

## Original Article

# Visual Inspection of Standard Photographs Taken from Skull and Mandible to Set Anthropological Profile: A Pilot Study

Paula Barreto Costa, Luciana Vigorito Magalhães, Juliane Bustamante Sá dos Santos, Marco Aurélio Guimarães, Ricardo Henrique Alves da Silva<sup>1</sup>

From the Department of Pathology and Forensic Medicine, Ribeirão Preto Medical School, University of São Paulo, <sup>1</sup>Department of Stomatology, Public Health and Forensic Odontology School of Dentistry of Ribeirão Preto, University of São Paulo, Ribeirão Preto, SP, Brazil

Received: 23 July 2020.  
Revised: 05 August 2020.  
Accepted: 27 April 2021.  
Published: 30 June, 2021.

## INTRODUCTION

Identity is the particular set formed by morphological and psychical characteristics capable of characterizing each human being and attributing unique qualities.<sup>[1]</sup> Human identification is a process of extreme relevance in the social context, since it can act in the resolution of criminal investigations and in civil cases.<sup>[2]</sup>

The process of human identification requires the use of scientific methods based on qualitative and quantitative variations of the human body.<sup>[3]</sup> According to INTERPOL, primary identification methods are DNA, ridgeology (fingerprints) and dental analysis. They are defined as those capable of establish identity without complementary methodologies and are considered the most reliable in human identification.<sup>[4]</sup>

Despite the effectiveness of the primary identification methods, these are based on comparison processes, requiring the prior information of the victim or possible preestablished suspects, but access to antemortem information is often not possible.<sup>[5]</sup> The

## ABSTRACT

**Background:** Despite the effectiveness and accuracy of the primary methods of human identification based on comparison between post- and antemortem information, in cases where there is no possibility of confrontation due to the absence of antemortem data, auxiliary methods can establish a profile of the victim and direct a search that may culminate in identification. Forensic anthropology is the field that can assist in human identification cases through the analysis of bone remains, which can collaborate in the definition of a possible profile of the victim, called an anthropological profile.

**Aim:** Analyze the applicability of the visual inspection of standard photographs of the skull and mandible for sex, age, and ancestry.

**Materials and Methods:** Ten skulls and their respective jaws were photographed, and a file with all the photographs was made available by an online platform to a group of ten criminal experts (specialized in forensic odontology) who filled a form with information about sex, ancestry, and age.

**Results:** Were obtained percentages of correctness and error of 67.86% and 32.14%, respectively, for sex determination, 88.57% and 11.43% for age estimation, and 63.57% and 27.86% for ancestry, with 8.57% of responses left blank in the last one.

**Conclusion:** Visual inspection of the standard photographs of the skull and mandible for the establishment of anthropological profile presented limited findings, and need to be carefully analyzed and applicable only if the direct examination is not possible..

**KEY WORDS:** *Forensic anthropology, forensic dentistry, photography, victim identification*

secondary methods are used in an attempt to establish a profile of the victim and direct the search that can culminate in identification.

Forensic anthropology is a science that can help through the analysis of bone remains that can collaborate in the estimation of a possible profile of the victim, called an anthropological profile. Within this profile, it is possible to estimate characteristics such as sex, age, height, and ancestry, and the remains may indicate the moment of death, presence of traumas, and possible pathology that led to death.<sup>[6]</sup>

With regard to the anthropological profile, it is known that the skull is able to provide a lot of information. Although most of the bones that are found are not complete, in a large number of cases the skull is present, as was verified in a survey carried out on bones sent to a Center of Legal Medicine in Brazil, analyzing the period between the years of 2007 and

## Address for correspondence:

Dr. Ricardo Henrique Alves da Silva, E-mail: [ricardohenrique@usp.br](mailto:ricardohenrique@usp.br)

This is an open access journal, and articles are distributed under the terms of the Creative Commons Attribution-NonCommercial-ShareAlike 4.0 License, which allows others to remix, tweak, and build upon the work non-commercially, as long as appropriate credit is given and the new creations are licensed under the identical terms.

For reprints contact: [WKHLRPMedknow\\_reprints@wolterskluwer.com](mailto:WKHLRPMedknow_reprints@wolterskluwer.com)

**How to cite this article:** Costa PB, Magalhães LV, Santos JBS, Guimarães MA, Silva RHA. Visual Inspection of Standard Photographs Taken from Skull and Mandible to Set Anthropological Profile: A Pilot Study. *Int J Forensic Odontol* 2021;6:3-7.

Access this article online	
Quick Response Code: 	Website: <a href="http://www.ijfo.org">www.ijfo.org</a>
	DOI: 10.4103/ijfo.ijfo_16_20

2009, where about 87.5% of these skeletons had the skull present.<sup>[7]</sup>

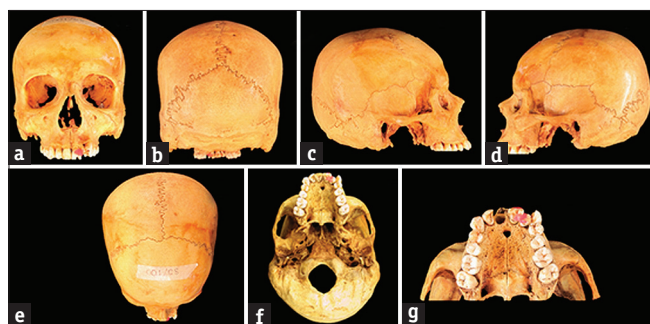
However, even with bone remnants available, sometimes the forensic service cannot count on trained professionals to perform this specific examination, and the absence of these professionals may end up leading to lack of technical-scientific analysis and devaluation of available evidence.<sup>[8]</sup> An alternative could be photographs of bone remnants with useful information to anthropology so that, through the inspection of these images, a trained professional, even if at a distance, could assist to set an anthropological profile. For this purpose, the use of photographic protocols is important to make the process more agile and practical.<sup>[9]</sup>

Scorsato, in 2012, showed that photographs have a great contribution to the forensic sciences regarding the cases of identification, description, and control of individuals.<sup>[10]</sup> Even so not much is known about their potential in establishing an anthropological profile and whether this profile will be similar to that established by the actual examination of the bone. Thus, the aim of this study was to analyze the applicability of the visual inspection of standard photographs of the skull and mandible for the determination of sex, age, and ancestry within the establishment of the anthropological profile.

## MATERIALS AND METHODS

The study was approved by the Research Ethics Committee (CAAE: 62490916.3.0000.5419). The sample of this pilot study consisted of ten skulls and their respective jaws, all belonging to stored skeletons. The skulls were photographed according to the protocol preestablished by the researchers in order to cover the greatest number of possible characteristics, addressing them in frontal, posterior, right lateral, left lateral, upper, lower, and occlusal photographs [Figure 1]. In relation to the mandible, photographs were taken from the frontal, posterior, right lateral, left lateral, and occlusal views [Figure 2].

After the photographic protocol, a file with the photos of all the views of the ten skulls and mandibles became available by an online platform for a group of ten participants. The participants were all dentists who work in forensic services as criminal experts or forensic odontologists, and used to work on anthropological analysis. Upon accessing these images, the volunteers proceeded to the analysis of the photographs and



**Figure 1:** Demonstration of the photographic protocol performed in the skull containing the frontal (a), posterior (b), right lateral (c), left lateral (d), upper (e), inferior (f), and occlusal (g) views

fill out an online form, which contained questions about the anthropological profile.

In this form, the participants evaluated questions about ancestry – being able to choose among Caucasian, Negroid, and Mongoloid; sex – being able to choose between male or female; and age – being able to choose among child (up to 11 years), teenager (12–18 years), adult (19–59 years), and elderly (60 years or more). The criteria used for this categorization were based on the report information used at the Center of Legal Medicine to human identification, which had previously been issued for each skeleton.

The forms were answered by each participant according to their individual knowledge of anthropology. After completed by the participants, the forms were sent back to the researcher who compared the anthropological profile established through the visual inspection of the photos with the anthropological profile established in the official report issued by the Laboratory of Forensic Anthropology. If the participant’s answer matched the answer that had been issued in the official report, it was considered correct, and if it was different from that of the report, it was considered incorrect. Data were processed using Microsoft Excel® (Microsoft®, USA), and subjected to descriptive statistical analysis.

## RESULTS

The evaluation of the results related to the sex determination showed a total correctness of 67.86% in the answer, whereas the incorrect answers totaled 32.14%. Regarding the age estimation, it was possible to detect the highest hit rate, with 88.57% of responses in agreement with the expert’s report, and a percentage of only 11.43% of disagreed answers considered incorrect. About ancestry estimation, it was possible to identify the lowest hit rate among the analysis, where 63.57% of the



**Figure 2:** Demonstration of the photographic protocol performed in the mandible containing the right lateral (a), anterior (b), left lateral (c), posterior (d), and occlusal (e) views

**Table 1: Results referring to the sex, age, and ancestry estimation**

	Sex (%)	Age (%)	Ancestry (%)
Correct answers	67.86	88.57	63.57
Incorrect answers	32.14	11.43	27.86
No answers	-	-	8.57
Total	100.00	100.00	100.00

answers were correct and 36.43% of the answers were not successful in estimating this characteristic, being 27.86% of incorrect answers and 8.57% who chose not to respond. The data are observed in Table 1.

## DISCUSSION

The establishment of the anthropological profile depends on several factors to be considered as the condition of the bone, what elements will be analyzed, what methods will be used, and the examiner's experience and knowledge.<sup>[11]</sup> In many cases, however, there are no trained professionals in the official expert teams for such profiles to be drawn, so there is a need for viable alternatives to this process.

In Brazil, forensic odontology is categorized as a specialty within odontology, and professionals in this area are able to perform human identification in alive, dead, skeleton, or even fragmented remains. It is up to these professionals the civil, labor, administrative, and criminal inspection.<sup>[12]</sup> The criminal experts and forensic odontologists act as official government experts to assist the Justice.

With the continuous development of technology, it is increasingly easy to take high-quality photos, which represent the reality with great fidelity and send practically in real time to any part of the world. The use of photographs has already been successful in human identification processes previously, as reported by Terada *et al.*<sup>[13]</sup> with the use of smile photographs and Silva *et al.*<sup>[14]</sup> in the analysis of the dental alignment. Miranda *et al.*<sup>[15]</sup> also demonstrated a case using photography for human identification through superimposition, highlighting the incisal outline (canine to canine), in which there was no medical and dental documentation.

Another study about photographs was done for age estimation using smartphone applications but proved not to be such an effective method for estimating age in women.<sup>[16]</sup> Its use for the anthropological profile establishment is not clear explored, and in this study, we used standard photographs of the skull and mandible in order to verify the possibility for this purpose.

During the establishment of the anthropological profile, the first point to be defined is the sex determination.<sup>[17]</sup> This due to the influence of sex in the definition of the other topics that make up the profile, since the methods for estimating age and height, for example, are directly related to the fact that the bone is identified as male or female.<sup>[18-20]</sup>

The skull has several characteristics of sexual dimorphism that provides substantial information for anthropological analyzes, such as glabella, forehead, mastoid process, styloid process, among others that lead to sex determination. It is also possible to find this type of information in the mandible, using characteristics as robustness, pronation of crests of muscular insertion, and arching of the bone.<sup>[21]</sup>

In the results obtained through the inspection of the photographs performed by the participants, when addressing the sex characteristic, 67.86% of the responses were correct and the percentage of errors was 32.14%. No studies that involve the attempt to establish an anthropological profile

by analyzing photos are available, not even including only sex determination, but the study of Amores-Ampuero, in 2017,<sup>[22]</sup> when analyzing the dimorphism of the skull taking into account its base and foramen magnum, presented higher accuracy percentages than those found in this study, reaching 75.7%. However, metric methods were used to base its data, which could justify better results since the present study was based only in qualitative analysis.

Another relevant point to be considered is the fact that the pelvis bone, as reported by authors such as Krishan *et al.*, in 2016,<sup>[23]</sup> and Lesciotta and Doershuk, in 2018,<sup>[24]</sup> is the primary choice structure in estimating sex because it shows evident reproductive differences. When it is present in the bone remains, such bone structure is the key point in the determination of sex, and therefore, its possible access for analysis in the photographs made available to the participants could increase the index of research success in the definition of sex.

For age estimation, it is possible to act by checking the closure of cranial sutures during bone analysis.<sup>[25,26]</sup> The age of an individual tends to grow in proportion to the degree of obliteration of the sutures; only a few suture segments can reach the ages of 70 and 80 years, being helpful in identifying people of advanced age.<sup>[27]</sup> In the present study, the accuracy index for the age estimation by the analysis of skull and jaw photographs was 88.57%, the most substantial among the characteristics analyzed.

However, the high success rate obtained in the results of this study may be correlated with the range of available age groups in the accessible response sheet for the participants. The choice of the age ranges was justified by what is established by the Child and Adolescent Statute,<sup>[28]</sup> and the final age group was defined according to the Statute of the Elderly,<sup>[29]</sup> leaving the "adult" between them. The range of the age groups may have facilitated classification by the participants, thus increasing assertive responses, which would not necessarily indicate a correct analysis of age estimation methods.

Sinthubua *et al.*, in 2016,<sup>[30]</sup> demonstrated a possible successful correlation between the age estimated by maxillary sutures and the actual age of the individuals. However, in the study by Ruengdit *et al.*, in 2020,<sup>[27]</sup> it was reported that the use of sutures for age estimation is so erratic in some studies that the fluctuating bias and high inaccuracy make appear to be fairly useless in forensic context. However, this tendency to provide erratic information does not mean that this method is useless. They show a good relationship between suture closure and age with the use of the right sutures in combination within particular age groups. Thus, for the age estimation, it would be ideal to associate more reliable methods with the analysis of the cranial sutures or even with other bones to reduce the eventuality of errors. The using of imaging technology with higher image resolution could provide better details about the suture closure characteristics, being also a possibility to improve this method in future.

For the ancestry evaluation in bones, several characteristics are related to dimorphisms, such as skull length, skull breadth, sagittal contour, zygomatic bones, zygomaticomaxillary suture

shape, the shape of the orbits, postbregmatic depression, mandibular ramus breadth, nasal aperture, anterior nasal spine, nasal profile, nasal contour, alveolar prognathism, and the shape of the mandible.<sup>[31]</sup> Among the results obtained, the ancestry characteristic was the one with the lowest hit rates, totaling 63.57% of correct answers, 27.86% of erroneous answers, and 8.57% of answers left blank.

Iskan and Cotton, in 1985,<sup>[32]</sup> evaluating the pelvis for ancestry estimation demonstrated a 75% better hit rate when evaluating a single skeletal structure or measure. Concerning skull analysis, Thomas *et al.*, in 2017,<sup>[11]</sup> obtained an accuracy of around 90.9% and older studies, such as DiBennardo and Taylor, in 1983,<sup>[33]</sup> also had a higher percentage of success, reaching 96.9%, but these included, in addition to the remaining ones, metric methods which could reinforce the information found and give more support to the estimation of the ancestry, besides carrying out the analysis through the presence of the bones.

A relevant fact to estimate ancestry is that, although extremely important within the anthropological profile, it can be specifically difficult due to the presence of large mixed population in Brazil, where a single skull can present singular characteristics of different ancestry, thus needing a combination of methods and the use of anthroposcopic and anthropometric features for decision-making.<sup>[34]</sup>

One point to be highlighted in this study is the fact that qualitative methods of analysis were used without the use of quantitative methods for complementation and evaluation of the characteristics, since these were photographs that did not allow success for metrical analysis. Lewis and Garvin, in 2016,<sup>[35]</sup> described that anthroposcopic evaluation methods have the advantage of being possible to be applied in fragmented bone remnants, do not require special equipment and have the possibility of being implemented in a practical and fast way. Sinhorini *et al.*, in 2019,<sup>[36]</sup> utilized a quantitative method to estimate sex and affirm the limitation of qualitative parameters when compared to the higher percentage of correct sex classification with the concomitant application of quantitative methods. However, Caple and Stephan, in 2016,<sup>[31]</sup> analyzed quantitative data and generated new exemplars of skull for ancestry and sex determination using photo-realistic morphotypes and they said that although the quantitative data are very important, they ignore the shape information between designated landmarks and all the color and texture information present in the skull.

It is worth mentioning that no information for comparison was provided to the volunteers, which may have made their analysis difficult. Caple and Stephan<sup>[31]</sup> demonstrated the importance of graphical illustrations in the establishment of an anthropological profile, where they could standardize anthroposcopic characteristics and specific anatomical variants that would support decision-making and increase the accuracy. Despite this, the intention of the study was not establish specific methods so that participants could choose the ones they were most familiar with in their daily work routines.

The choice of specific estimation methodologies may improve results in future studies.

In the forensic field, indexes of correctness are not liable for large margins of error because they are legal or criminal information. According to Lourenço, in 2010,<sup>[37]</sup> any estimation or diagnosis that is below 80% cannot be accepted, thus other studies would be necessary, testing the association of more methods with the analysis of the photographs or the introduction of new bone structures for an attempt to increase the indexes of correctness in the establishment of the anthropological profile.

## CONCLUSION

After the analysis of the results from this pilot study, it was possible to conclude that the visual inspection of the standard photographs of the skull and mandible for the establishment of anthropological profile presented limited findings, and need to be carefully analyzed and applicable only if the direct examination is not possible.

## ACKNOWLEDGEMENT

Center of Legal Medicine for the assistance with the collection of my data.

## FINANCIAL SUPPORT AND SPONSORSHIP

Nil.

## CONFLICTS OF INTEREST

There are no conflicts of interest.

## REFERENCES

1. Berketa JW, James H, Lake AW. Forensic odontology involvement in disaster victim identification. *Forensic Sci Med Pathol* 2012;8:148-56.
2. Vandurangi SK, Radhika MB, Paremala K, Reshma V, Sudhakara M, Hosthor SS. Adjunctive role of dental restorations in personal identification of burnt victims. *J Oral Maxillofac Pathol* 2016;20:154-61.
3. França GV. *Medicina Legal*. 8<sup>th</sup> ed. Rio de Janeiro: Guanabara Koogan; 2008.
4. International Crime Police Organization (Interpol). *Disaster Victim Identification Guide*; 2018. Available from: [https://www.interpol.int/content/download/589/file/18Y1344%20E%20DVI\\_Guide.pdf](https://www.interpol.int/content/download/589/file/18Y1344%20E%20DVI_Guide.pdf). [Last accessed on 2021 May 10].
5. Traithephanapai P, Mahakkanukrauh P, Kranioti EF. History, research and practice of forensic anthropology in Thailand. *Forensic Sci Int* 2016;261:167.e1-6.
6. Biancalana RC, Ortiz AG, Araújo LG, Semprini M, Galo R, Silva RH. Determinação do sexo pelo crânio: Etapa fundamental para a identificação humana. *Rev Bras Criminol* 2015;4:38-43.
7. Francisco RA, Velloso AP, Silveira TC, Secchieri JM, Guimarães MA. Forensic anthropology at Medico Legal Centre of the Faculty of Medicine of Ribeirão Preto/USP – Comparative study of cases from 1999-2009. *Medicine (University of São Paulo – Ribeirão Preto)* 2011;44:241-8.
8. Brasil JA, Musse JO. Caracterização da Perícia Odontológica em Instituto Médico Legal do Interior da Bahia. *Rev Bras Odontol Leg RBOL* 2015;2:35-47.
9. Yoshio I, Calixto LR. Fotografia de face na odontologia. *Rev Dent Press Estét* 2011;8:42-50.

10. Scorsato H. Uso da fotografia em processos de identificação e o método Bertillon – Século XIX. *Rev Estud Hist.* 2012;6(9). Available from <https://www.estudioshistoricos.org/edicion9/eh0911.pdf>. [Last accessed on 2021 May 10].
11. Thomas RM, Parks CL, Richard AH. Accuracy rates of ancestry estimation by forensic anthropologists using identified forensic cases. *J Forensic Sci* 2017;62:971-4.
12. Brazil. Consolidação das normas para procedimentos nos conselhos de odontologia. Resolution No 63. (June 2005). Available from: <http://transparencia.cfo.org.br/wp-content/uploads/2018/03/consolidacao.pdf>. [Last accessed on 2021 May 10].
13. Terada AS, Leite NL, Silveira TC, Seccieri JM, Guimarães MA, Silva RH. Identificação humana em odontologia legal por meio de registro fotográfico de sorriso: Relato de caso. *Rev Odontol Unesp* 2011;40:199-202.
14. Silva RF, Franco A, Picoli FF, Rodrigues LG, Tolentino PH, Mendes SD. Delineamento dental computadorizado das bordas incisais, em fotografias de sorriso, com finalidade pericial. *Rev Bras Odontol Leg Rbol* 2016;3:74-82.
15. Miranda GE, Freitas SG, Maia LVA, Melani RFH. An unusual method of forensic human identification: use of selfie photographs. *Forensic Sci Int* 2016;263:e14–e17.
16. Rezende Machado AL, Dezem TU, Bruni AT, Alves da Silva RH. Age estimation by facial analysis based on applications available for smartphones. *J Forensic Odontostomatol* 2017;35:55-65.
17. Curate F, Albuquerque A, Ferreira I, Cunha E. Sex estimation with the total area of the proximal femur: A densitometric approach. *Forensic Sci Int* 2017;275:110-6.
18. Bruzek J, Murail P. Methodology and reliability of sex diagnosis from the skeleton. In: Schmitt A, Cunha E, Pinheiro J, editors. *Forensic Anthropology and Medicine: Complementary Sciences from Recovery to Cause of Death*. New Jersey: Humana Press; 2006. p. 225-42.
19. Spradley MK, Jantz RL. Sex estimation in forensic anthropology: Skull versus postcranial elements. *J Forensic Sci* 2011;56:289-96.
20. Cataldo-Ramirez C, Garvin HM, Cabo L. A quantitative assessment of zygomatic projection for ancestry estimation. *J Forensic Sci* 2020;65:580-90.
21. Vanrell JP. *Odontologia Legal & Antropologia Forense*. 3<sup>rd</sup> ed. Rio de Janeiro: Guanabara Koogan; 2019.
22. Amores-Ampuero A. Sexual dimorphism in base of skull. *J Biol Clin Anthropol* 2017;74:9-14.
23. Krishan K, Chatterjee PM, Kanchan T, Kaur S, Baryah N, Singh RK. A review of sex estimation techniques during examination of skeletal remains in forensic anthropology casework. *Forensic Sci Int* 2016;165:e1-8.
24. Lesciotto KM, Doershuk LJ. Accuracy and reliability of the klasses *et al.* (2012) morphoscopic pelvic sexing method. *J Forensic Sci* 2018;63:214-20.
25. Chandra S, Dwivedy S, Sah K, Sinha S. Application of modified reverse panoramic radiograph on lambdoid suture for age estimation. *Quant Imaging Med Surg* 2015;5:519-23.
26. Boyd KL, Villa C, Lynnerup N. The use of CT scans in estimating age at death by examining the extent of ectocranial suture closure. *J Forensic Sci* 2015;60:363-9.
27. Ruengdit S, Troy Case D, Mahakkanukrauh P. Cranial suture closure as an age indicator: A review. *Forensic Sci Int* 2020;307:110111.
28. Brazil. Statute of the Child and Adolescent Act of 1990, Pub. L. No. 8.069 (July 13, 1990). Available from: <https://www.gov.br/mdh/pt-br/centrais-de-conteudo/crianca-e-adolescente/estatuto-da-crianca-e-do-adolescente-versao-2019.pdf>. [Last accessed on 2021 May 10].
29. Brazil. Elderly Statute Act of 2003. Pub. L. No 10.741 (October 1st. 2003). Available from: [http://www.planalto.gov.br/ccivil\\_03/leis/2003/110.741.html](http://www.planalto.gov.br/ccivil_03/leis/2003/110.741.html). [Last accessed on 2021 May 10].
30. Sinthubua A, Theera-Umpon M, Auephanwirivakul S, Ruengdit S, Das S, Mahakkanukrauh P. New method of age estimation from maxillary sutures closure in a Thai population. *Clin Ter* 2016;167:33-7.
31. Caple J, Stephan CN. Photo-realistic statistical skull morphotypes: New exemplars for ancestry and sex estimation in forensic anthropology. *J Forensic Sci* 2017;62:562-72.
32. Iscan MY, Cotton TS. The effect of age on the determination of race from the pelvis. *J Human Evol* 1985;14:275-82.
33. Dibennardo R, Taylor JV. Multiple discriminant function analysis of sex and race in the postcranial skeleton. *Am J Phys Anthropol* 1983;61:305-14.
34. Tinoco RL, Lima LN, Delwing F, Franceschini L Jr., Daruge E Jr. Dental anthropology of a Brazilian sample: Frequency of nonmetric Traits. *Forensic Sci Inter* 2016;102:e1-5.
35. Lewis CJ, Garvin HM. Reliability of the walker cranial nonmetric method and implications for sex estimation. *J Forensic Sci* 2016;61:743-51.
36. Sinhorini PA, Costa IA, Lopez-Capp TT, Biazevic MG, de Paiva LA. Comparative analysis of four morphometric methods for sex estimation: A study conducted on human skulls. *Leg Med (Tokyo)* 2019;39:29-34.
37. Lourenço AM. A fiabilidade do método de estimativa da idade à morte através das suturas cranianas em indivíduos adultos de meia-idade e idosos [Thesis]. *Fac Med Univ Coimbra* 2010..