ORIGINAL ARTICLE

Brazilian's dental anthropometry: Human identification

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Abstract

Background: Human stature and sex determination are significant data that can and should be used in criminal profiling in the human identification processes. Teeth are widely used in investigations because of their properties of resistance and uniqueness. **Aims:** The present study aimed to verify, by means of dental anthropometry, the correlation of these with the stature and sex. **Materials and Methods:** Measurements of linear (mid distal and incisor cervical) dental measurements were performed on the upper right teeth of Brazilians, aged between 18 and 30 years, being 100 male and 100 female participants. Linear dental measurements were measured with a digital caliper and stature was measured with a stadiometer. For the statistical analysis, the IBM® SPSS® 25 Statistics program was used. Kolmogorov–Smirnov, Pearson correlation, and Stepwise-Forward (Wald) logistic regression analyses were applied to sex determination and stature estimation. **Results:** The results indicated that all measures performed are dimorphic, but that lateral incisor and canine tooth measurements are statistically significant with a $P \leq 0.001$. The obtained model allows for sexing with 70.5% accuracy, being able to be used in anthropological studies in Brazilians. **Conclusion:** It can be concluded that dental measurements are useful tools to identify gender and the canine measurements also showed a strong and proportional correlation with stature, but it was not possible to establish a mathematical model for this.

Key words: Dental, human identification, sex determination, stature

Introduction

The process by which one attributes peculiarities and defines an individual is called human identification.[1] Given the difficulties encountered in human remains identification exams, as the number of subsidies found increases, the greater the chances of issuing a report with the positive identity of the individual.[2,3]

The teeth have the properties of mineralization and indestructibility[4,5] making it possible to obtain relevant information regarding ancestry, stature, age, and sex.[6,7]

Stature can be estimated using long-bone measurements[8,9] and also using dental measurements of the mandible using Carrea[10-12] and Lima *et al.*[3] method.

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Sex determination is an important information used in identification processes, and teeth can provide us with this information to a high degree of reliability.[5,13-16]

In view of this, the present study sought to verify if there is a proportional relationship between dental measurements with stature and sex.

Subjects and Methods

Sample

The sample consisted of 100 males and 100 females, aged between 18 and 30 years, with a mean age of 22.9 ± 3.27 years. Participants, who had uncorrupted central incisors, lateral, and upper right upper canine elements were included in the study. Individuals who reported hormonal problems, parafunctional dental habits, gingival hyperplasias, erosions in measurement areas, or who had undergone sex-change surgery were excluded from the study.

Ethical aspects

The Ethics Committee of the University of Dentistry of Piracicaba/UNICAMP approved the study (CEP/FOP/UNICAMP CAAE 87344418.8.0000.5418 de 03/05/2018), and the study was carried out in accordance with the Norms and Ethical Guidelines of Resolution No. 466/2014 of the National Health Council of the Brazilian Ministry of Health.

Methodology

A prior clinical examination discarded the participants that did not fit the criteria established by the research project. Information regarding gender and age was collected directly from the general registration document.

Anthropometric measurement

Stature

The stature was measured using an aluminum wall stadiometer with a maximum height of 2.200 mm. The participant was asked to lean against it, barefoot and in an upright position, with their head positioned with the Frankfurt plane parallel to the ground.

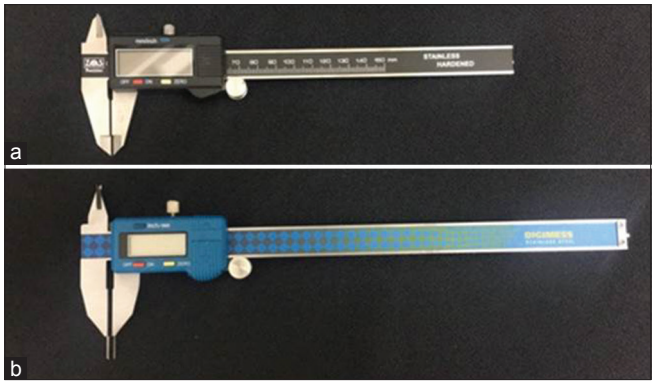


Figure 1: (a) Stainless® conventional digital pachymeter and (b) adapted pachymeter

Dental measurements

With a 150-mm stainless steel digital caliper adjusted and adapted [Figure 1], the mesiodistal and cervicoincisal measurements of the crowns and teeth were measured in millimeters: Central maxillary, lateral and canine incisors, always considering the largest measurement in the horizontal and sagittal planes [Figure 2], the right side was chosen randomly to standardize the study.

Statistical considerations

An intraexaminer calibration was performed beforehand, in which the dental measurements of 25 participants were checked three times in different periods with a concordance index of 0.93.

The data were inputted into MS Excel and then the IBM® SPSS® 25 USA statistics program was used for the analysis.

The sample consisted of 200 individuals, of which 100 males and 100 females, with the purpose of obtaining the same pairing. In relation to stature, these were grouped into three classes, as shown in Table 1.

A descriptive analysis was performed using the central tendency measurements as the mean and the dispersion measurements as the standard deviation for all variables [Table 2].

After checking the general characteristics of the sample, the data were submitted to the Kolmogorov–Smirnov test to verify their normality, as shown in Table 3. It was verified that all measures were presented within

Table 1: Sample distribution in relation to stature

	Frequência	%
144-159 cm	27	13,5
160-175 cm	120	60,0
>176 cm	53	26,5
Total	200	100,0

Figure 2: Dental measurements

the nullity hypothesis because all the values obtained indicated a value of $P \geq 0.05$, and parametric tests could be used.

Results

Sex determination

The six variables of the study were tested and applying logistic regression for sex determination using the stepwise-forward method (Wald), which goes from the simplest to the most complex model, it was observed that the variables ILS-DIC, CANINE-DMD, and CANINE-DIC were those defined for the elaboration of the best model [Table 4].

For all the variables selected, a Pearson's correlation was done, and there was a strong correlation for all [Table 5], thus confirming the regression test result and in the sequence, the Logito was elaborated.

SEX LOGITO = 13,847+ (0,569*ILS-DIC) + (−1,021*CANINE-DMD) + (−1,105*CANINE-DIC).

Table 6 reveals that the method results in 72.0% sensitivity, 69.0% specificity, and 70.5% accuracy proving to be effective in sex prediction over mere random hit, that is, values >0.5 (cut-off) would be considered "male" and smaller than 0.5 as "female."

Stature estimation

In relation to stature analysis, person correlation was also applied to the variables, and it was observed that there is a strong and positive correlation between stature and canine measurements. The ILS-DIC measure showed weak correlation [Table 7].

Table 2: Descriptive statistics

	Mean	Std. deviation	Min	Max	Sum
ICS-DMD	8.609	0.604	7.07	10.12	1721.88
ICS-DIC	10.008	1.040	6.49	12.80	2001.63
ILS-DMD	6.713	0.625	4.52	8.86	1342.69
ILS-DIC	8.510	0.964	4.55	11.32	1702.02
CANINE-DMD	7.733	0.624	5.79	9.13	1546.67
CANINE-DIC	9.771	1.100	6.85	14.16	1954.34

From this study, one can consider those canine measurements are directly proportional to stature, that is, when stature increases, canine measurements also increase. However, it was not possible to elaborate a mathematical prediction model.

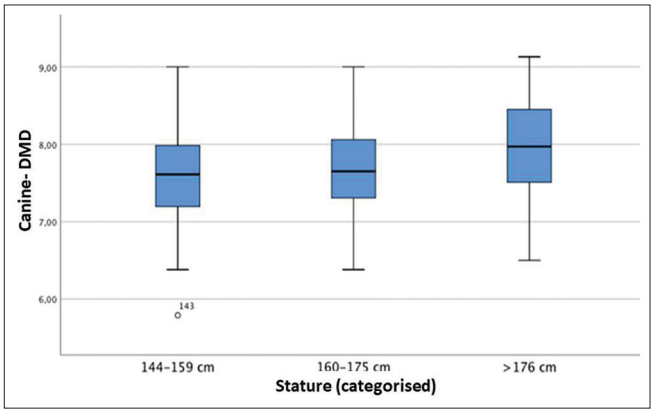
In the CANINE-DMD variable analysis, the measurements showed greater homogeneity, and it was observed that the width of the upper canine was very similar in the 144–159 cm and 160–170 cm groups, whereas individuals taller than 176 cm presented a mesiodistal distance canine median of 8 mm. Only, this group presented values >9 mm for this measurement [Graph 1].

Moreover, finally the CANINE-DIC presented greater value discrepancy and outliers [Graph 2].

Discussion

In the present study, when testing the regression model, a sex prediction accuracy of 70.5% in the upper right dental elements analysis was obtained, according to the data obtained by Peckmann *et al*.[5] (66.7% accuracy) in their study of the mesiodistal distances of the maxillary central incisors and canines.

Viciano *et al*.[17] concluded that canines are the most dimorphic teeth with a prediction index of 76.5% including in a study of adolescents. Already in 2013, Viciano *et al*.



Graph 1: Superior canine measurements mesiodistal distance

Table 3: Kolmogorov-Smirnov test for variables

	n	Normal parameters[a,b]		Most extreme differences			Test statistic	Asymp. Sig. (2-tailed)
		Mean	Std. deviation	Absolute	Positive	Negative		
ICS- DMD	200	8.609	0.604	0.044	0.044	-0.037	0.044	0.200[c,d]
ICS-DIC	200	10.008	1.040	0.049	0.030	-0.049	0.049	0.200[c,d]
ILS-DMD	200	6.713	0.625	0.060	0.042	-0.060	0.060	0.081[c]
ILS-DIC	200	8.510	0.964	0.047	0.033	-0.047	0.047	0.200[c,d]
CANINE- DMD	200	7.733	0.624	0.054	0.045	-0.054	0.054	0.200[c,d]
CANINE- DIC	200	9.771	1.100	0.032	0.032	-0.030	0.032	0.200[c,d]

[a]Test distribution is Normal. [b]Calculated from data. [c]Lilliefors Significance Correction. [d]This is a lower bound of the true significance.

Table 4: Stepwise-forward (Wald) logistic regression analysis for sex determination

Model Variables								
	B	S.E.	Wald	Df	Sig.	Exp (*B*)	95% C.I.for EXP (*B*)	
							Lower	Upper
ILS-DIC	0.569	0.238	5.705	1	0.017	1.766	1.107	2.816
CANINE-DMD	-1.021	0.306	11.136	1	0.001	0.360	0.198	0.656
CANINE-DIC	-1.105	0.245	20.286	1	0.000	0.331	0.205	0.536
Constant	13.847	2.719	25.927	1	0.000	1031687.695		

Table 5: Pearson correlation between model variables

	ILS-DIC	CANINE- DMD	CANINE- DIC
ILS- DIC			
Pearson Correlation	1	0.215**	0.681**
Sig. (2-tailed)		0.002	0.000
n	200	200	200
CANINE-DMD			
Pearson Correlation	0.215**	1	0.364**
Sig. (2-tailed)	0.002		0.000
n	200	200	200
CANINE- DIC			
Pearson Correlation	0.681**	0.364**	1
Sig. (2-tailed)	0.000	0.000	
n	200	200	200

**Correlation is significant at the 0.01 level (2-tailed)

Table 6: Frequency distribution and correct percentages for sex prediction

Prediction by model			
SEX		Correct	Percentage
Masculine	Feminine		
SEX			
Masculine	72	28	72,0
Feminine	31	69	69,0
% Total			70,5

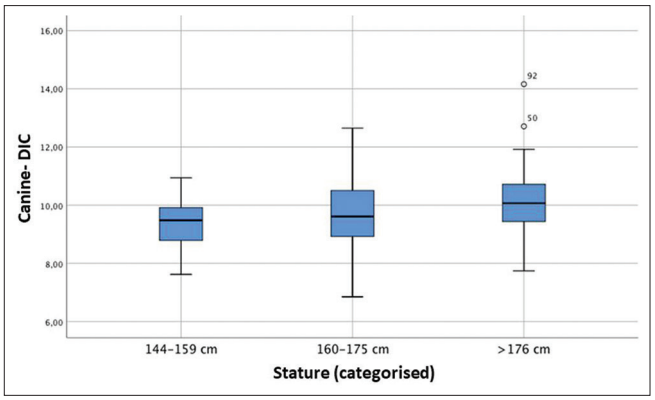
Cut-off value is 0,5

Table 7: Pearson correlation between model variables

	ILS-DIC	CANINE-DMD	CANINE-DIC	Height (Categorised)
ILS-DIC				
Pearson Correlation	1	0.215**	0.681**	0.12
Sig. (2-tailed)		0.002	0	0.089
n	200	200	200	200
CANINE- DMD				
Pearson Correlation	0.215**	1	0.364**	0.250**
Sig. (2-tailed)	0.002		0	0
n	200	200	200	200
CANINE- DIC				
Pearson Correlation	0.681**	0.364**	1	0.240**
Sig. (2-tailed)	0	0		0.001
n	200	200	200	200

**Correlation is significant at the 0.01 level (2-tailed).

had developed a model using canine measurements with prediction accuracy of between 78.1% and 93.1%.[18]



Graph 2: Upper canine incision cervical distance

Martínez *et al*.[14] validated regression models in 98 lower canines in the city of Bogotá, Colombia, obtaining 87.8% for males and 52.8% for females.

In the same line of significant results, after measuring 500 participants, Shankar *et al*.[4] concluded that the mesiodistal distances of the lower canines and the intercanine distance of the mandible provide good evidence for sexual identification. The intercanine distance was also evaluated by Júnior *et al*.,[19] with a success rate of 25% in sex determination.

Munoz *et al*.[20] also measured fifty canines in Spain and found that, of permanent canines, the lower ones are the most dimorphic, data also found in an analysis study of all permanent teeth by Sabóia *et al*.[21]

Even the studies pointing to the more dimorphic lower canines in accordance with that presented the systematic review by Pratapiene *et al*.[15] It is known that the jaw is often unavailable for analysis, as it is a small bone and disarticulated from the skull, and hence, studies with upper dental elements are of utmost importance.

In relation to stature estimation in this study, it could be observed that the shorter individuals have shorter upper canines. The first studies relating stature and dental measurements were by Carrea[10] who proposed a mathematical model using the measurements of the lower teeth. Furlan *et al*.[6] in validated Carrea's method in the north-western region of Paraná, Brazil, presenting a 91.6% accuracy index of stature prediction.

Bezerra *et al*.[22] replicated the Carrea technique paired with a modification proposed by Cavalcanti,[12] where they verified the reliability of the modified method compared to the original, achieving similar values for both techniques. However, Lima *et al*.[3] modified the Carrea technique and managed to achieve results more favorable to the estimate of height utilizing dental measures (arc and chord) of the mandible with and without malocclusion. It is known that the Carrea technique and/or other modified methods are

dependent on the existence of a complete arch of lower teeth, and in Brazil, this arch is not always present due to edentulism and/or the relation to the lack of a fully-featured set of teeth. This study sought a correlation between upper teeth and their height; however, no mathematical model was obtained for the estimate, and as such further studies are recommended.

Conclusion

It can be concluded that dental measurements are useful tools to identify gender and the canine measurements also showed a strong and proportional correlation with stature, but it was not possible to establish a mathematical model for this.

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Nil.

Conflicts of interest
There are no conflicts of interest.

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