AB)}$	$p^{(2)} = 0.011$*
• Supra-orbital	5.95 ± 1.62 (5.70)$^{(A)}$	7.11 ± 1.91 (6.69)$^{(B)}$	5.85 ± 1.90 (6.28)$^{(A)}$	$p^{(4)} = 0.010$*
• Infra-orbital	5.63 ± 2.15 (5.24)$^{(A)}$	6.92 ± 2.35 (6.52)$^{(B)}$	6.82 ± 2.86 (6.66)$^{(AB)}$	$p^{(2)} = 0.022$*
• Lateral orbit	7.10 ± 2.34 (6.84)$^{(A)}$	8.84 ± 3.24 (8.47)$^{(B)}$	8.67 ± 1.85 (8.85)$^{(AB)}$	$p^{(5)} = 0.007$*
• Inferior malar	12.12 ± 3.59 (11.88)	13.58 ± 5.06 (13.90)	11.54 ± 3.48 (12.29)	$p^{(2)} = 0.394$
• Zygomatic arch	7.59 ± 2.94 (7.28)	8.24 ± 2.68 (7.66)	7.45 ± 2.31 (7.59)	$p^{(2)} = 0.439$
• Supra-glenoid	9.68 ± 3.52 (9.96)$^{(A)}$	11.92 ± 3.57 (12.09)$^{(B)}$	11.04 ± 4.87 (9.39)$^{(AB)}$	$p^{(1)} = 0.025$*
• Gonion	16.51 ± 6.29 (15.85)	17.75 ± 6.75 (19.4)	15.54 ± 8.28 (12.36)	$p^{(2)} = 0.388$
• Supra M2	26.59 ± 5.47 (26.61)	29.58 ± 5.47 (29.54)	27.57 ± 8.19 (29.03)	$p^{(1)} = 0.076$
• Occlusal line	22.18 ± 4.37 (22.56)	24.17 ± 4.45 (23.68)	22.52 ± 4.43 (21.83)	$p^{(1)} = 0.130$
• Sub M2	23.11 ± 4.52 (23.36)	23.15 ± 5.89 (22.97)	20.35 ± 5.10 (19.65)	$p^{(1)} = 0.207$

(*): Significant difference at 5.0%; (1): Through the Student t-test with equal variances.; 2): Through the Mann-Whitney test.

Table 5. Statistics of the averages of the distances according to according to the nutritional status.

Distances (D_i)	Nutritional status			p value
	Normal weight Mean ± SD (median)	Overweight Mean ± SD (median)	Obesity Mean ± SD (median)	
• Supra-glabella	4.20 ± 1.20 (4.11)	4.19 ± 1.14 (4.14)	4.95 ± 1.27 (4.90)	$p^{(1)} = 0.304$
• Glabella	4.58 ± 1.30 (4.61)$^{(A)}$	5.06 ± 1.34 (5.09)$^{(A)}$	6.45 ± 1.05 (6.51)$^{(B)}$	$p^{(2)} = 0.001$*
• Nasion	5.38 ± 1.68 (5.50)$^{(A)}$	5.91 ± 1.39 (6.02)$^{(A)}$	8.08 ± 3.17 (7.37)$^{(B)}$	$p^{(3)} = 0.001$*
• Rhinion	4.29 ± 2.69 (3.25)	4.07 ± 1.92 (3.85)	3.22 ± 0.93 (3.20)	$p^{(1)} = 0.622$
• Midphiltrum	12.98 ± 3.20 (12.76)	13.31 ± 2.96 (13.73)	13.64 ± 2.30 (13.30)	$p^{(2)} = 0.800$
• Supradentale	10.39 ± 2.76 (10.02)	11.42 ± 2.40 (11.57)	1.85 ± 2.48 (11.00)	$p^{(2)} = 0.185$
• Infradentale	9.88 ± 2.55 (9.54)	10.11 ± 2.62 (9.66)	11.05 ± 0.84 (10.96)	$p^{(1)} = 0.099$
• Supramentale	12.01 ± 2.36 (12.15)	12.16 ± 2.63 (12.04)	11.69 ± 2.09 (12.20)	$p^{(2)} = 0.890$
• Pogonion	9.94 ± 2.42 (9.80)$^{(A)}$	12.06 ± 2.59 (12.32)$^{(B)}$	12.06 ± 1.95 (12.72)$^{(B)}$	$p^{(3)} < 0.001$*
• Menton	6.22 ± 2.47 (5.57)$^{(A)}$	8.14 ± 2.41 (7.96)$^{(B)}$	9.19 ± 3.52 (10.40)$^{(B)}$	$p^{(1)} = 0.001$*
• Supra-orbital	5.82 ± 1.62 (5.85)$^{(A)}$	6.63 ± 1.86 (6.31)$^{(A)}$	8.50 ± 1.24 (8.86)$^{(B)}$	$p^{(3)} < 0.001$*
• Infra-orbital	5.93 ± 2.53 (5.43)	6.28 ± 2.11 (5.84)	7.56 ± 1.77 (7.23)	$p^{(1)} = 0.077$
• Lateral orbit	7.37 ± 2.49 (6.95)$^{(A)}$	8.14 ± 2.93 (7.57)$^{(AB)}$	9.92 ± 2.44 (9.07)$^{(B)}$	$p^{(3)} = 0.041$*
• Inferior malar	11.70 ± 3.76 (10.85)$^{(A)}$	12.89 ± 4.27 (12.17) (A)	17.07 ± 3.20 (16.83)$^{(B)}$	$p^{(1)} = 0.004$*
• Zygomatic arch	7.45 ± 2.68 (7.45)	7.89 ± 2.95 (7.47)	9.78 ± 2.22 (10.86)	$p^{(1)} = 0.070$
• Supra-glenoid	9.70 ± 3.67 (9.89)$^{(A)}$	11.32 ± 3.90 (10.35)$^{(AB)}$	13.31 ± 2.52 (12.17)$^{(B)}$	$p^{(1)} = 0.018$*
• Gonion	16.25 ± 6.64 (15.70)	17.45 ± 6.60 (16.95)	17.66 ± 7.71 (15.08)	$p^{(1)} = 0.623$
• Supra M2	26.28 ± 5.57 (26.49)$^{(A)}$	28.99 ± 6.23 (29.24)$^{(AB)}$	31.77 ± 4.11 (31.90)$^{(B)}$	$p^{(3)} = 0.014$*
• Occlusal line	21.37 ± 4.36 (21.28)$^{(A)}$	24.14 ± 3.54 (23.67)$^{(B)}$	28.15 ± 3.57 (27.07)$^{(C)}$	$p^{(3)} < 0.001$*
• Sub M2	21.71 ± 4.99 (21.23)$^{(A)}$	24.00 ± 5.06 (24.90)$^{(B)}$	25.48 ± 3.85 (24.13)$^{(B)}$	$p^{(4)} = 0.035$*

(*): Significant difference set at 5.0%; (1): F (ANOVA) test; (2): Kruskal Wallis test comparisons of that test. Obs: If all the letters in parentheses are distinct is proved significant difference between the corresponding nutritional status categories.

Table 6. Comparison between values of Brazilian males and other populations (Colombian, Corean, Slovak, African, Chinese).

Distances	Brazilian♂		Colombian[2]♂	Korean[3]♂	Slovak[4]♂	African[5]♂	Chinese[6]♂
	Mean	DP	P value$^{(1)}$	P value$^{(1)}$	P value$^{(1)}$	P value$^{(1)}$	P value$^{(1)}$
Supra-glabella	4.4	1.2	**	<0.001*	<0.001*	<0.001*	0.076
Glabella	4.6	1.2	**	0.035*	<0.001*	0.002*	0.987
Nasion	6.0	1.7	0.001*	0.248	<0.001*	< 0.001*	0.898
Rhinion	5.2	2.8	<0.001*	< 0.001*	<0.001*	<0.001*	<0.001*
Midphiltrum	14.7	2.6	0.424	<0.001*	0.010*	<0.001*	<0.001*
Supradentale	11.7	2.6	0.936	0.704	0.001*	<0.001*	<0.001*
Infradentale	10.1	2.6	0.003*	<0.001*	**	0.706	<0.001*
Supramentale	12.5	2.1	0.932	0.019*	**	0.279	<0.001*
Pogonion	10.2	2.4	**	0.001*	**	<0.001*	0.773
Menton	6.3	2.5	<0.001*	0.030*	**	0.076	0.106
Supra-orbital	5.9	1.5	0.026*	0.001*	<0.001*	0.001*	0.001*
Infra-orbital	6.3	2.8	0.011*	0.002*	0.051	0.231	0.072
Lateral orbit	7.0	2.4	0.031	<0.001*	<0.001*	0.322	<0.001*
Inferior malar	11.9	3.0	<0.001*	<0.001*	<0.001*	< 0.001*	**
Zygomatic arch	7.1	2.5	0.039*	0.014*	<0.001*	<0.001*	0.001*
Supra-glenoid	9.4	3.7	0.207	<0.001*	<0.001*	0.020*	0.034*
Gonion	15.9	6.9	0.475	0.040*	**	0.030*	0.052
Supra M2	26.4	5.5	0.007*	0.112	<0.001*	< 0.001*	0.325
Occlusal line	21.9	4.6	0.220	0.710	<0.001*	<0.001*	0.001*
Sub M2	23.0	4.9	0.194	0.002*	**	< 0.001*	<0.001*

(*): Difference significant at 5%; (**): Value not available in the study; (1): Using t-Student Test; (2) Perlaza (2013); (3) Hwang et al. (2012); (4) Panenková et al. (2012); (5) Philips, Smuts (1996); (6) Dong et al. (2012).

Table 7. Comparison between values of Brazilian females and other populations (Colombian, Corean, Slovak, African, Chinese).

Distances	Brazilian♀		Colombian[2]♀	Korean[3]♀	Slovak[4]♀	African[5]♀	Chinese[6]♀
	Mean	DP	*P* value[(1)]	*P* value[(1)]	*P* value[(1)]	*P* value[(1)]	*P* value[(1)]
Supra-glabella	3.9	1.1	**	0.001*	0.011*	< 0.001*	0.523
Glabella	4.5	1.4	**	0.032*	0.003*	0.001*	0.886
Nasion	4.6	1.3	<0.001*	0.401	<0.001*	0.149	0.001*
Rhinion	3.0	1.9	0.003*	0.003*	0.001*	0.213	0.164
Midphiltrum	10.8	2.6	<0.001*	0.156	0.016*	0.007*	0.146
Supradentale	8.6	1.9	0.008*	0.049*	<0.001*	<0.001*	<0.001*
Infradentale	9.6	2.5	0.012*	<0.001*	**	< 0.001*	<0.001*
Supramentale	11.4	2.5	<0.001*	0.001*	**	0.770	0.001*
Pogonion	9.6	2.5	**	0.001*	**	0.054	0.513
Menton	6.1	2.5	<0.001*	0.945	**	0.330	0.617
Supra-orbital	5.7	1.8	0.960	0.547	0.001*	0.140	0.072
Infra-orbital	5.4	2.1	0.194	<0.001*	0.008*	0.109	0.053
Lateral orbit	7.8	2.6	0.011*	0.006*	0.017	0.298	0.001*
Inferior malar	11.5	4.7	<0.001*	<0.001*	<0.001*	< 0.001*	**
Zygomatic arch	8.0	2.8	0.886	0.737	0.255	<0.001*	<0.001*
Supra-glenoid	10.1	3.6	0.381	0.688	0.374	< 0.001*	0.543
Gonion	16.7	6.4	0.075	<0.001*	**	<0.001*	0.008*
Supra M2	26.2	5.7	0.003*	0.680	0.987	< 0.001*	0.589
Occlusal line	20.7	4.0	0.817	0.109	0.771	0.142	<0.001*
Sub M2	20.0	4.7	0.446	0.030*	**	< 0.001*	0.476

(*): Difference significant at 5%; (**): Value not available in the study; (1): Using t-Student Test; (2) Perlaza (2013); (3) Hwang et al. (2012); (4) Panenková et al. (2012); (5) Philips, Smuts (1996); (6) Dong et al. (2012).

gonion and supra M2 had average thickness higher than in males. The other average measurements were correspondingly higher in males. Significant statistical differences were observed between sexes ($p<0.05$) in distances nasion, rhinion, midphiltrum, supradentale, and lateral orbit.

However, based on statistical analysis, only forth of the thickness measurements of the soft tissues of these anthropological marks were significantly different between men and women. The same difference between sexes was found in the Chinese population[22], men had thicker soft tissue than women in most points of reference, similar to other populations[23,27,28]. A study on Slovakia population[1] showed that soft tissue thickness of men's face exceeded females' in 13 reference points, with 9 points with significant difference ($p < 0.05$). Men showed higher values in points: lower malar, occlusal line and upper M2.

Among the age groups (Table 8) significant differences were recorded ($p < 0.05$) in measures: midphiltrum; menton; supra-orbital; infra-orbital; lateral orbit; supra-glenoid. According to Panenková[1], in Slovak population, men differ between the three age groups in supraglenoid point and midphiltrum. Soft tissue thickness in females differed significantly in the glabella, midphiltrum, supra-orbital and infra-orbital. Therefore, soft tissue thickness might be different when comparing age groups.

According to BMI, the measurement with significant differences were glabella; nasion; pogonion; menton; supra-orbital; lateral orbit; inferior malar; supra-glenoid; supra M2; occlusal line; sub M2, with lower soft tissue value when the patient was normal followed by over weighted patients. In Chinese population[22] for both sexes, when considering individuals overweighed, less distances had significant differences when comparing to those with normal weight.

On the other hand, Colombians over weighted males had around half the amount of distances with a significant difference, maybe because this study had a small sample. Thus, it is possible to say that, when comparing populations between them, BMI may be an important variable to consider since the differences tend to diminish as the weight increases. However, since there is only these three populations considering this variable, one of them with small samples

Table 8. Comparison of soft tissue thickness of Brazilian overweighed males and females and other populations (Colombian and Chinese).

Distances	Brazilian♂		Chinese[2]♂	Colombian[3]♂	Brazilian[4]♀		Chinese[2]♀
	Mean	DP	*P* value[(1)]		Mean	DP	*P* value[(1)]
Supra-glabella	4.3	1.2	0.009*	**	4.4	1.2	0.330
Glabella	5.3	1.5	0.138	**	5.3	1.1	0.220
Nasion	6.3	2.1	0.208	0.310	6.2	1.5	0.638
Rhinion	4.2	1.7	0.009*	<0.001*	3.5	2.1	0.422
Midphiltrum	13.9	2.8	0.033*	0.084	12.3	2.7	0.147
Supradentale	11.9	2.1	<0.001*	0.028*	10.1	2.6	0.002*
Infradentale	10.5	2.8	<0.001*	0.001*	9.6	1.3	< 0.001*
Supramentale	12.2	2.7	0.088	0.585	11.9	2.3	0.135
Pogonion	12.1	2.6	0.009*	**	11.9	2.4	0.063
Menton	8.3	2.6	0.166	<0.001*	8.3	2.6	0.703
Supra-orbital	6.8	2.1	0.021*	0.122	7.1	1.3	0.651
Infra-orbital	6.5	2.1	<0.001*	0.021*	6.5	2.2	0.034*
Lateral orbit	7.4	2.3	<0.001*	0.007*	10.6	2.9	0.190
Inferior malar	13.5	4.3	**	<0.001*	13.6	4.6	**
Zygomatic arch	7.6	2.5	0.358	0.008*	9.5	3.3	0.089
Supra-glenoid	11.3	3.6	0.468	0.387	12.4	3.7	0.056
Gonion	16.1	5.8	0.566	<0.001*	20.4	7.6	0.136
Supra M2	28.4	5.9	0.330	0.131	31.6	5.7	0.349
Occlusal line	24.5	3.8	0.044*	0.409	25.4	3.9	0.017*
Sub M2	23.2	4.9	0.598	0.286	26.4	4.3	0.061

(*): Difference significant at 5%; (**): Value not available in the study; (1): Using t-Student Test; (2) Dong et al. (2012); (3) Perlaza (2013); (4) There was no comparison between Brazilians and Colombians overweighed females because the authors did not studied this population.

(Colombian/30 individuals)[27], further studies must be taken in order to study this issue more profoundly.

Some anthropometric points showed significant differences between sex, age groups and nutritional status. Between sexes, men had greater means. Among age groups, there was also significant differences in some distances. In relation to nutritional status, the distances were lower among normal weight and higher among the obese. When considering various populations, soft tissue thickness had significant differences in many craniometric points highlighting how distinct they might be.

CONCLUSION

Some anthropometric points showed significant differences between sex, age groups and nutritional status. Between sexes, men had greater means. Among age groups, there was also significant differences in some distances. In relation to nutritional status, the distances were lower among normal weight and higher among the obese. When considering various populations, soft tissue thickness had significant differences in many craniometric points highlighting how distinct they might be.

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COLLABORATIONS

MMFS Data curation; writing - original draft preparation.

GGP Analysis and/or data interpretation; conception and design study; final manuscript approval; methodology; project administration; resources; writing - review & editing.

AAA Conception and design study; conceptualization.

EPS Conception and design study; supervision.

MVDC Conceptualization; supervision.

RSCS Conception and design study; methodology; supervision; writing - review & editing.

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***Corresponding author:** **Gabriela Granja Porto**
Av. General Newton Cavalcanti, nº1650 - Camaragibe, PE, Brazil
Zip Code 54753-220
E-mail: gabriela.porto@upe.br