Original article

Forensic Anthropology

Morphological study of population affinity using dry skulls of contemporary identified Brazilians

Estudo morfológico de afinidade populacional utilizando crânios secos de brasileiros contemporâneos identificados

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ABSTRACT

The present study aimed to analyze morphoscopic data to estimate the population affinity of dry human skulls from Brazilians. This observational research was carried out at the Center for Forensic Anthropology Studies at the Faculty of Dentistry of the University of Pernambuco (CEAF/FOP/UPE), at the Laboratory of Forensic Anthropology and Osteology at the Federal University of Pernambuco (LAOF/UFPE) and the Identification Laboratory and Forensic Osteology (LIHOF) at UFPE. Three hundred twenty-eight skulls were evaluated, based on the method of Hefner (2009), using eleven morphological indicators: anterior nasal spine (ANS), inferior nasal opening (INA), interorbital width (IOB), malar tubercle (MT), nasal opening width (NAW), nasal bone contour (NBC), nasal prominence (NO), post-bregmatic depression (PBD), supranasal suture (SPS), transverse palatal suture (TPS), and zygomaticomaxillary suture (ZS). In addition to descriptive statistics, inferential statistics were used, using the Chi-Square and Fisher's Exact tests. The set of the three osteological collections showed a predominant composition of Africans and Europeans. Of the eleven morphoscopic traits analyzed, ten showed significant results for the population affinity analysis ($p<0.005$). Only the MT variable was not considered statistically significant. In a country like Brazil, due to its continental extension and the variation in colonizing groups, with known differences between their regions, there is a great need for more studies like the one carried out here, which investigate these diversities and allow the establishment of the Brazilians' population affinity profile, considering their historical-regional training peculiarities.

Keywords: Forensic anthropology; skull; population affinity.

RESUMO

O presente estudo teve como finalidade analisar dados morfoscópicos para a estimativa da afinidade populacional em crânios humanos secos de brasileiros. Esta pesquisa observacional foi realizada no Centro de Estudos em Antropologia Forense da Faculdade de Odontologia da Universidade de Pernambuco (CEAF/FOP/UPE), no Laboratório de Antropologia e Osteologia Forense da Universidade Federal de Pernambuco (LAOF/UFPE) e no Laboratório de Identificação Humana e Osteologia Forense (LIHOF) da UFPE. Considerando-se as três coleções osteológicas, um quantitativo de 328 crânios foi avaliado, com base no método de Hefner (2009), utilizando-se onze indicadores morfológicos: espinha nasal anterior (ANS), abertura nasal inferior (INA), largura interorbital (IOB), tubérculo malar (MT), largura da abertura nasal (NAW), contorno do osso nasal (NBC), proeminência nasal (NO), depressão pós-bregmática (PBD), sutura supranasal (SPS), sutura palatina transversa (TPS) e sutura zigomático-maxilar (ZS). Além da estatística descritiva, foi utilizada a estatística inferencial, pelos testes Qui-Quadrado e Exato de Fisher. O conjunto das três coleções osteológicas apresentou composição predominate de africanos e europeus. Dos onze traços morfoscópicos analisados, dez apresentaram resultados significativos para a análise de afinidade populacional ($p<0,005$). Apenas a variável MT não foi considerada estatisticamente significativa. Em um país como o Brasil, por sua extensão continental e pela variação nos grupos colonizadores, com sabidas diferenças entre suas regiões, há uma grande necessidade de mais estudos como este, que investiguem essas diversidades e obtenham o perfil de afinidade populacional dos brasileiros, considerando-se suas peculiaridades histórico-regionais de formação.

Descritores: Antropologia Forense; Crânio; Afinidade populacional.

INTRODUCTION

The population affinity from human skeletal remains is one of the main objectives of the forensic anthropologist when obtaining a bioanthropological profile of an unidentified individual[1]. The whole process of human identification can generate a profile with information regarding the parameters of sex, stature, age at death, and population affinity for comparison and characterization of unknown individuals[2].

In Brazil, the estimation of population affinity is challenging due to the miscegenation of the Brazilian people, which differentiates it from any other society[3,4]. There is still a lack of research in Forensic Anthropology, so the analysis of this population is often performed using data generated from different populations[5].

The study of ancestry in forensic anthropology generally includes two methodological approaches: one metric and one nonmetric or morphoscopic. Many forensic anthropological analyses implemented today reflect a growing concern with the standardization of methods and the search for more accurate, reliable, and demonstrably valid analysis[6].

The skull is commonly used for population affinity estimation because of the characteristics of the populations of the various geographic regions present in this part of the body and its great preservability[7].

Obtaining concise data regarding the population affinity of Brazilian skulls is relevant since, as stated earlier, estimating this component of the biological profile is an important step in a forensic anthropological investigation[8].

To describe cranial morphoscopic features, Hefner[7] studied the bony anatomy and noted features such as the design of the transverse palatal suture; the presence or absence of the nasal prominence; as well as morphoscopic features that can be compared to some kind of object, for example, the width of the nasal aperture, which resembles a bell, a pear, or can be compared to the shape of a drop.

After studying Hefner's notes, the present research was designed to analyze morphoscopic data for the estimation of population affinity in dried human skulls of Brazilians, using the software developed by Hefner[7] in order to identify the most evident morphoscopic traits for classifying the sample studied according to the ancestral groups available in his database. It is also proposed to discuss the importance of this study to the field of Brazilian forensic anthropology.

MATERIALS AND METHODS

The present research was previously approved by the Research Ethics Committee (CEP) of the Vitória Academic Center (CEP-CAV), Federal University of Pernambuco (UFPE), obtaining opinion no. 4,494,614 and CAAE: 36465620.7.3001.5195, according to the dictates of the National Health Council Resolution no. 466/12, Ministry of Health, Brazil, which regulates research involving human beings.

This observational study was carried out at the Center for Studies in Forensic Anthropology of the Faculty of Odontology of the University of Pernambuco (CEAF/FOP/UPE), at the Laboratory of Forensic Anthropology and Osteology (LAOF) of the Federal University of Pernambuco (UFPE), both in the city of Recife, as well as at the Laboratory of Human Identification and Forensic Osteology (LIHOF) of the UFPE, Vitória de Santo Antão campus (CAV), distant 52 kilometers from Recife.

The CEAF/FOP/UPE osteological collection has 427 cataloged skeletons, of which 223 are male and 207 female, with ages between 0 and 109 years. The LAOF/UFPE collection comprises 68 individuals, 22 females and 46 males, with ages at death ranging from 17 to 94 years. The Osteological Collection of LIHOF/CAV/UFPE comprises 204 skeletons, 107 females and 97 males, with ages ranging from 10 to 101 years.

Skulls presenting pathologies, traumas, or artifacts at the morphoscopic trace analysis sites that prevented precise observation of the regions of interest were excluded from the study so that 193 skulls were eliminated from the CEAF/FOP/UPE sample, 25 skulls from LAOF, and 40 skulls from LIHOF. It is worth noting that LIHOF has only 91 skeletons with skulls.

A pilot study was conducted as a training stage for the researcher to test the data collection methods and verify inter and intraobserver agreement. To the interobserver agreement, evaluations were performed by an external examiner with experience in forensic anthropology, considered the gold standard in data analysis. To assess intraobserver error, the analyses were repeated on 10% of the sample, on randomly selected skulls, within 15 days, without the researcher knowing the previous analyses. The Kappa Coefficient of Concordance was applied, obtaining an interobserver agreement equal to 0.75 and an intraobserver agreement equal to 0.77, resulting in a strong agreement for both situations.

To characterize the population affinity of the three contemporary collections studied, 328 skulls were analyzed using the morphoscopic features available in the software hefneR, present in the free access platform osteomics.com. Eleven morphological indicators were analyzed: anterior nasal spine (ANS), inferior nasal aperture (INA), interorbital width (IOB), malar tubercle (MT), nasal aperture width (NAW), nasal bone contour (NBC), nasal prominence (NO), post-bregmatic depression (PBD), supranasal suture (SPS), transverse palatal suture (TPS), and zygomaticomaxillary suture (ZS).

In hefneR software, population groups are clustered into four strata according to geographic ancestry: African, European, Asian, and Native American. For each morphoscopic trait, the program presents illustrations of the trait to be evaluated to compare with the sample under study. The illustrations represent two to five forms of variations of the same trait, depending on the analyzed morphoscopic trait. If the examiner cannot identify a specific feature in a skull, or if it is not present due to the absence of the bone where it would be located, the program gives the option to mark the alternative 'absent'. Once all the data has been entered, the probability of the individual belong to a given population group is calculated at the end of the analysis.

The collected data were initially entered into a database in Microsoft Office Excel® 2010 and later transferred to the IBM© SPSS® software (Statistical Package for the Social Sciences) for Windows version 22.0 for statistical analysis. In addition to descriptive statistics, which aimed to characterize the studied sample, inferential statistics were used, represented by the Chi-Square and Fisher's exact tests. A confidence interval of 95% and a p-value <0.05 was considered for statistical analyses.

RESULTS

The total number of skulls from the three osteological collections was 328. The CEAF/FOP/UPE was the collection with the most significant number of samples, corresponding to 71.3% of all the skulls examined (Table 1).

Table 1. Sample distribution according to the osteological collection

Osteological collection	N	%
CEAF/FOP/UPE	234	71.3
LAOF/UFPE	43	13.1
LIHOF/UFPE/CAV	51	15.5
Total	**328**	**100.0**

It was observed that there was a predominant composition of African and European ancestral groups when the data was analyzed using the hefneR software when considering the set of skulls from the three collections (Table 2).

Table 2. Population affinity of the sample studied

Population affinity	N	%
African	142	43.3
European	132	40.2
Asian	41	12.5
Amerindian	13	4.0
Total	**328**	**100.0**

Tables 3 and 4 show the eleven variables called morphoscopic traits with their respective classifications, indicating the highest prevalence of the ancestral group. According to the Chi-square test and the Fisher's Exact test, ten of the eleven morphoscopic traits analyzed showed significant results for the analysis of population affinity ($p<0.005$). Only the MT variable (table 3) was not considered statistically significant concerning population affinity between the groups studied.

The African sample was characterized as the most predominant morphoscopic features (Tables 3 and 4): anterior nasal spine with medium projection; wide nasal aperture width; wide interorbital width; high and rounded nasal bone contour; nasal prominence absent; post-bregmatic depression present; supranasal suture closed but visible; transverse palatine suture with M-shaped deviation; zygomaticomaxillary suture with a non-angled design; inferior nasal aperture with a right angle or mild edge; and malar tubercle with a projection between two or fewer millimeters or between two and four millimeters.

Thus, the African group of the studied osteological collections presented nine morphoscopic traits considered relevant for the characterization of this ancestral group once the inferior nasal aperture and the malar tubercle (table 3) were less significant variables for the characterization of the African population affinity.

For the Amerindian sample of the studied collections, ten morphoscopic traits considered significant for the characterization of this ancestral group were obtained, except for the zygomaticomaxillary suture (Table 4), because it presents two characteristics with the same percentage of frequency (suture without angle and suture with only one angle). It is inferred that this variable was not significant for characterizing the Amerindian ancestral population in these collections. It is important to point out that the number of individuals in this sample was relatively smaller in relation to the African and European groups, so there may be a statistical discrepancy in the percentage of this group compared to the others (Table 2).

The profile observed for this group in the sample studied was of individuals with: anterior nasal spine with medium projection; inferior nasal aperture with a right angle; narrow interorbital width; malar tubercle with a projection between two and four millimeters; medium nasal aperture width; steep nasal bone contour with narrow plateau; absent nasal prominence; absent post-bregmatic depression; closed but visible supranasal suture; and transverse palatal suture with posterior bulging (table 3 and 4).

In the analysis of the Asian sample, all variables were significant in characterizing this group (Tables 3 and 4), presenting as characteristics: absent nasal spine; inferior nasal aperture with a right angle; medium interorbital width; malar tubercle with a projection between two and four millimeters; width of the middle nasal aperture; steep nasal bone contour with a wide plateau; no overgrowth (projection) of the nasal bone; absence of post-bregmatic depression; closed but visible supranasal suture; M-shaped transverse palatal suture; and zygomaticomaxillary suture without angle.

The European group of the analyzed collections presented the eleven significant variables having as predominant characteristics (Tables 3 and 4): long anterior nasal spine; inferior nasal aperture with a smooth edge; medium interorbital width; malar tubercle between two and four millimeters; narrow nasal aperture width; steep nasal bone contour with a narrow plateau; no overgrowth (projection) of the nasal bone; the presence of post-bregmatic depression; closed but visible supranasal suture; M-shaped transverse palatal suture; and zygomaticomaxillary suture with an angle.

For this European group, disagreements were observed in four variables concerning the same characteristics described for this group by Hefner[7], to whom Europeans do not present a projection on the malar tubercle (Table 3). The nasal bone contour has a triangle shape without plateau (Table 3), they do not present a post-bregmatic depression (Table 4), and the zygomaticomaxillary suture is most often without an angle or with an angle (Table 4).

Considering only the European and African population groups, which were the most prevalent in the collections studied (Table 2), the main variables that differentiated these groups were ANS, IOB, NAW, NBC, and ZS.

Table 3. Significance of morphoscopic traits for population affinity according to the ancestral group

Variables	Population affinity African n (%)	Amerindian n (%)	Asian n (%)	European n (%)	p-value
ANS (Anterior nasal spine)					
Absent	40 (32.0)	2 (15.4)	18 (51.4)	8 (6.3)	< 0.001 *
Medium	56 (44.8)	9 (69.2)	12 (34.3)	55 (43.3)	
Long	29 (23.2)	2 (15.4)	5 (14.3)	64 (50.4)	
INA (Inferior nasal aperture)					
Total inclination	12 (8.7)	0 (0.0)	2 (5.0)	0 (0.0)	< 0.001 **
Slightly angled inclination	37 (26.8)	3 (23.1)	4 (10.0)	2 (1.5)	
Right angle	40 (29.0)	8 (61.5)	29 (72.5)	17 (12.9)	
Mild edge	39 (28.3)	2 (15.4)	3 (7.5)	73 (55.3)	
Pronounced edge	10 (7.2)	0 (0.0)	2 (5.0)	40 (30.3)	
IOB (Interorbital width)					
Narrow	4 (2.8)	8 (61.5)	4 (9.8)	50 (38.5)	< 0.001 *
Intermediate	31 (22.0)	5 (38.5)	31 (75.6)	67 (51.5)	
Large	106 (75.2)	0 (0.0)	6 (14.6)	13 (10.0)	
MT (Malar tubercle)					
No prominence	15 (10.6)	0 (0.0)	2 (4.9)	6 (4.6)	0.166 **
2 millimeters or less	44 (31.0)	4 (30.8)	11 (26.8)	39 (29.8)	
Between 2 and 4 millimeters	46 (32.3)	9 (69.2)	16 (39.0)	52 (39.6)	
4 millimeters or more	37 (26.1)	0 (0.0)	12 (29.3)	34 (26.0)	
NAW (Nasal aperture width)					
Narrow	7 (5.1)	1 (7.7)	2 (5.3)	65 (52.0)	< 0.001 *
Medium	45 (33.1)	10 (76.9)	27 (71.0)	49 (39.2)	
Large	84 (61.8)	2 (15.4)	9 (23.7)	11 (8.8)	
NBC (Nasal bone contour)					
Low and rounded	32 (23.4)	0 (0.0)	0 (0.0)	0 (0.0)	< 0.001 **
High and rounded	50 (36.4)	2 (15.4)	6 (15.0)	21 (16.4)	
Angled with a wide plateau	19 (13.9)	1 (7.7)	25 (62.5)	32 (25.0)	
Angled with a narrow plateau	32 (23.4)	10 (76.9)	8 (20.0)	52 (40.6)	
No plateau	4 (2.9)	0 (0.0)	1 (2.5)	23 (18.0)	

(*) Chi-Square test (**) Fisher's exact test.

Table 4. [Continuation] Significance of morphoscopic traits for population affinity according to the ancestral group.

Variables	Population affinity				p-value
	African n (%)	Amerindian n (%)	Asian n (%)	European n (%)	
NO (Nasal overgrowth)					
Absent	72 (61.5)	8 (66.7)	25 (83.3)	58 (51.3)	0.014 *
Present	45 (38.5)	4 (33.3)	5 (16.7)	55 (48.7)	
PBD (Post-bregmatic depression)					
Absent	51 (36.7)	7 (58.3)	28 (71.8)	58 (45.0)	0.001 *
Present	88 (63.3)	5 (41.7)	11 (28.2)	71 (55.0)	
SPS (Supranasal suture)					
Obliterated	38 (27.3)	4 (30.8)	4 (9.8)	24 (18.3)	0.020 *
Open	41 (29.5)	2 (15.4)	9 (22.0)	50 (38.2)	
Closed but still visible	60 (43.2)	7 (53.8)	28 (68.2)	57 (43.5)	
TPS (Transverse palatal suture)					
Without major deviations	21 (17.5)	1 (11.1)	6 (17.1)	19 (15.3)	0.004 **
Anterior bulging	40 (33.3)	0 (0.0)	7 (20.0)	44 (35.5)	
M-shape deviation	47 (39.2)	3 (33.3)	18 (51.5)	56 (45.2)	
Posterior bulging	12 (10.0)	5 (55.6)	4 (11.4)	5 (4.0)	
ZS (Zygomaticomaxillary suture)					
Suture without angle	72 (52.9)	6 (46.2)	23 (56.1)	38 (31.4)	0.003 **
Suture with one angle	37 (27.2)	6 (46.2)	11 (26.8)	61 (50.4)	
Suture with two or more angles	17 (12.5)	0 (0.0)	2 (4.9)	10 (8.3)	
No suture	10 (7.4)	1 (7.6)	5 (12.2)	12 (9.9)	

(*) Chi-Square test (**) Fisher's exact test.

DISCUSSION

Establishing an individual's identity involves legal, ethical, and social circumstances. In this sense, estimating population affinity is important because it facilitates the elaboration of the examined biotype for comparison with previous data, added to the other aspects of the complete biological profile of the individual[9].

Population affinity as one of the requirements for estimating the individual's biological profile has been increasingly discussed and empirically explored in the forensic literature[10]. In the present research, a methodology was approached, focusing on estimating the population affinity based on genealogical peculiarities according to the respective regions and geographic ancestries.

An observer's experience and careful perception of human anatomical variability are necessary to estimate the population affinity using the nonmetric method. The morphoscopic analysis does not require instruments, and the bone accidents are easily observable[11].

Even with all the difficulties concerning the analysis of population affinity in Brazilian skulls, and despite several metric and nonmetric methods employed for this estimation, forensic anthropologists must consider that it is not only one characteristic or a set of them that defines an ancestral group[12].

In agreement with the arguments of Urbanová et al.[13], one of the factors that make the analysis of population affinity in mixed populations difficult is the fact of the low intra-population homogeneity since the genetic crossing of different populations induces a more significant biological variation that hinders the identification of a specific ancestral group.

Regarding divergences in morphoscopic traits, Plens et al.[14] stated that samples based on the methods used in Brazil present some differences because the population groups have a small sample number, consequently making uncertain results when not employed in the population in which it was created. This reality was observed in the present study concerning the Asian group, for example, since the sample n of the collections was 41 skulls described as Asian, while the sample n of Hefner's study[7] was 75 skulls belonging to the Asian ancestral group.

It is noteworthy that the hefneR database does not have Brazilian samples, which is a probable disadvantage since the accuracy of the program is directed to more specific populations because, even with common characteristics, they are distinct populations. Thus, the methods should be adapted and tested in each region, and it is essential to insert information in the software database that seeks to approximate the results more closely for the case of miscegenated populations such as the Brazilian one.

According to the present study's analysis, the groups with the highest occurrence in the contemporary collections were African and European population affinities, a credible result when analyzing the history of the Brazilian people, as stated by Nascimento et al.[15], regarding its historical process of colonization.

According to Vanrell[16], later, with each population's social and cultural evolution, the navigations and slave trade were crucial factors in generating the miscegenation process that formed the different contemporary peoples, such as the Brazilian one. This argument corroborates data from the Brazilian Institute of Geography and Statistics (IBGE) - 2010 survey[17], which attested that the Brazilian population was historically constituted by immigrants from European populations, enslaved people from African populations, and Native Americans.

The proportion of the individual contribution of each population varies according to the region of the country, and these regions present differences due to the colonization models. For example, some states in Brazil's South and Southeast regions have individuals with more European population affinity, the North region with more native formation, and the Northeast region more related to African peoples[16,18].

Therefore, the regional development of Forensic Anthropology and the research in different population groups is of fundamental importance, especially in cases where population variation can cause problems in identifying a native individual from a particular geographical region, with the application of standards developed for distinct populations[19].

In a country like Brazil, due to its continental extension and the variation of colonizing groups, with known differences among its regions, there is a great need for more studies like the one carried out here, which investigate these diversities and allow obtaining the profile of population affinity of Brazilians, considering their historical and regional peculiarities.

The analysis of the population affinity of the African, Amerindian, Asian, and European population groups from the Brazilian osteological collections studied showed that the morphoscopic traits observed were statistically significant, except for the malar tubercle (MT) variable.

This study showed some factors that make it difficult to achieve greater accuracy in terms of describing the Brazilian population affinity more forcefully, one of them being the number of samples from the four ancestral groups since the Asian and American Indian groups obtained a discrepant quantity concerning the African and European groups, and a pseudo result may occur in these groups with a smaller sample number.

The lack of samples from Brazilian populations in population affinity reference databases makes more precise work difficult since they are compared to non-mixed populations. It is a real challenge to adjust foreign methods to Brazilian populations, leading to a lack of confidence in the results obtained.

CONCLUSION

Despite all the difficulties that can be noted regarding the study of population groups, it is of the utmost importance to carry out more studies that investigate these diversities and obtain the profile of the population affinity of Brazilians, considering their historical and regional peculiarities.

Conflict of interest

There are no known conflicts of interest associated with this publication, and there has been no significant financial support for this work that could have influenced its outcome.

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