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Odontometrics analysis from a commingled archaeological human population related to 1755 Lisbon's earthquake*

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Abstract

Introduction: The variation observed when studying odontometrics has immensely contributed over time to the investigation of hominid evolution and the population groups' diversity, according to their geographic distribution. The present study consists in the evaluation of odontometrics belonging to commingled human remains found in Academia das Ciências de Lisboa from the 1755 Lisbon's Earthquake. Aims: The first purpose is to comprehend if the odontometrics obtained in this study's sample fit its time and region, through the comparison of other populations in different locations. The second one is focused on the analysis of odontometrics' evolution through time, in the same region. Materials and methods: The whole sample of 1479 teeth was weighed in two different types of electronic scales and measured, using a digital caliper, through three diameters: mesiodistal (MD), buccopalatine (BP) and crown height (CH). Results: The average values of mesiodistal and buccopalatine diameter of upper incisors are respectively, 8.200 mm and 7.021 mm for the central incisor, and 6.296 mm and 6.209 mm for the lateral. The upper canine has an average value of mesiodistal diameter of 7.435 mm and an average value of buccopalatine diameter of 8.016 mm. The measurements revealed a high concentration of observations with values close to the median and few observations with distant values (very few outliers). Conclusion: Odontometrics obtained in Lisboa's sample are within the expected standards for that epoch. Plus, the results captured in recent studies reveal MD and BP diameters values slightly high.

Keywords: odontometry; mesiodistal diameter; buccopalatine diameter; population characteristics; tooth size evolution

Introduction

The earthquake of 1755 is known as one of the greatest natural catastrophes that Portugal has ever suffered. In the morning of November 1st, Lisboa and its suburbs were devastated by an earthquake, followed by a tsunami and fires which, together, caused an almost total destruction of the city and, consequently, thousands of deaths. Years later, in 2004, skeletal remains (including teeth articulated with the skull, the mandible and loose) of this tragedy were discovered in the Southern Wing of the Cloister of Academia das Ciências de Lisboa, while archaeological excavations were being conducted in the building (1). There is evidence that burial dates from the skeletal remains found in the Southern Wing of the Cloister of Academia das Ciências de Lisboa belong, indeed, to the 1755 Lisbon earthquake's population (1).

The teeth, being more resistant to diagenetic agents than bones (both ante-mortem and post-mortem) (2), represent the most durable structures in the body and, consequently, the best-preserved element in archaeological samples (3). On that account, teeth play a crucial role in anthropological, forensic, dental and genetic investigations, thus revealing extreme importance in situations of catastrophic events and, therefore, facilitating the study of disarticulated populations. In addition, dental morphology is essential in reconstructing the history of populations and evolutionary relationships, both globally and regionally (4,5).

All humans share a similar tooth structure. Yet, due to a complex interaction between a diversity of genetic and environmental factors, there are many variations among individuals and populations in teeth's size and morphology (6,7), which makes the dentition a major contributor to human beings' individuality (8).

Odontometrics – the measurement and study of tooth size – represent one of the main techniques used when studying the association between tooth crown dimensions and geographic distribution of modern human populations, therefore playing an important role in the comprehension of humans' biological diversity and phylogenetic affinities (9). Among all odontometrics, Mesiodistal (MD) and Buccopalatine (BP) Diameters and Crown Height are the most commonly applied measures (10).

The variation observed when studying odontometrics has immensely contributed over time to the investigation of hominid evolution and the population groups' diversity, according to their geographic distribution (11). In order to study this evolution in a given population, odontometrics measured in samples separated by thousands, or even millions, of years should be taken (12).

Among the various studies performed on skeletal human populations, it has been noticed a general tendency towards reduction of tooth size, reaching its lowest point in Mediaeval European populations. Even if that trend's cause is related to advancing cultural evolution, it remains unclear how the two correlate. Although Europeans or Caucasians' teeth size is considered small, odontometrics' variation in the contemporary European populations is not certain. Besides, it has also been detected a reversal of the reduction pattern in this measure. Therefore, it's suspected that European populations' teeth dimensions may suffer significant changes in short periods of time, as well as not being uniformly small (13).

With this being said, odontometrics are fundamental and irreplaceable when characterizing paleodemographically disarticulated populations, revealing themselves as a crucial method to Dental Anthropology.

There are two main purposes for this study. The first one is to comprehend if the odontometrics obtained in this study's sample – commingled and disarticulated human remains found in Academia das Ciências de Lisboa – fit its time and region, through the comparison with other populations in different locations. The second one is focused on the analysis of odontometrics' evolution through time, in the same region.

Materials and methods

In the interest of concretizing the proposed objectives, all 1479 teeth belonging to the sample were measured and weighed. From the total of 1210 loose teeth, 1034 are permanent and 176 are deciduous. The first ones can be separated into 361 incisors, 199 canines, 257 premolars

and 215 molars, which sums up to 1032 teeth since two teeth were excluded. From the total of 65 teeth articulated with skulls, 8 are incisors, 7 are canines, 23 are premolars and 27 are molars. From the total of 204 teeth articulated with mandibles, 21 are incisors, 16 are canines, 54 are premolars and 113 are molars.
The whole sample was weighted, according to its weight, in two different types of electronic scales: the Kern model (± 0.1g) for remains up to 600g (maximum weight) and the Salter 323 model (± 1g) for remains weighing more than 600g (maximum weight of 5kg). The dental measurements were taken using a digital caliper (Absolute Digimatic Caliper ®, Mitutoyo), with a

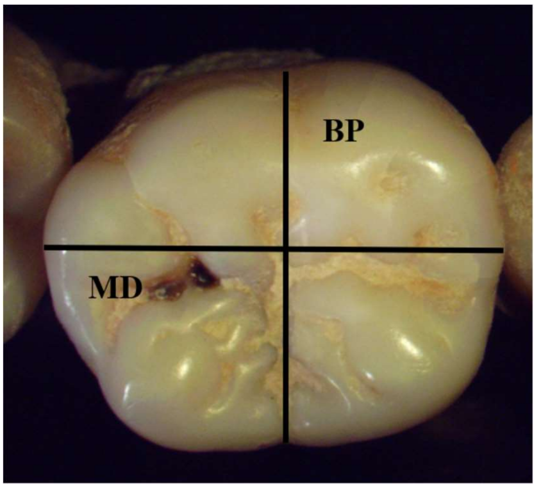

Figure 1. Example of mesiodistal and buccopalatine diameter measurements. BP – buccopalatine diameter; MD – mesiodistal diameter.

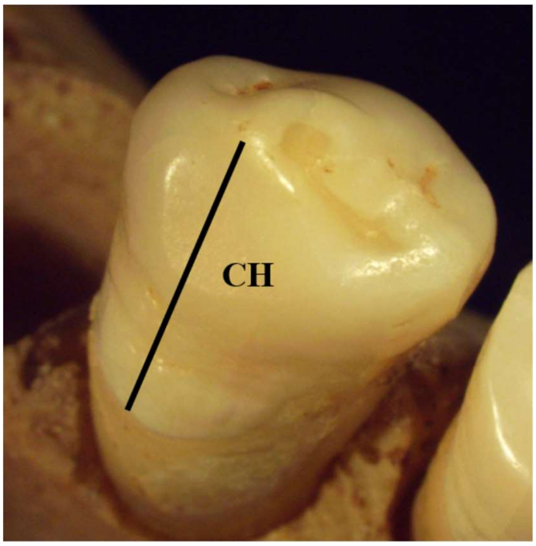

Figure 2. Example of crown height measure. CH – crown height.

nominal resolution of 0.01mm and an associated error of ± 0.02 mm.

In order to characterize paleodemographically this population through their teeth, there are three main measurements, according to Buikstra and Ubelaker (1994), which were used: the mesiodistal diameter (MD), the buccopalatine diameter (BP) and the crown height. The first diameter corresponds to the maximum width of the tooth crown in the mesiodistal plane, while the second one is defined as the widest diameter of the tooth, measured perpendicularly to the mesiodistal plane - Figure 1. Crown height (CH), obtained on the vestibular surface of the tooth, is measured from the cementoenamel junction (CEJ) to the incisal/occlusal surface on incisors, canines and premolars, whilst on molars this measure is taken by the distance between CEJ and the most inferior point in the middle of two cusps - Figure 2 (14).
This data was directly registered in a spreadsheet of Microsoft Office's program Excel, for Windows (2013). All data was introduced, verified and analyzed through IBM SPSS® software, 27th and 28th version.

Results
Regarding our sample, it was established a minimum number of 73 individuals (MNI). This determination was possible through the analysis of the frequency of each tooth in both dentitions (permanent and deciduous), concluding that the most frequent teeth were the permanent left superior central incisor (54 teeth) and the deciduous right superior lateral incisor (19 teeth).
For a better understanding of the results, the whole sample of 1479 teeth was divided into two different groups – upper and lower teeth. These groups where then subdivided according to different types of teeth – central incisors (I1), lateral incisors (I2), canines (C), first premolars (P1), second premolars (P2), first molars (M1), second molars (M2) and third molars (M3). The presence of "r" or "l" before a type of tooth (e.g. rP1) represents the side where that tooth belongs – right or left. It's crucial to note that, when it comes to the total of 1210 loose teeth (both upper and lower), measures were only taken on the permanent ones (1034 teeth).
This division method was applied to the sample since it has been noted, in previous studies, that measuring isolated teeth, compared to the ones articulated to the skull and mandible, produces larger values, due to the propensity to use the maximum crown size found, instead of relying on

anatomic contact points (15). Nevertheless, no significant differences were detected between articulated and loose teeth in this study and, therefore, all teeth of the same type were grouped together.
Table 1 provides the sample size, mean, standard deviation, minimum and maximum of MD, BP and CH for upper and lower teeth.
Hence, regarding the upper teeth, the values of MD diameter vary between 7.040 mm and 9.560 mm, having an average value of 8.200 mm and a standard deviation of 0.597 on tooth I1; vary between 4.290 mm and 7.310 mm, having an average value of 6.296 mm and a standard deviation of 0.590 on tooth I2; and vary between 6.150 mm and 8.900 mm, having an average value of 7.435 mm and a standard deviation of 0.527 on tooth C. On the lower teeth, the values of MD diameter vary between 4.300 mm and 6.440 mm, having an average value of 5.248 mm and a standard deviation of 0.451 on tooth I1; vary between 4.610 mm and 6.650 mm, having an average value of 5.589 mm and a standard deviation of 0.462 on tooth I2; and vary between 5.330 mm and 7.470 mm, having an average value of 6.561 mm and a standard deviation of 0.407 on tooth C. The statistical description of the results of the remaining measurements inherent to the teeth are available on Table 1.
The highest average values of mesiodistal and buccopalatine diameters are found on the first molar, but the mesiodistal diameter is greater in lower first molars while buccopalatine diameter is greater on upper first molars, as expected according to the dental morphology (14). Regarding the posterior upper teeth there is a downward trend in mesiodistal and buccopalatine diameters average values along the maxillary arch. However, this pattern does not repeat on the mandibular teeth, as the third lower molar seems to have higher values than the second molar.
Hence, it is possible to observe significant differences between measurements of different teeth and between lower and upper teeth in any of the three measurements, as well as small disparities of measurements on the same tooth type on the same group. The boxplot of MD diameter for the upper teeth (Figure 3) also reveals the same idea, a large concentration of observations with values close to the median and very few outliers. The boxplot of the remaining

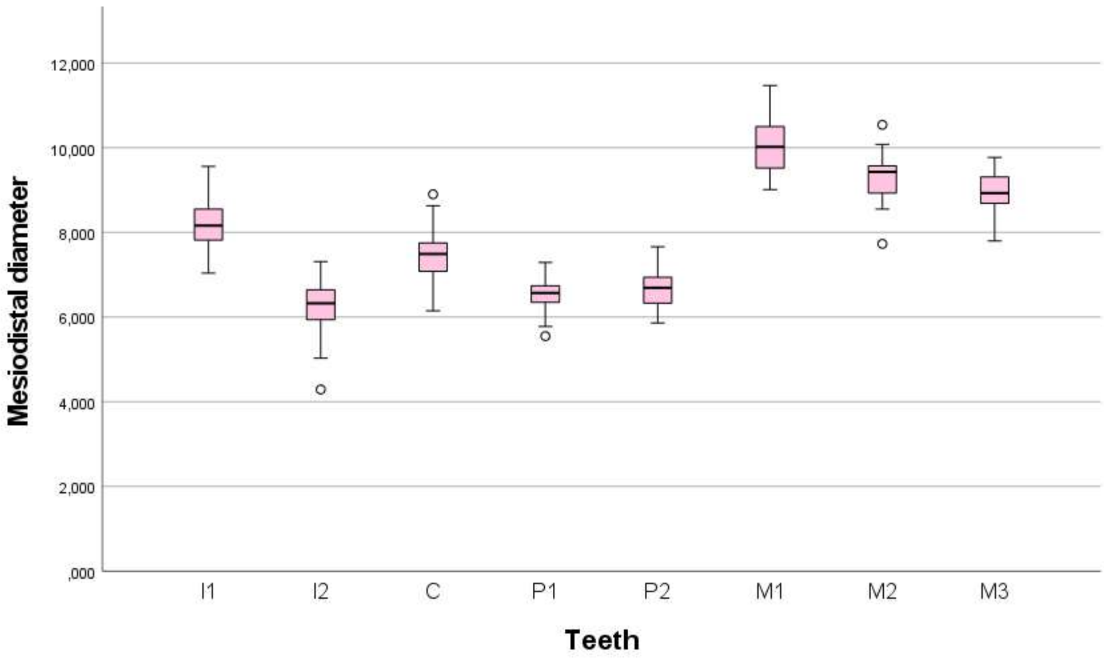

Figure 3. Boxplot of the MD – mesiodistal diameter (mm) – for the upper teeth. Teeth are represented as: I1 – central incisor; I2 – lateral incisor; C – canine; P1 – first premolar; P2 – second premolar; M1 – first molar; M2 – second molar; M3 – third molar.

measures for the upper teeth are all similar, just like for the lower teeth.

Discussion

Over the past years, innumerous investigations have been carried out to understand more about the variation of human dentition's size and shape throughout the centuries and between geographically distinct populations. According to Kieser (1990), "tooth length and width provide significant information on such human biological problems as the genetic relationship between populations". However, the lack of scientific evidence about this topic, mainly on Iberian Peninsula, constitutes an obstacle for the present study (16).

In order to study the correlation between odontometric values from different populations, stone reproductions are commonly used on teeth measurement (13). However, due to the initial expansion of alginate, followed by expansion of gypsum products, the obtained measurements tend to be superior to the ones from the original teeth. Although these differences may arise, they are so minimal that can be despised. Furthermore, the effects of attrition and erosion may also represent a possible error source, since it is being solely studied, the permanent teeth of this Portuguese sample (13).

Regarding the comparison between MD and BP diameters obtained in our commingled sample with the ones found in populations geographically distant from the same epoch, some disparities are noticed, as presented in Table 2.

Focusing on a Sub-Saharan African population from the XIX century, a general tendency for higher odontometric values is noted. Nevertheless, there are some exceptions – the lower I1's MD and BP diameters and the upper I1's BP diameter measured in the African group are lower than the ones from the earthquake's sample. Since populations from Sub-Saharan Africa (and others derived from this area) tend to show higher mean values for crown diameters than the ones observed in Caucasian individuals, in spite of the considerable variability of each population, these results are consistent (15).

On the other hand, the odontometric values obtained from an Italian population of the early XX century show many similarities to the ones obtained in Lisboa's XVIII century population. Even though both studies follow the same pattern, it can be observed a significant discrepancy (of about 1 mm) solely for upper M1, M2 and M3's BP diameter, with Lisboa's sample presenting lower values than Italia's (17).

The depicted values of the skeletal remains found in the major cemetery of Coimbra, a city in the central zone of the country, from individuals who lived between 1807 and 1917, also show a similar pattern when comparing its odontometric values with the MD and BP diameters obtained in Lisboa's sample (16). Though, it is worth noting that there is a minimum discrepancy between the M3's (both mandibular and maxillary) BP diameter, showing slightly lower values in the Coimbra's population. Nonetheless, the remaining teeth show similar odontometric values between the two samples (Coimbra and Lisboa) .

The geographic distance or proximity might be a justification for the differences in the comparison analysis conducted between these three studies from the same period of time, with Italia and Coimbra's populations showing a similar pattern to Lisboa's sample, whilst Sub-Saharan Africa's population presents bigger odontometric disparities.

Focusing on the analysis of MD and BP diameters obtained in various recent odontometrics studies (from 1950 to present), as shown in Table 2, some differences are also observed when compared to our study's population.

Addressing the paper established by Axelsson G. et al., who studied Icelanders' human dentition from 1983, and a study accomplished by Sağlam et al., in a Turkish population in 2004, the measurements from both studies are generally higher than the ones from the 1755 earthquake's population. In fact, the first study concluded that "Compared with several Caucasian populations (...) Icelanders have large teeth, both mesiodistally and buccolingually" (13,18).

Through the comparison between our study's population and a contemporary Nigerian population, and concerning only measurements taken of MD diameter, it's possible to conclude that all values were slightly higher, being I2 and upper and lower P1 the teeth with greater discrepancy (19).

Deepak et al., in a study carried out in an Indian population, presented values of mesiodistal and buccopalatine diameters for four different groups, of which the one with the most similar measurements with our study's population was the group of Christians. Considering the MD and BP values, they were also very close to those from Lisboa's XVIII century population (20).

In a study performed in 2005, by Pereira, the measurements of both MD and BP diameters show higher values than the ones obtained in our

sample, being the upper central incisor and the upper canine the teeth in which these values differ the most (21).
The measurements for CH – applied to Lisboa's 1755 population – were taken considering the anatomical crown. However, it's not possible to compare the obtained values for CH with data present in other studies since all other CH measurements consider the clinical crown, obtained through dental casts.

Conclusion

Regarding the first purpose of our study, it is possible to conclude that odontometrics obtained in Lisboa's earthquake sample, both MD and BP diameters' values, are within the expected standards for that epoch in Europe. It is noted that the collected measurements are mainly close to the values of the populations from Coimbra (Portugal) and Italy, with slightly greater discrepancies compared to the other population, from Sub-Saharan Africa (non-European country). The superior geographic distance which separates this population from ours might be a potential factor that justifies these differences.
Concerning the second purpose, the results captured in all recent studies, previously reviewed, reveal lightly superior MD and BP diameter values. This apparent evolution stands in accordance with what Axelsson and Kirveskari refer to in their paper, being, however, imprudent to conclude this with certainty – due to a big variation in these odontometrics among populations from all over the world.

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Author contributions

Cristiana Palmela Pereira: Conceptualization and Methodology. Maria Vitória Lameiro, Mariana Correia, Patrícia Antunes, Raquel Carvalho, Tatiana Major, Cristiana Palmela Pereira, Rui Santos: Validation, Investigation. Rui Santos: Formal analysis. Cristiana Palmela Pereira, Rui Santos: Resources. Maria Vitória Lameiro, Mariana Correia, Patrícia Antunes, Raquel Carvalho, Tatiana Major: Data curation, Writing - Original draft. Cristiana Palmela Pereira: Supervision Project. Cristiana Palmela Pereira, Rui Santos: Writing- Reviewing and Editing

Table 1. Odontometric values for upper and lower teeth. Measurements are represented as: MD – mesiodistal diameter (mm); BP – buccopalatine diameter (mm); CH – crown height (mm). The results are represented according to: n – sample size; x̄ – mean; sd – standard deviation, m – minimum; M – maximum.

		Upper teeth			Lower teeth		
Teeth		MD (mm)	BP (mm)	CH (mm)	MD (mm)	BP (mm)	CH (mm)
I¹	n	81	82	71	72	68	63
	x̄	8.200	7.021	10.049	5.248	5.986	8.394
	sd	0.597	0.485	1.092	0.451	0.485	0.917
	m	7.040	5.510	7.970	4.300	5.090	6.140
	M	9.560	8.320	12.460	6.440	7.340	10.340
I²	n	68	67	61	59	54	48
	x̄	6.296	6.209	8.610	5.589	6.201	8.376
	sd	0.590	0.540	0.929	0.462	0.437	1.036
	m	4.290	4.360	6.700	4.610	4.690	5.650
	M	7.310	7.620	11.210	6.650	7.150	10.700
C	n	74	79	54	95	89	64
	x̄	7.435	8.016	9.632	6.561	7.518	10.262
	sd	0.527	0.646	1.075	0.407	0.595	1.137
	m	6.150	6.770	7.770	5.330	6.330	6.280
	M	8.900	10.050	12.540	7.470	9.010	13.030
P¹	n	41	40	25	96	90	59
	x̄	6.531	8.6375	7.317	6.638	7.382	7.814
	sd	0.365	0.637	0.896	0.406	0.516	1.057
	m	5.550	6.780	4.890	5.360	6.380	4.660
	M	7.290	10.210	8.310	7.830	9.150	9.860
P²	n	48	45	29	73	72	44
	x̄	6.663	8.870	7.324	6.986	8.088	7.268
	sd	0.408	0.600	0.815	0.457	0.591	1.000
	m	5.860	7.250	4.690	5.990	6.840	5.020
	M	7.660	10.120	8.920	8.250	10.070	8.750
M¹	n	47	33	23	55	54	51
	x̄	10.021	10.746	6.784	11.011	10.060	6.494
	sd	0.612	0.679	0.925	0.708	0.634	1.186
	m	9.010	9.530	5.290	9.500	8.310	4.130
	M	11.470	11.950	8.310	12.900	10.890	9.300
M²	n	21	19	8	65	60	41
	x̄	9.300	10.517	6.641	10.627	9.812	6.372
	sd	0.625	0.599	0.987	0.591	0.594	1.171
	m	7.730	9.310	5.650	9.210	7.850	3.630
	M	10.540	11.530	8.660	11.910	11.240	8.740
M³	n	33	31	17	27	26	20
	x̄	8.951	10.463	6.819	10.631	9.738	6.018
	sd	0.497	0.688	0.967	0.823	0.597	0.878
	m	7.800	8.750	4.810	8.330	8.700	4.900
	M	9.770	12.340	8.480	12.060	11.080	7.880

Table 2. Odontometric values (MD – mesiodistal diameter (mm); BP – buccopalatine diameter (mm)) for both maxilla and mandible, from other studies.

			Maxilla		Mandible	
Author	**Population**	**Tooth**	**MD (mm)**	**BP (mm)**	**MD (mm)**	**BP (mm)**
Harris *et al.*, 1989	**Sub-Saharan African**	**I^1**	8.01	6.32	4.73	5.20
		I^2	6.45	5.80	5.47	5.79
		C	7.21	7.66	6.77	7.07
		P^1	6.97	8.91	6.94	7.83
		P^2	6.87	9.41	7.31	7.95
		M^1	10.30	10.79	11.60	10.00
		M^2	9.81	11.24	11.06	10.19
		M^3	8.93	10.96	10.86	10.22
Viciano *et al.*, 2021	**Italian**	**I^1**	8.33	7.58	5.58	6.06
		I^2	6.46	6.38	6.15	6.65
		C	7.78	8.33	6.89	8.02
		P^1	7.14	8.73	7.13	7.84
		P^2	6.88	8.84	7.36	8.24
		M^1	9.93	11.60	10.97	10.32
		M^2	9.52	11.74	10.76	10.04
		M^3	8.92	11.34	10.78	9.96
Galera *et al.*, 1993	**Portuguese (Coimbra)**	**I^1**	7.94	6.91	4.81	5.68
		I^2	5.92	6.12	5.37	6.09
		C	7.00	7.97	6.02	7.48
		P^1	6.15	8.66	6.19	7.45
		P^2	5.94	8.87	6.38	8.01
		M^1	9.59	10.49	10.39	9.68
		M^2	8.66	10.21	10.00	9.48
		M^3	8.00	9.53	10.00	9.28
Axelsson *et al.*, 1983	**Icelandic**	**I^1**	8.87	7.28	5.53	5.99
		I^2	6.89	6.54	6.11	6.37
		C	7.94	8.33	6.94	7.53
		P^1	7.14	9.29	7.20	7.83
		P^2	6.86	9.47	7.35	8.56
		M^1	10.84	11.74	11.28	10.78
		M^2	9.92	11.55	10.64	10.44
Sağlam *et al.*, 2004	**Turkish**	**I^1**	9.09	-	5.97	-
		I^2	7.35	-	6.39	-
		C	8.14	-	7.09	-
		P^1	7.50	-	7.45	-
		P^2	7.19	-	7.48	-
		M^1	10.74	-	11.33	-
Ajayi *et al.*, 2010	**Nigerian**	**I^1**	8.80	-	5.60	-
		I^2	7.19	-	6.15	-
		C	7.99	-	7.16	-
		P^1	7.48	-	7.52	-
		P^2	7.06	-	7.48	-
		M^1	10.48	-	11.20	-
Deepak *et al.*, 2015	**Indian (Christian)**	**I^1**	8.48	6.89	5.25	5.85
		I^2	6.81	6.47	5.80	6.30
		C	7.60	7.49	6.57	7.37
		P^1	6.77	9.20	6.82	7.85
		P^2	6.53	9.49	6.81	8.46
		M^1	9.74	11.14	10.76	10.54
		M^2	9.46	10.65	9.80	10.35
Pereira *et al.*, 2005	**Portuguese**	**I^1**	8.81	-	-	-
		I^2	6.71	-	-	-
		C	7.85	8.38	-	-

References

1. Pereira C. Commingled assemblage from earthquake 1755 of Lisbon: Forensic anthropology study. Forensic Science International. 2012;149–68.
2. Babu SS, Nair SS, Gopakumar D, Kurian N, Parameswar A, Baby TK. Linear odontometric analysis of permanent dentition as a forensic aid: A retrospective study. J Clin Diagnostic Res. 2016;10(5):ZC24–8.
3. Flohr S, Kierdorf U, Kierdorf H. Odontometric sex estimation in humans using measurements on permanent canines. A comparison of an early Neolithic and an early medieval assemblage from Germany. Anthropol Anzeiger. 2016;73(3):225–33.
4. Paul KS, Stojanowski CM. Comparative performance of deciduous and permanent dental morphology in detecting biological relatives. Am J Phys Anthropol. 2017;164(1):97–116.
5. Pereira C, Bernardo M, Pestana D, Santos JC, Mendonça MC de. Contribution of teeth in human

forensic identification - Discriminant function sexing odontometrical techniques in Portuguese population. J Forensic Leg Med [Internet]. 2010;17(2):105–10.
6. Scott GR, Turner CG. The Anthropology of Modern Human Teeth. The Anthropology of Modern Human Teeth. 1997.
7. Hattab FN, Al-Khateeb S, Sultan I. Mesiodistal crown diameters of permanent teeth in Jordanians. Arch Oral Biol. 1996;41(7):641–5.
8. Pereira T, Shetty S, Surve R, Gotmare S, Kamath P, Kumar S. Palatoscopy and odontometrics for sex identification and hereditary pattern analysis in a Navi Mumbai population: a cross-sectional study. J Oral Maxillofac Pathol. 2018;22(2):271–278.
9. Romero A, Ramirez-Rozzi F V, Pérez-Pérez A. Dental size variability in Central African Pygmy hunter-gatherers and Bantu-speaking farmers. Am J Phys Anthropol. 2018;166(3):671–81.
10. Pandey N, Ma MS. Evaluation of sexual dimorphism in maxillary and mandibular canine using mesiodistal, labiolingual dimensions, and crown height. Indian J Dent Res. 2016;27(5):473–6.
11. Hanihara T, Ishida H. Metric dental variation of major human populations. Am J Phys Anthropol. 2005;128(2):287–98.
12. Kieser JA. Human adult odontometrics: the study of variation in adult tooth size. 1st ed. Cambridge: Cambridge University Press; 1990. 206 p.
13. Axelsson G, Kirveskari P. Crown size of permanent teeth in icelanders. Acta Odontol Scand. 1984;42(6):339–43.
14. Buikstra JE, Ubelaker DH, Hass J. Dental data collection II: dental morphology, measurements of the secondary dentition. In: Standards for Data Collection from Human Skeletal Remains. Fayetteville: Arkansas Archeological Survey; 1994. p. 61–3.
15. Harris EF, Rathbun TA. Small tooth sizes in a nineteenth century South Carolina plantation slave series. Am J Phys Anthropol. 1989 Mar;78(3):411–20.
16. Galera V, Cunha E. Dental Patterns of Coimbra population. Anthropologie (1962-). 1993;31(1):35–44.
17. Viciano J, Tanga C, D'Anastasio R, Belcastro MG, Capasso L. Sex estimation by odontometrics of nonadult human remains from a contemporary Italian sample. Am J Phys Anthropol. 2021;175(1):59–80.
18. Sağlam AM, Ozbaran HM, Sağlam AA. A comparison of mesio-distal crown dimensions of the permanent teeth in subjects with and without fluorosis. Eur J Orthod. 2004 Jun;26(3):279-81.
19. Adeyemi TA, Isiekwe MC. Mesio-distal crown dimensions of permanent teeth in a Nigerian population. Afr J Med Med Sci. 2003;32(1):23–5.
20. Deepak V, Goryawala SN, Reddy Y, Chhabra RJ, Nandaprasad, Shah NK. Assessment of Ethnicity in Indian Population using Tooth Crown Metric Dental Traits. J Int Oral Health. 2015;7(9):83–87.
21. 21. Pereira C. Contribuição para a Identificação humana a partir dos dentes: determinação do dimorfismo sexual em população adulta portuguesa [master's thesis]. [Lisboa]: Universidade de Lisboa; 2005. 458 p.