UNIVERSIDADE ESTADUAL DE CAMPINAS
FACULDADE DE ODONTOLOGIA DE PIRACICABA

Daniel Pignatari Mahet Rodrigues

Avaliação do dimorfismo sexual em brasileiros utilizando parâmetros antropométricos do viscerocrânio

Assessment of sexual dimorphism in brazilians using viscerocranium anthropometric parameters

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Dissertação apresentada à Faculdade de Odontologia de Piracicaba da Universidade Estadual de Campinas como parte dos requisitos exigidos para a obtenção do título de Mestre em Biologia Buco-Dental, na Área de Odontologia Legal e Deontologia.

Dissertation presented to the Piracicaba Dental School of the University of Campinas in partial fulfillment of the requirements for the degree of Master in Dental Biology in Forensic Dentistry and Ethics area

Orientador: Prof. Dr. Eduardo Daruge Junior

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RESUMO

O processo de identificação é uma das principais e mais importantes tarefas dentro dos contextos médico e odontolegais. Nesses contextos, é sabido que o crânio pode fornecer diversas informações relevantes para a análise antropológica do sexo. O objetivo deste estudo foi avaliar a relação de medidas faciais para determinar o sexo em crânios humanos de brasileiros. Para isso, foram avaliados 113 crânios humanos íntegros (55 masculinos e 58 femininos). Foram realizadas 7 medidas faciais lineares em cada crânio, com paquímetro digital entre pontos craniométricos das regiões nasal e zigomática. Todas as medidas foram realizadas pelo mesmo pesquisador para evitar o erro interclasse e a análise estatística foi realizada no software R CRAN (open source). A curva de normalidade foi verificada pelo teste de Shapiro-Wilk, exceto para a medida da Largura Máxima Nasal, onde foi realizado o teste de Wilcoxon. Foi aplicado o teste comparativo T de Student para analisar o dimorfismo sexual, aplicando o nível de significância de $p<0.05$. Além disso, foram realizadas as médias, desvios padrões e gráficos box plots das mensurações realizadas. A partir do teste de correlação intraclasse foi obtido o valor de 0.986, o que demonstra uma reprodutibilidade excelente. As médias e desvios padrões de todas as medidas foram maiores no sexo masculino, exceto o índice nasal que possui relação inversamente proporcional. Verificou-se também que há interações estatisticamente significantes ($p<0.05$) entre o sexo para as medidas do índice nasal, altura nasal e largura facial máxima, com poder de teste T de Student igual a 0.0041, 1.835 e 1.377, respectivamente. Com isso, pode-se concluir que é possível criar padrões antropométricos regionalizados para a determinação do sexo em crânios não identificados, adequados à realidade brasileira.

Palavras-chaves: Crânio; dimorfismo sexual; Mensurações cranianas; Antropologia Forense; Anatomia.

ABSTRACT

The identification process is one of the major and most important tasks within Forensic Medicine and Forensic Dentistry. In these contexts, it is known that the skull can provide a relevant information to the anthropological analysis of sex. The objective of this study was to evaluate the relationship of facial measures to sex determination in human skulls of Brazilians. For this, 113 human skulls (55 males and 58 females) were evaluated. Seven linear facial measurements were performed on each skull, with a digital caliper between craniometric points of the nasal and zygomatic regions. All measurements were performed by the same researcher to avoid interclass error and statistical analysis was performed in CRAN (open source) software. The normality curve was verified by the Shapiro-Wilk test, except for the Maximum Nasal Width measurement, where the Wilcoxon test was performed. The Student's t-test was used to analyze the sexual dimorphism, applying the level of significance of $p < 0.05$. In addition, the means, standard deviations and box plots of the measurements were performed. From the intraclass correlation test, a value of 0.986 was obtained, which shows excellent reproducibility. The means and standard deviations of all measurements were higher in males, except for the nasal index that has an inversely proportional relation. It was also verified that there were statistically significant ($p < 0.05$) sex interactions for nasal index, nasal height and maximum facial width, with Student's t test power equal to 0.0041, 1,835 and 1,377, respectively. With this, it can be concluded that it is possible to create regionalized anthropometric standards for the determination of sex in unidentified skulls, appropriate to the Brazilian forensic context.

Key words: Skull; Sexual dimorphism; Cranial measurements; Forensic anthropology; Anatomy.

SÚMARIO

1. INTRODUÇÃO

A Antropologia Forense é a área em que acontece a aplicação da antropologia física a contextos periciais. Sendo um campo multidisciplinar que trata com diversas questões que vão desde uso de conhecimentos da osteologia até a fisionomia humana, para auxiliar no processo de identificação (Krishan K. et al 2016).

Este processo é uma das principais e mais importantes tarefas dentro dos contextos médico e odontolegais (Fortes de Oliveira, O. et al 2012). Nos casos em que o cadáver se encontra mutilado, em avançado estado de decomposição ou esqueletizado, a análise antropológica é realizada em duas etapas, que inclui a avaliação das características gerais e das individuais. (Krishan K. et al 2016)

Primeiramente são avaliadas as gerais, como sexo, ancestralidade, idade e estatura. Depois as individuais, que são características específicas de uma pessoa, que possibilitam a separação de uma das outras, triagem. Conforme mencionado acima, essas características biológicas pessoais podem ser as cicatrizes, tatuagens ou qualquer anormalidade e/ou deformidade evidente no mesmo que auxiliem na identificação (Hu, K.S. et al. 2006 e Krishan K. et al 2016).

Dentro deste processo, a etapa de determinação do sexo em casos periciais tem um importante papel, pois reduz o número de possíveis correspondências, eliminando todos os membros do sexo oposto, e aumenta a precisão dos métodos subsequentes para estimar o perfil biológico do cadáver, (Dayal et al. Kimmerle, E.H. et al 2008; Naikmasur, V.G. et al 2010; Fortes de Oliveira, O. et al 2012; Franklin, D. et al 2013; Gamba, T.O. et al 2014; Mahakkanukrauth, P. et al 2015; Ekizoglu, O. et al 2016; Krishan K. et al 2016 e Ubelaker, D.H. et al 2016), devido a existência de diferenças sexuais observáveis nos traços morfológicos relacionados à ancestralidade, a idade e estatura (Krishan K. et al 2016 e Ubelaker, D.H. et al 2016).

O desenvolvimento de tais características dimórficas está inerentemente ligado a diferenças básicas de desenvolvimento, biomecânica e funcionalidade específicas do sexo, que após a fase de puberdade se tornam mais evidentes e precisas. (Bigoni, L. et al 2010; Mahakkanukrauth, P. et al 2015; Franklin, D. et al 2013; Ekizoglu, O. et al 2016 e Krishan K. et al 2016).

O crânio, depois da pelve, é o que apresenta maior dirmofismo sexual e precisão para avaliação. (Fortes de Oliveira, O. et al 2012; Gamba, T.O. et al. 2014; Dong, H. et al. 2015; Ekizoglu, O. et al 2016 e Krishan K. et al 2016).

No entanto, a preservação da estrutura óssea determina a qualidade das informações que serão obtidas. (Naikmasur, V.G. et al 2010 e Franklin, D. et al 2013), já que em geral, a determinação do sexo não é uma dificuldade quando se tem um esqueleto completo. Mas esta nem sempre é a condição que os restos esqueletizados são encontrados nos contextos periciais, podendo estar destruídos ou reduzidos a pequenos segmentos.

No entanto, ao classificar os restos humanos por sexo, especialmente os crânios, o pesquisador deve levar em consideração o pedomorfismo, ou seja, o fato dos crânios humanos adultos poderem reter alguns traços juvenis. Após o início da puberdade, as diferenças entre o crânio masculino e feminino se tornam mais claras, uma vez que o crânio masculino desenvolve algumas características adultas, no entanto, os crânios femininos tendem a reter características pedomórficas, podendo gerar conclusões errôneas. (Krishan K et al 2016)

Ainda há que considerar o fato das características determinantes do sexo no tecido ósseo ilustrarem diferenças entre as populações, pois seu desenvolvimento é também influenciado por fatores ambientais, o que gera a necessidade de estudos populacionais de padrões específicos usando métodos mais confiáveis.

Os métodos utilizados comumente para estimativa do sexo podem ser classificados como não métricos ou qualitativos e métricos ou quantitativos (Dayal, M.R. et al 2008; Kranioti, E.F. et al 2008; Bigoni, L. et al 2010; Naikmasur, V.G. et al 2010; Fortes de Oliveira, O. et al 2012; McDowell, J.L. et al 2012; Mahakkanukrauth, P. et al 2015; Krishan K. et al 2016 e Ubelaker, D.H. et al 2016).

Dentro das avaliações do dimorfismo sexual podemos ressaltar duas principais formas, as diretas, que examinam os próprios crânios secos (Hwang T.S. et al. 2005, Cantín, L.M. et al. 2009 e Fortes de Oliveira, O. et al. 2012.) e as indiretas, que avaliam através de exames de imagens, como radiografias (Naikmasur, V.G. et al. 2010 e Prado, F. B. et al. 2011), digitalização por *scanners* (Bigoni, L. et al. 2010), tomografias computadorizadas (Gamba, T.O. et al. 2104), ressonância magnética e fotografias.

Os métodos não métricos ou qualitativos dependem da análise visual dando resultados valiosos e rápidos numa avaliação preliminar. Esses traços, no entanto, são muito influenciados pelo nível de subjetividade. Nos ossos intactos os resultados

são melhores, enquanto nos casos de ossos fragmentados ou incompletos seu grau de precisão tende a diminuir (Krishan K. et al 2016 e Ubelaker, D.H. et al 2016).

Já os estudos métricos ou quantitativos são baseados na variabilidade das dimensões entre os sexos masculino e feminino e, principalmente, utilizam diferentes métodos estatísticos. Os resultados numéricos obtidos a partir deles são mais fáceis de avaliar e interpretar, sendo a precisão na estimativa do sexo variada, de acordo com o método estatístico utilizado. (Krishan K. et al 2016 e Ubelaker, D.H. et al 2016).

Além desses, pode ser utilizado o método molecular do DNA, já que os fatores genéticos contribuem para o desenvolvimento das variações sexuais encontrados no esqueleto. Esse método apresenta um alto grau de confiabilidade, porém é muito mais caro, invasivo e exigem maior nível de treinamento, equipamentos e nem sempre as condições da amostra permitem uma análise viável.

Sua utilização na determinação do sexo pode ser importante em casos onde o indivíduo não atingiu a fase adulta, ou seja, ainda não desenvolveu características dimórficas confiáveis, e em casos onde apenas pequenos fragmentos ou elementos ósseos são encontrados, sendo insuficientes para uma estimativa sexual através dos exames antropológicos tradicionais (Krishan K. et al 2016 e Ubelaker, D.H. et al 2016).

Diante do exposto, o objetivo do presente estudo foi avaliar os padrões quantitativos relacionados ao sexo da população adulta do Brasil por meio da obtenção de medidas lineares do viscerocrânio, a partir de pontos craniométricos pré-determinados, a fim de obter padrões de mensuração representativos dessa população para utilização em contextos periciais.

2. ARTIGO: ASSESSMENT OF SEXUAL DIMORPHISM IN A BRAZILIAN BONE COLLECTION USING VISCEROCRANIUM ANTHROPOMETRIC PARAMETERS

*Artigo submetido ao periódico: *Australian Journal of Forensic Science* (Anexo 1).

ABSTRACT

The identification process is one of the major and most important tasks within Forensic Medicine and Forensic Dentistry. In these contexts, it is known that the skull can provide relevant information for the anthropological analysis of sex. The aim of this study was to evaluate the relationship between facial measurements and sex determination in Brazilian human skulls. For this, 113 human skulls (55 males and 58 females) were evaluated. Seven linear facial measurements were performed on each skull using a digital caliper between craniometric points of the nasal and zygomatic regions. All measurements were performed by the same researcher to avoid interclass error, and statistical analyses were performed in the CRAN (open source) software. The normality curve was verified by the Shapiro-Wilk test, except for the Maximum Nasal Width measurement, where the Wilcoxon test was performed. Student's t-test was used to analyze sexual dimorphism, applying the level of significance of $p < 0.05$. In addition, the means, standard deviations and box plots of the measurements were performed. For the intraclass correlation test, a value of 0.986 was obtained, thus demonstrating excellent reproducibility. The means and standard deviations of all measurements were higher in males, except for the nasal index, which had an inversely proportional relation. There were also statistically significant ($p < 0.05$) sex interactions for nasal index, nasal height and maximum facial width, with Student's t test powers equal to 0.0041, 1.835 and 1.377, respectively. Thus, it can be concluded that it is possible to create regionalized anthropometric standards for the determination of sex in unidentified skulls that are appropriate for the Brazilian forensic context.

Key words: Skull; Sexual dimorphism; Cranial measurements; Forensic anthropology; Anatomy.

INTRODUCTION

Anthropological examinations are carried out in two stages: an evaluation of the general characteristics and an evaluation of the physical person. First, we evaluated general characteristics, such as sex, ancestry, age and height. Then, we evaluated individuals for scars, tattoos or any abnormality and/or deformity that can be used as auxiliary information[1-3].

Among the general characteristics, the sexual estimate has a relevant importance in reconstructing the biological profile of a cadaver[1,3-9].

Sexual estimation can be performed in most human bones[10] and is thus a complementary method to human identification that is widely used in forensic dentistry[6]. The pelvis and skull present the highest degrees of reliability[1,3,6,8,10]. Skeletal components consist of hard tissues that can withstand adverse conditions while preserving their characteristics, which is valuable for estimating sex. It should be noted that the quality of the information obtained from the bone structures depends on the state of preservation of the remaining remnants[5].

Sexual estimation is more accurate in adult individuals because the influence of hormonal factors can change the speed of bone growth in childhood and adolescence [3,6].

The anatomical characteristics of sex in the bone tissue exhibit differences among populations because their development is influenced by environmental factors, thus creating the need for population studies of specific patterns that use more reliable methods. The methods that are commonly used for sex estimation can be classified as non-metric or qualitative and metric or quantitative, the latter of which is more subjective and requires greater, more objective and precise experience[1,3,5,7,9,11-14].

Several studies[1,5,12,13,15,17-20] analyzed measurements by landmarks in the viscerocranium region and obtained accurate results for analyses of sexual dimorphism. However, few studies evaluated the Brazilian population, which led to great miscegenation.

For the morphometry parameters of the nasal region, Hwang et al.[21] reported that anthropological studies suggest that climatic influences act to increase respiration efficiency in both the heating and moistening of inspired air, consequently influencing the shapes and widths of the nasal region.

There is also an influence of ancestry and sexual dimorphism on the nasal bones and piriform aperture that may provide useful information for the field of anthropology[21-23]. For this reason, the measurements of the nasal region were evaluated in this study. The nasal index, which is an important reference index for the evaluation of the ancestry of the individual, was not used for sexual dimorphism in any previous studies.

The aim of this study was to evaluate the dimensions in the viscerocranium region and their sexual dimorphism in a Brazilian bone collection.

MATERIALS AND METHODS

The research was approved by the Research Ethics Committee of the School of Dentistry of Piracicaba, University of Campinas (protocol number: 134/2015).

Sample

The present study was conducted on 113 Brazilian dried skulls of known sex and age at death for 55 males and 58 females from the Bone Collection in the School of Dentistry of Piracicaba, University of Campinas. The age ranged from 18 to 64 years. Fractured, pathological, or deformed skulls were excluded from the study.

Viscerocranium measurements

All measurements were taken using an accurate digital caliper (ZAAS®). Each measurement was taken between predetermined craniometric points (Table 1; Figure 1). From the anatomical locations presented, linear measurements were taken between points (Table 2).

Three non-consecutive measurements of the skull using either sliding or spreading calipers are given in Table 1. The average of these three measurements was recorded for each individual.

The evaluators were blinded to the sex of the skulls at the time of the measurements. Measurements were repeated in 20% of the samples randomly and on different days, with a minimum interval of two weeks to evaluate the intraclass error. Finally, the data collected during the study were stored in a Microsoft Excel (Microsoft Windows, USA) spreadsheet, separated by sex, for statistical analyses.

Table 1. Description of the landmarks that were used.

SYMBOL	LANDMARK	DESCRIPTION	REFERENCES
N	Nasion	Junction of the internasal suture with the nasofrontal suture in the median plane	**Green H et al.[15] McDowell JL et al.[14] Franklin D et al.[17]**
Nsp	Superior Nasal	Point at junction of nasomaxilla and frontal sutures	**McDowell JL et al.[14]**
Rhi	Rhinion	Midline point at the inferior end of the internasal suture	**Green H et al.[15]**
Ni	Inferior Nasal	Most inferior point on the nasomaxilla suture	**McDowell JL et al.[14]**
Ns	Nasospinale	Point where the line tangent to the inferiormost points of the two curves of the inferior nasal aperture margin crosses the midline	**Green H et al.[15] Franklin D et al.[17]**
Al	Alare	Most lateral point on the nasal aperture in a transverse plane	**Green H et al.[15] McDowell JL et al.[14] Franklin D et al.[17]**
Zy	Zygion	Most lateral point on the zygomatic arch	**Franklin D et al.[17]**

Table 2. Description of linear mensurements used.

MEASUREMENTS	LANDMARKS	DEFINITION
Superior nasal width	nsp-nsp	Distance between Superior nasal points
Inferior nasal width	ni-ni	Distance between Inferior nasal points
Nasal height	n – ns	Distance between Nasion to Nasospinale Point
Nasal bones height	n – rhi	Distance between Nasion to Rhinion
Nasal width	al-al	Distance between Alare points
Maximum facial width	zy-zy	Distance between Zygion points
Nasal index	$\frac{\text{al-al}}{\text{n-ns}}$	Maximum breadth of Piriform Aperture divided by Nasal Height

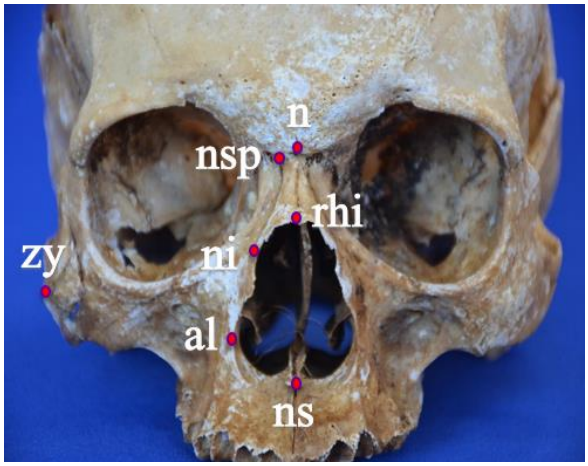

Figure 1. Anterior view of viscerocranium. The points (in red) were the landmarks used in the present study.

Data analysis

The R CRAN software (open source) was used for statistical analysis. All measurements were obtained by the same researcher to avoid interclass error, and the intraclass correlation test was obtained.

The normality curve was verified by the Shapiro-Wilk test, except for the Maximum Nasal Width measurement, for which the Wilcoxon test was performed. Student's t-test was used to analyze the sexual dimorphism, applying a level of significance of $p < 0.05$. In addition, the means and standard deviations of the measurements were calculated.

RESULTS

From the intraclass correlation test, a value of 0.986 was obtained (excellent reproducibility). The averages and standard deviations of all measures are listed in Table 3, divided by sex. All of the values are larger in males, except for the nasal index, which has an inversely proportional relation. There were also statistically significant ($p < 0.05$) interactions between sex and nasal index, nasal height and maximum facial width, with Student's t test powers equal to 0.0041, 1.835 and 1.377, respectively (Figures 2,3 and 4).

Table 3. Mean and Standard deviation of the measures performed in each sex.

	SEX			
	MALE		**FEMALE**	
MENSUREMENTS	*MEAN*	*STANDARD DEVIATION*	*MEAN*	*STANDARD DEVIATION*
NASAL INDEX	0.49057	0.05387074	0.5197259	0.05176239
NSP-NSP	12.71218	2.682265	11.93018	2.580384
NI-NI	15.36582	1.927875	15.07086	2.12064
AL-AL	25.24582	2.190853	24.5819	2.187555
N-NS	51.67455	3.250903	47.42241	2.712899
N-RHI	22.25982	3.129359	20.73259	2.826069
ZY-ZY	130.0585	5.316897	121.2845	5.739469

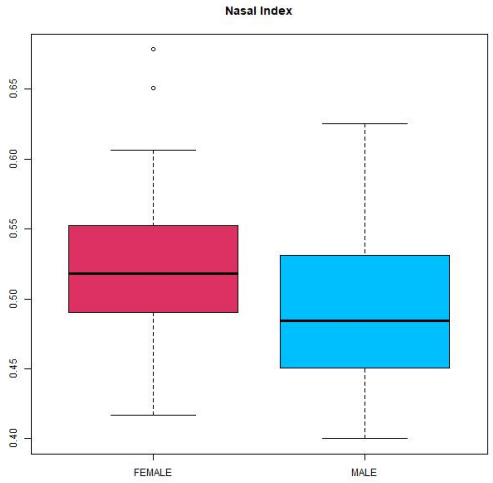

Figure 2. Box Plot of Nasal Index.

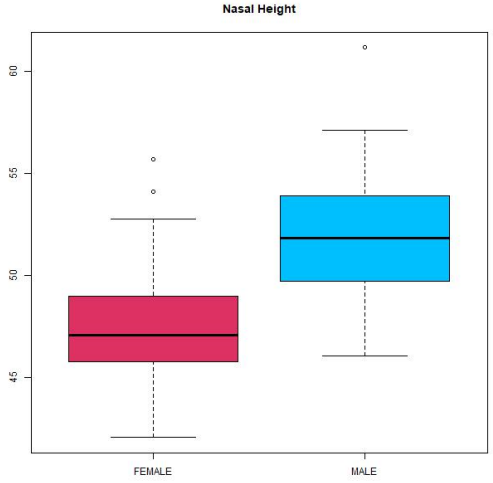

Figure 3. Box Plot of Nasal Height.

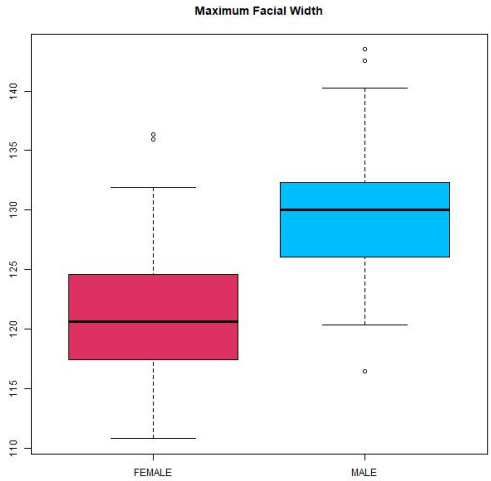

Figure 4. Box Plot of Maximum Facial Width.

DISCUSSION

Estimations of sex are key analytical pieces when constructing a biological profile of an unidentified corpse that needs an anthropological evaluation[1,3-9]. In a restricted geographic region, the patterns of sexual dimorphism can vary significantly, so specific studies with unanimous findings are needed for each population to increase the accuracy of a sex assessment.

An important aspect of sexual dimorphism is the difference between male and female bone sizes, but the accuracy depends on factors that cause variations in sex, such as hormonal and environmental factors. The hormonal factor interferes most strongly in puberty, where the average male skull is enlarged and becomes stronger than the female skull[3,7,8,11,20]. Environmental factors are related to the variations in sexual dimorphism between the populations and can be very significant. The authors thus suggest the need for a specific study for each population, which would increase the accuracy of a sex estimate.

Among the authors studied, four evaluated sexual dimorphism in the Brazilian population, Fortes de Oliveira et al.[1], Gamba et al.[6], Cantín et al.[22] and Prado et al.[23]. Most of them were relative to other countries or regions, such as Asia, Europe, Oceania, Africa, South America and North America.

The accuracy of methods of sex estimates in highly mixed populations is generally lower than that in areas of ethnic predominance of a single group, such as Central Europe[1]. In the present study, six measurements and one index in the

viscerocranium were obtained by using traditional anthropometric instruments and are easily reproducible.

For the maximum facial width (Zy-Zy), we obtained a significant sexual dimorphism; the measurements were always larger in males, in agreement with the results of several authors[1,5,7,8,12,13,17,18,20] (Table 4). This fact is most likely explained by the insertion and action of muscle groups in this region[1].

Table 4. Measurements of the Maximum Facial Width of the studies evaluated.

	MAXIMUM FACIAL WIDTH (ZY-ZY)				
	MALE		**FEMALE**		
AUTHORS	***MEAN***	***STANDARD DEVIATION***	***MEAN***	***STANDARD DEVIATION***	***POPULATION***
Rodrigues DPM et al.	130,05	±5,31	121,28	±5,73	BRAZIL
Dayal MR et al.[12]	130.6	±4.71	123.97	±5.03	SOUTH AFRICA
Ekizoglu O et al.[8]	131.8	± 5.1	122.9	± 4.7	TURKEY
Fortes de Oliveira O et al.[1]	110.88	±7.06	103.29	±5.99	BRAZIL
Franklin D et al.[17]	132.1	±4,81	122.8	±4.66	AUSTRALIA
Kranioti EF et al.[13]	130.54	±5.13	122.07	±4.57	GREECE
Mahakkanukrauth P et al.[7]	133.81	±3.97	124.72	±4.82	THAILAND
Moreddu E et al.[18]	126.19	±4.97	117.06	±6.27	FRANCE
Naikmasur VG et al.[5]	132.37	±5.429	124.67	±3.606	INDIA
Naikmasur VG et al.[5]	140.54	±4.132	133.48	±3.918	TIBET
Ramamoorthy B et al.[20]	113.6	±6.10	108.8	±5.73	SOUTH OF INDIA

We used measures in the nasal region because, according to Cantín et al.[22], the characteristics of this region have been reported to be indicators of sexual differentiation. Hwang et al.[21] suggested that the piriform aperture dimensions and nasal bone types are directly related to the temperature and humidity of the air breathed by the individual. For this reason, it is believed that the dimensions of the piriform aperture and the shape of the nasal bones are adapted to the environment and geographic variations.

Regarding the measurement of nasal width (Al-Al), the present study found no significant difference between the sexes, consistent with Ramamoorthy et al.[20], Hwang et al.[21] and Cantím et al.[22]. Although the difference was not significant, the measurements were higher in males. Differently, Prado et al.[23], Asghar et al.[16], Dayal et al.[12], Franklin et al.[17], Kranioti et al.[13], Mahakkanukrauth et al.[7] and Moreddu et al.[18]

observed significant results in this measure, as described in Table 5. These differences are most likely influenced by environmental factors[21] because the samples are from different populations. In Brazilian samples, only Prado et al.[23] found significance in the Al-Al value, which is most likely justified by the large miscegenation and small sample sizes of the studies, thus corroborating that there should be studies with a larger Brazilian population sample.

When we compared our study with those done in Indian populations, the difference most likely arises because the samples are from different regions: one from the North[16] and the other from the South[20]. In the study by Asghar et al.[16], who considered a population from the North, the authors concluded that the individuals are mostly platirrines; they present a nasal width greater than the nasal height, thus justifying a significant value of the Alar-Alar measurement, in addition to presenting different ethnic origins, racial changes and exposure to different climates.

Table 5. Measurements of nasal width of the studies evaluated.

	NASAL WIDTH (AL-AL)				
	MALE		FEMALE		
AUTHORS	***MEAN***	***STANDARD DEVIATION***	***MEAN***	***STANDARD DEVIATION***	***POPULATION***
Rodrigues DPM et al	25.24	±2.19	24.58	±2.18	BRAZIL*
Ramamoorthy B et al.[20]	27.0	±2.18	26.3	±1.71	SOUTH OF INDIA*
Hwang TS et al.[21]	25.7	±1.7	25.4	±2.1	SOUTH KOREA*
Cantín LM et al.[22]	26.87	±4.8	25.26	±2.6	BRAZIL*
Prado FB et al[23]	35.0	-------	30.0	-------	BRAZIL
Asghar A et al.[16]	24.9	±1.59	22.77	±1.57	NORTH OF INDIA
Dayal MR et al.[12]	27.93	±1.91	27.09	±1.94	SOUTH AFRICA
Franklin D et al.[17]	24.8	±2.22	23.9	±2.11	AUSTRALIA
Kranioti EF et al.[13]	23.98	±2.54	23.16	±2.11	GREECE
Mahakkanukrauth P et al.[7]	27.03	±1.82	25.60	±1.69	THAILAND
Moreddu E et al.[18]	25.32	±1.86	24.0	±1.77	FRANCE

*not significant

Our study also did not find significant values for sexual dimorphism as measured by nasal bone height (N-Rhi), as well as Asghar et al.[16], in a population of Northern India and Hwang et al.[21], in a study in a population of South Korea, with values of respectively 22.25 ± 3.12 males and 20.73 ± 2.82 females, 17.76 ± 2.77 males and 17.25 ± 1.96 females, and 25.9 ± 3.8 males in the sex males and 24.5 ± 3.7 females,

with both being larger in males. This is probably due to the environmental influence[16,21] and also because the population of North India has a great miscegenation[16].

We found significant values for sexual evaluation in the nasal height (N-NS), as well as in the study by Cantín et al.[22] and Prado et al.[23], in Brazilian populations as well as in Dayal et al.[12], Franklin et al.[17], Kranioti et al.[13], Mahakkanukrauth et al.[7] and Ramamoorthy et al.[20], in different populations (Table 6). The anthropological studies suggested, that climatic influences can affect not only the width but also the height of the nasal region and, for this reason, it is believed that these dimensions are adapted to the environment and geographic variations[23]. The results of our study are very similar to those of Cantín et al.[22] and Prado et al.[23], of Brazilian population, demonstrating that the morphology of this region can be an anatomical landmark can vary according population.

Table 6. Measurements of Nasal Height of the studies evaluated.

	NASAL HEIGHT (N-NS)				
	MALE		FEMALE		
AUTHORS	***MEAN***	***STANDARD DEVIATION***	***MEAN***	***STANDARD DEVIATION***	***POPULATION***
Rodrigues DPM et al	51.67	±3.25	47.42	±2.71	BRAZIL
Cantín LM et al.[22]	50.82	±2.82	47.53	±3.29	BRAZIL
Prado FB et al[23]	50.0	-------	45.0	-------	BRAZIL
Dayal MR et al.[12]	48.29	±3.47	46.12	±2.42	SOUTH AFRICA
Franklin D et al.[17]	54.3	±3.08	51.0	±2.84	AUSTRALIA
Kranioti EF et al.[13]	51.60	±3.04	48.20	±2.98	GREECE
Mahakkanukrauth P et al.[7]	53.53	±3.06	48.78	±2.69	THAILAND
Ramamoorthy B et aL.[20]	49.9	±2.83	48.1	±2.94	SOUTH OF INDIA

In relation to the superior nasal width (Nsp-Nsp), our study found no significant measures between sex, as did the study of Yüzbaşioğlu et al.[19] in a Turkish population and that of Hwang et al.[21] in a South Korean population. However, in both our study and the South Korea, the values were higher for males, in contrast to the study from Turkey. The size of the South Korean population was smaller, which corroborated the fact that in cold and dry climates, the heating and humidification of inhaled air are facilitated by a longer nasal passage and a narrower piriform aperture,

which reduces the base of the nose due to an increased surface and a longer period during which the air is inspired[21,22].

Comparing our study data with other population data clearly shows that the sex estimation accuracy changes in different populations. This situation highlights the importance of using population-specific data in sex estimation studies.

In conclusion, this study has the potential of contributing to population-specific standards for the Brazilian population. The results obtained in this study showed that for all measures obtained in the Brazilian population that was evaluated, males presented a mean of the analyzed values that was higher than that in females. We found a significant relationship between sexual dimorphism and the measures of maximum facial width, nasal height and nasal index. Therefore, the nasal region of the viscerocranium was dimorphic for sex in the evaluated sample.

Therefore, these interactions can be used to create anthropometric patterns for estimating sex in unidentified skulls in the forensic context that are appropriate for the Brazilian population.

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3 CONCLUSÃO

A partir dos resultados deste estudo foi possível concluir que:

- O sexo masculino apresentou uma média dos valores analisados maior do que o feminino em todas as medidas.
- As únicas medidas nas quais encontramos relação significativa no dimorfismo sexual foram as medidas da largura facial máxima, altura nasal e Índice Nasal.
- Verificamos a necessidade de criação de padrões antropométricos com as medidas significativas para a determinação do sexo em crânios não identificados.

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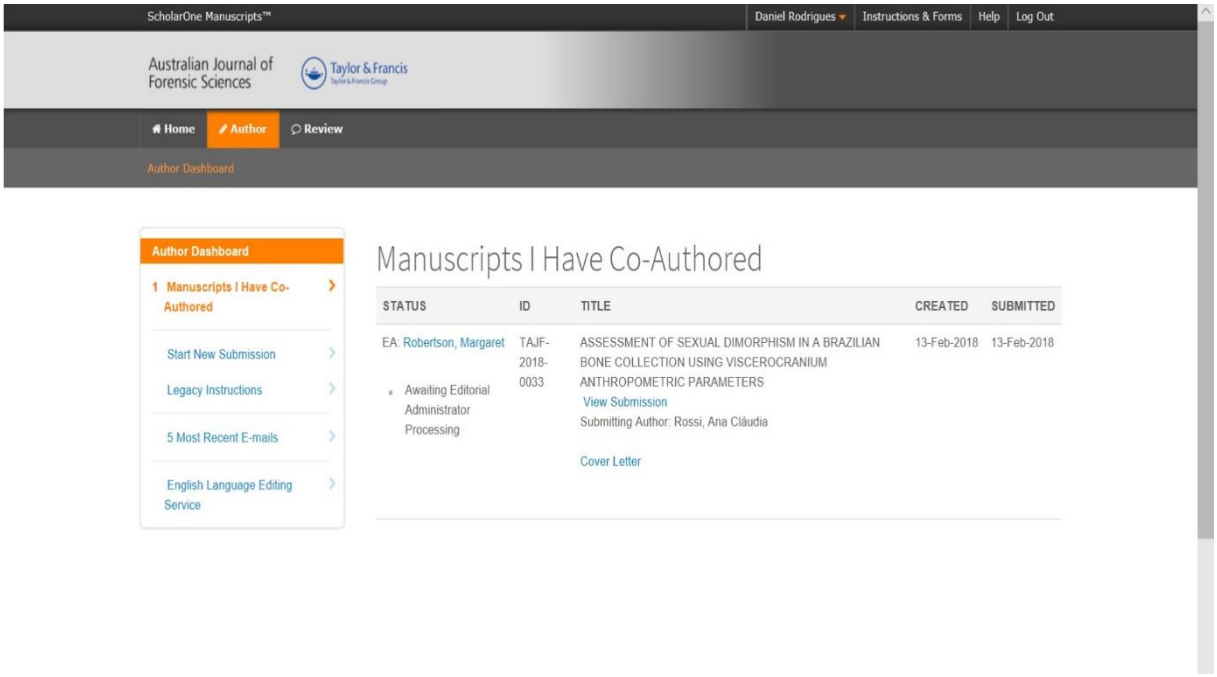
ANEXO 1 - Comprovante de submissão



COMITÊ DE ÉTICA EM PESQUISA
FACULDADE DE ODONTOLOGIA DE PIRACICABA
UNIVERSIDADE ESTADUAL DE CAMPINAS

CERTIFICADO

O Comitê de Ética em Pesquisa da FOP-UNICAMP certifica que o projeto de pesquisa "**Estimativa da Ancestralidade a Partir de Medidas da Face**", CAAE **49942715.8.0000.5418**, dos pesquisadores **Talita Lima de Castro, Eduardo Daruge Júnior, Ana Cláudia Rossi, Daniel Pignatari Mahet Rodrigues e Rachel Lima Ribeiro Tinoco**, satisfaz as exigências das resoluções específicas sobre ética em pesquisa com seres humanos do Conselho Nacional de Saúde – Ministério da Saúde e foi aprovado por este comitê em 04/11/2015 (projeto original) e em 21/12/2017 (segunda emenda).

The Research Ethics Committee of the School of Dentistry of Piracicaba of the University of Campinas (FOP-UNICAMP) certifies that research project "**Ancestry Estimate from Face Measures**", CAAE **49942715.8.0000.5418**, of the researcher's **Talita Lima de Castro, Eduardo Daruge Júnior, Ana Cláudia Rossi, Daniel Pignatari Mahet Rodrigues and Rachel Lima Ribeiro Tinoco**, meets the requirements of the specific resolutions on ethics in research with human beings of the National Health Council - Ministry of Health, and was approved by this committee on 4th of November of 2015 (original project) and on 21st of December of 2017 (second amendment).

Profa. Fernanda Miori Pascon

Vice Coordenador
CEP/FOP/UNICAMP

Prof. Jacks Jorge Junior

Coordenador
CEP/FOP/UNICAMP

Nota: O título do protocolo e a lista de autores aparecem como fornecidos pelos pesquisadores, sem qualquer edição.
Notice: The title and the list of researchers of the project appears as provided by the authors, without editing.