applied sciences

MDPI

Article

Sex Prediction Based on Mesiodistal Width Data in the Portuguese Population

João Albernaz Neves [1], Nathalie Antunes-Ferreira [2,3], Vanessa Machado [1,4], João Botelho [1,4,*], Luís Proença [5], Alexandre Quintas [2,3], José João Mendes [1,4] and Ana Sintra Delgado [1,4]

1 Clinical Research Unit (CRU), Centro de Investigação Interdisciplinar Egas Moniz (CiiEM), Egas Moniz, CRL, 2829-511 Caparica, Almada, Portugal; jalbernazneves@gmail.com (J.A.N.); vanessamachado558@gmail.com (V.M.); jmendes@egasmoniz.edu.pt (J.J.M.); anasintradelgado@gmail.com (A.S.D.)

2 Laboratório de Ciências Forenses e Psicológicas Egas Moniz (LCFPEM), Centro de Investigação Interdisciplinar Egas Moniz (CiiEM), Egas Moniz CRL, 2829-511 Caparica, Almada, Portugal; natantfer@gmail.com (N.A.-F.); alexandre.quintas@gmail.com (A.Q.)

3 Laboratory of Biological Anthropology and Human Osteology (LABOH), CRIA/FCSH, Universidade NOVA de Lisboa, 1069-061 Lisboa, Portugal

4 Orthodontics Department, Egas Moniz Dental Clinic (EMDC), Egas Moniz, CRL, 2829-511 Caparica, Almada, Portugal

5 Quantitative Methods for Health Research (MQIS), CiiEM, Egas Moniz, CRL, 2829-511 Caparica, Almada, Portugal; lproenca@egasmoniz.edu.pt

* Correspondence: jbotelho@egasmoniz.edu.pt; Tel.: +351-21-294-6700

Received: 21 May 2020; Accepted: 13 June 2020; Published: 17 June 2020

Abstract: Accurate sex prediction is a key step in creating a postmortem forensic profile as it excludes approximately half the population. It is our goal to develop a predictive model to establish sex through teeth mesiodistal widths in a Portuguese population. The pretreatment dental casts of 168 of Portuguese orthodontics subjects (59 males and 109 females) were included. Mesiodistal widths from right first molar to left first molar were measured on each pretreatment cast to the nearest 0.01 mm using a digital caliper. Overall, the mesiodistal widths of the upper and lower canines, premolars, and molars were found to be significantly different between females and males. Conversely, no significant differences between sexes were identified for incisors. A multivariate logistic regression model for sex prediction was developed and the teeth included in the final reduced model being the upper left canine (2.3), the lower right lateral incisor (4.2) and the lower right canine (4.3). There is a prevalence of sexual dimorphism in all teeth except the incisors. The canines present the most noticeable difference between sexes. The presented sex determination predictive model exhibits an overall correct classification of 75%, outperforming all available models for this purpose and therefore is a potential tool for forensic analysis in this population.

Keywords: forensic dentistry; sex determination; sexual dimorphism; dental measurements; predictive model; Portuguese population

1. Introduction

Forensic dentistry emerges as a part of forensic medicine and dental anthropology. This is the branch of dentistry that focuses on the issues of identifying human remains by direct comparison, bite mark identification, clinical malpractice, and forensic dental profiling, such as sex and age estimation, in cases of unknown human remains, in order to facilitate their subsequent identification [1,2].

Teeth are the hardest organ in the human body and very important in postmortem identification procedures. Although pelvic and cranial bones can be more accurate in identifying sex, they are rarely in optimal condition in extreme cases, such as natural disasters or mass graves, which may prevent accurate estimation through them. Teeth are considered quite useful in these scenarios as they are often recovered intact [3–6]. However, there may be some setbacks that prevent dental eruption of teeth useful for forensic identification [7–10].

Accurate sex prediction is a key step in creating a postmortem forensic profile as it excludes approximately half the population [11]. Several studies state that teeth have a high degree of sexual dimorphism [2,4,5,12,13]. Generally, male teeth are larger than female teeth, however data are not consensual and reverse dimorphism also occurs [4,12]. Sexual dimorphism may vary between different populations, possibly due to variations in the environment, available food resources, or genetic pool [3,14].

The most usual way to obtain data is from dental casts using a digital caliper. There are several measures to take into account and their analysis may be performed through direct comparison of measures, statistical analyses, or indexes.

Only two previous studies presented potential predictive sex models for Portuguese populations using dental measurements. Pereira et al. (2010) [1], using upper canine-to-canine teeth, rendered a combination of incisors mesiodistal and canine diagonal distances. As the proposed model was confined to only six teeth, it lacks a complete teeth analysis. On the other hand, Silva et al. (2015) [12] employed the mandibular canine index [15] with a modest success rate of 64.2%, concluding that this index should be restrictively applied to the Portuguese scenario in sex identification.

Given the lack of robust sex identification models for the Portuguese population, we aimed to use cast models of a previously studied sample (Machado et al., 2018) [16] to develop a new sex prediction model based on mesiodistal width measures. We hypothesize that there is a sex-based teeth dimorphism in this population and it is distinguishable through a predictive model; therefore our null hypothesis is that such dimorphism may not exist.

2. Materials and Methods

2.1. Study Design

This study used a previously reported sample [16] that has received approval by the Egas Moniz Ethics Committee (Number 600). Written informed consents were obtained from all participants during their first appointment at the Orthodontic Department of the Egas Moniz Dental Clinic.

This investigation follows the transparent reporting of a multivariable prediction model for individual prognosis or diagnosis (TRIPOD) reporting guidelines [17] for validation of prediction models (see supplementary material). This study was conducted on a triple-blind basis with respect to diagnosis and clinical outcome, data collection, and analysis.

2.2. Participants

The assessment tool consisted of pre-treatment dental casts, a part of standard orthodontic treatment planning, in dental stone selected from the archives of the Egas Moniz Dental Clinic Orthodontic Department (Almada, Portugal). From a total of 541 casts gathered from November 2010 to December 2017, 168 (59 males and 109 females) were selected according to the inclusion and exclusion criteria.

The inclusion criteria were: all teeth, from first molar in the right side to first molar in the left side in both upper and lower jaws, were fully erupted and present; no history of interproximal stripping; no proximal caries that might interfere with precise tooth measurement; no restorations, abrasions or attrition; no previous or ongoing orthodontic treatment; no abnormal tooth morphology or congenitally missing or impacted [16]. All patients failing to fulfil these criteria were excluded.

2.3. Dental Casts Analysis and Measurement Reproducibility

Dental cast measurements were performed by one researcher (VM) using a digital caliper to measure the mesiodistal tooth widths from the right first molar to the left first molar to the nearest 0.01 mm. The mesiodistal width of each tooth was measured at the widest distance between the mesial and distal contact points. The position of the caliper had to be perpendicular to the occlusal surface of the measured tooth [1,11,14,16,18–21].

Ten study casts were randomly chosen from the total of 168 and remeasured one week later by the same investigator (V.M.). Intraclass correlation coefficient (ICC) was calculated with an absolute agreement of ICC = 0.98.

2.4. Statistical Analysis

Data analysis was performed using IBM SPSS Statistics version 25.0 for Windows (Armonk, NY: IBM Corp.). Descriptive statistics as mean and standard deviation (SD) were determined for the mesiodistal width per tooth. Mean mesiodistal width for each tooth was compared according to sex and by Student's *t*-test. A multivariate stepwise adjusted logistic regression procedure was applied to derive a reduced predictive model for sex determination based on the mesiodistal widths for each tooth. To test the performance of the obtained model and compare it to previous ones, the sensitivity, specificity, accuracy, and precision were determined for all models when applied to the studied sample [22]. Performance measurement was assessed by binary area under the curve (AUC) and through receiver operating characteristics (ROC) analysis. The level of significance was set at 5%, in all statistical inference analyses.

3. Results

3.1. Mesiodistal Width Per Tooth

In the studied sample the mean age was 20.1 (±7.3) (see Machado et al., 2018 [16] for a detailed description). The mean mesiodistal width for each tooth, according to sex, is presented in Table 1. Overall, the mean mesiodistal widths of upper and lower canines, premolars, and molars were found to be significantly different between females and males. Regarding the incisors, no significant differences were found as a function of sex.

Table 1. Descriptive values of mesiodistal width (mm), presented as mean and standard deviation (SD) for each tooth, as a function of sex (n = 168).

Semi-Arch	Tooth Type	Tooth Code	Female (n = 109)		Male (n = 59)		*p*-Value *
			Mean (±SD)	Range (Min–Max)	Mean (±SD)	Range (Min–Max)	
Upper right	Molar	1.6	10.13 (±0.56)	8.50–12.52	10.40 (±0.60)	9.26–12.37	**0.004**
	Premolars	1.5	6.62 (±0.47)	5.51–8.04	6.40 (±0.52)	5.71–8.30	**0.008**
		1.4	6.93 (±0.47)	5.70–8.17	7.18 (±0.48)	6.35–8.50	**0.001**
	Canine	1.3	7.67 (±0.46)	6.40–8.90	7.97 (±0.57)	6.10–9.22	**<0.001**
	Incisors	1.2	6.64 (±0.61)	5.20–7.89	6.70 (±0.63)	5.25–8.55	0.565
		1.1	8.60 (±0.58)	7.00–10.05	8.68 (±0.66)	6.47–10.78	0.414
Upper left		2.1	8.62 (±0.54)	7.39–9.88	8.69 (±0.67)	6.47–10.66	0.437
		2.2	6.54 (±0.60)	4.73–7.89	6.71 (±0.65)	5.25–8.30	0.091
	Canine	2.3	7.65 (±0.46)	6.40–8.70	8.04 (±0.52)	6.83–9.22	**<0.001**
	Premolars	2.4	6.92 (±0.48)	5.70–8.17	7.17 (±0.50)	5.96–8.28	**0.002**
		2.5	6.62 (±0.47)	5.51–8.04	6.84 (±0.52)	5.70–8.30	**0.005**
	Molar	2.6	10.12 (±0.56)	8.50–12.52	10.33 (±0.59)	9.4–12.44	**0.018**
Lower right	Molar	4.6	10.63 (±0.61)	9.10–12.32	11.03 (±0.57)	9.82–12.17	**<0.001**
	Premolars	4.5	7.19 (±0.52)	6.04–8.93	7.36 (±0.54)	6.17–8.98	**0.050**
		4.4	7.08 (±0.43)	6.11–8.30	7.36 (±0.51)	6.22–8.50	**0.001**
	Canine	4.3	6.63 (±0.42)	5.84–8.15	7.01 (±0.48)	6.03–8.91	**<0.001**
	Incisors	4.2	5.89 (±0.43)	4.50–6.94	5.97 (±0.44)	4.98–6.95	0.253
		4.1	5.38 (±0.43)	4.50–7.60	5.46 (±0.43)	4.68–6.51	0.280
Lower left		3.1	5.38 (±0.44)	4.50–7.60	5.41 (±0.47)	3.73–6.37	0.708
		3.2	5.86 (±0.44)	4.50–6.78	5.99 (±0.42)	4.92–6.99	0.052
	Canine	3.3	6.63 (±0.41)	5.84–8.16	7.00 (±0.50)	6.14–8.95	**<0.001**
	Premolars	3.4	7.03 (±0.50)	5.65–8.30	7.35 (±0.52)	6.22–8.50	**<0.001**
		3.5	7.14 (±0.50)	6.04–8.70	7.37 (±0.58)	6.00–8.98	**0.008**
	Molar	3.6	10.62 (±0.57)	9.10–12.32	11.00 (±0.61)	9.76–12.17	**<0.001**

Note: * Student's *t*-test. Significant *p*-values ($p < 0.05$) denoted in bold.

3.2. Sex Prediction Model Development

In order to develop a model for sex prediction based on the teeth mesiodistal width, a multivariate logistic regression procedure was implemented considering a first stage that included all teeth that exhibited significant differences in the sex-based comparison: canines, premolars and molars. Then, a stepwise adjusted logistic regression procedure derived a reduced best fitting model that is depicted in Table 2. In this final optimized model, the upper left canine (2.3), the lower right lateral incisor (4.2) and the lower right canine (4.3) were the only teeth included.

Table 2. Final reduced logistic regression model (n = 168).

Variables	*B*	*p*-Value	EXP (B)	EXP (B) 95% CI	
				Lower	Upper
Tooth 2.3	1.208	0.019	3.35	1.22	9.22
Tooth 4.3	1.800	0.003	6.05	1.84	19.91
Tooth 4.2	−1.317	0.018	0.27	0.09	0.80
Constant	−14.546	<0.001	-	-	-

R^2(N) = 0.268, % correct classification = 75%; H&L: X^2 = 6.767 (p = 0.562); Note: outcome variable (sex) coded as male: 1, female: 0.

From the fitted model data, the following formula can be derived:

$$\ln (p/(1 - p)) = -14.546 + 1.208x + 1.800y - 1.317z$$

where p is the probability of an individual being classified as male, with a lower cutoff value of 0.5, and with x, y, and z representing the mesiodistal width of the upper left canine (2.3), lower right canine (4.3) and lower right lateral incisor (4.2), respectively.

3.3. Comparison with Previous Models

The achieved model was then compared to the previous sex prediction tools by means of performance when applied to this sample (Table 3).

Table 3. Performance assessment of the different models when applied to the studied sample. Measures are presented as percentage. For AUC, estimation by a 95% confidence interval (95% CI) is also shown.

Model		Sensitivity (%)	Specificity (%)	Accuracy (%)	Precision (%)	AUC within ROC Analysis (95% CI)
Acharya et al., 2007 [23]	Model 1	85.3	50.8	73.2	76.2	0.642 (0.551–0.733)
	Model 2	13.8	93.2	41.7	78.9	0.637 (0.546–0.728)
Mitsea et al., 2014 [4]		65.1	45.8	58.3	68.9	0.681 (0.592–0.770)
Peckmann et al., 2016 [5]	Model 1	89.9	39.0	72.0	73.1	0.535 (0.445–0.625)
	Model 2	59.6	49.2	56.0	68.4	0.555 (0.463–0.646)
	Model 3	65.1	45.8	58.3	68.9	0.644 (0.553–0.736)
	Model 4	88.1	37.3	70.2	72.2	0.544 (0.452–0.636)
	Model 5	86.2	37.3	69.0	71.8	0.555 (0.463–0.646)
	Model 6	82.6	45.8	69.6	73.8	0.627 (0.535–0.719)
	Model 7	81.7	45.8	69.0	73.6	0.618 (0.525–0.710)
Neves et al., 2020		87.2	52.5	75.0	77.2	0.768 (0.693–0.843)

AUC—Area under the curve; ROC—Receiver operating characteristic.

4. Discussion

Sex estimation is a vital step in forensic medicine for body identification both in single and mass disaster events. In the Portuguese scenario, sex estimation models through dental hard tissues are scarce and previous proposed models lacked consistency and only accounted for a small subset of teeth. Therefore, we aimed to develop a potential model using mesiodistal widths of models cast previously for studies of orthodontic indexes. Then, we compared the performance of this model with other full-mouth mesiodistal models published elsewhere. Overall, our model outperformed all available strategies and might be used as a forensic tool for sex estimation in Portuguese samples.

As previously stated, sexual dimorphism may vary between populations, possibly due to a variety of reasons [3,14]. Therefore, this new model arises as a valuable tool to forensic dentistry.

Our results have prospective importance. (1) Until now, there were no models developed for the Portuguese population from complete models. (2) Dental hard tissues are of utmost interest because they are the most lasting tissue of human body, even in post-mortem difficult conditions. (3) This tool may be very useful in single or mass disasters or body identification cases in Portugal, especially due to the unpredictability of these situations. (4) These results confirm sexual dimorphism on teeth mesiodistal width in canines, premolars, and molars of the upper and lower arches.

Dental crown dimensions can be obtained through intraoral measurements [18], dental forms [4,11,13,14,16,19,24], or human remains [20,21]. The mesiodistal and buccolingual measurements of the crown were the two most commonly used and studied dimensions [1,11,14,18–21], followed by diagonal measurements (mesiobuccal-distolingual and distobuccal-mesiolingual) [1,21,25] and the canine mandibular index (expressed as the ratio between the mesiodistal dimension of the canines and the width of the intercanine arch [12,15,19,26]). These studies have shown that canine dimensions provide the highest sexual dimorphism [16,18,21,24,25], followed by premolars [21,25], first and second molars [20,21,25,27].

In this study, we analyzed the degree of sexual dimorphism in different teeth by measuring the maximum mesiodistal diameters of fully erupted permanent teeth from study casts. Overall, several teeth are sexually dimorphic and the crown mesiodistal dimensions were larger on average in males than in females. The results of this study confirm what was previously demonstrated, canine teeth are the most dimorphic teeth [1–5,7,19,21,24–26] but also molars present significant differences between sexes [11,13,23,25,28–30]. Within the elements that fit into our sex prediction model, the upper left canine, the lower right lateral incisor, and the lower right canine were the most appropriate and with better replicability.

Regarding the performance, our developed model outperformed previous published indexes in terms of AUC. In terms of accuracy and precision values, our model also outperformed the remaining models (75.0% and 77.2% for accuracy and precision, respectively). Furthermore, for sensitivity and specificity, this newly developed model presented the best combination of results, only being outperformed in sensitivity by Peckmann et al., 2016 [5] (model 4) and in specificity by Acharya et al., 2007 [23] (model 2).

Like other methodologies used in sex prediction, the amount and quality of evidence available for analysis are critical in forensic investigation. Some limitations of the applied methodology include any post-eruptive changes such as caries, interproximal wear, and interproximal restorations, which compromises the correct measurement of the teeth.

5. Strengths and Limitations

A possible limitation of this study is the fact that we have not accounted for second molars, mainly because the data that this analysis is derived from is an orthodontic population whose main purpose was to study a mesiodistal proportion measure. This measure, Bolton's analysis [31], only accounts for the mesiodistal width from the first molar to the first molar. Nevertheless, two previous large-base studies from this population revealed that second molars are one of the most commonly missing teeth, aside from first molars and premolars [32,33]. Interestingly, none of them accounted for the final model. Another possible limitation is the fact that the new model emerged from the same sample being studied, which may influence the results. The new model should be further investigated with a new sample in a future study.

6. Conclusions

Considering the limitations of this study, the present study found that there is a prevalence of sexual dimorphism in all teeth except the incisors and that the canines exhibit the most noticeable difference between sexes, followed by the first mandibular molars and premolars.

Through a stepwise adjusted logistic regression procedure, a suitable model for sex determination was developed. The reduced model was based on the upper left canine (2.3), the lower right lateral incisor (4.2), and the lower right canine (4.3) and achieved an accuracy of 75%.

Supplementary Materials: The following are available online at http://www.mdpi.com/2076-3417/10/12/4156/s1.

Author Contributions: Conceptualization, V.M. and J.B.; methodology, J.A.N.; validation, J.B., V.M. and L.P.; formal analysis, L.P.; investigation, J.A.N.; resources, A.S.D.; writing—original draft preparation, J.A.N.; writing—review and editing, J.J.M., N.A.-F. and A.Q.; supervision, J.J.M., A.S.D., N.A.-F. and A.Q.; project administration, J.J.M. and A.S.D. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Conflicts of Interest: The authors declare no conflict of interest.

References

1. Pereira, C.; Bernardo, M.; Pestana, D.; Santos, J.C.; de Mendonça, M.C. Contribution of teeth in human forensic identification—Discriminant function sexing odontometrical techniques in Portuguese population. *J. Forensic Leg. Med.* **2010**, *17*, 105–110. [CrossRef]
2. Khamis, M.F.; Taylor, J.A.; Malik, S.N.; Townsend, G.C. Odontometric sex variation in Malaysians with application to sex prediction. *Forensic Sci. Int.* **2014**, *234*, 183.e1–183.e7. [CrossRef]
3. Işcan, M.Y.; Kedici, P.S. Sexual variation in bucco-lingual dimensions in Turkish dentition. *Forensic Sci. Int.* **2003**, *137*, 160–164. [CrossRef]
4. Mitsea, A.G.; Moraitis, K.; Leon, G.; Nicopoulou-Karayianni, K.; Spiliopoulou, C. Sex determination by tooth size in a sample of Greek population. *HOMO-J. Comp. Hum. Biol.* **2014**, *65*, 322–329. [CrossRef] [PubMed]
5. Peckmann, T.R.; Logar, C.; Garrido-Varas, C.E.; Meek, S.; Pinto, X.T. Sex determination using the mesio-distal dimension of permanent maxillary incisors and canines in a modern Chilean population. *Sci. Justice* **2016**, *56*, 84–89. [CrossRef] [PubMed]
6. Capitaneanu, C.; Willems, G.; Thevissen, P. A systematic review of odontological sex estimation methods. *J. Forensic Odontostomatol.* **2017**, *35*, 1–19. [PubMed]
7. Isola, G.; Anastasi, G.; Matarese, G.; Williams, R.; Cutroneo, G.; Bracco, P.; Piancino, M. Functional and molecular outcomes of the human masticatory muscles. *Oral Dis.* **2018**, *24*, 1428–1441. [CrossRef]
8. Isola, G.; Alibrandi, A.; Rapisarda, E.; Matarese, G.; Williams, R.C.; Leonardi, R. Association of vitamin D in patients with periodontitis: A cross-sectional study. *J. Periodontal Res.* **2020**, 1–11. [CrossRef]
9. Staderini, E.; Patini, R.; Guglielmi, F.; Camodeca, A.; Gallenzi, P. How to manage impacted third molars: Germectomy or delayed removal? A systematic literature review. *Medicina* **2019**, *55*, 79. [CrossRef]
10. Botelho, J.; Machado, V.; Proença, L.; Delgado, A.S.; Mendes, J.J. Vitamin D deficiency and oral health: A comprehensive review. *Nutrients* **2020**, *12*, 1471. [CrossRef]
11. Angadi, P.V.; Hemani, S.; Prabhu, S.; Acharya, A.B. Analyses of odontometric sexual dimorphism and sex assessment accuracy on a large sample. *J. Forensic Leg. Med.* **2013**, *20*, 673–677. [CrossRef] [PubMed]
12. Silva, A.M.; Pereira, M.L.; Gouveia, S.; Tavares, J.N.; Azevedo, Á.; Caldas, I.M. A new approach to sex estimation using the mandibular canine index. *Med. Sci. Law.* **2016**, *56*, 7–12. [CrossRef] [PubMed]
13. Prabhu, S.; Acharya, A.B. Odontometric sex assessment in Indians. *Forensic Sci. Int.* **2009**, *192*, 129.e1–129.e5. [CrossRef] [PubMed]
14. Brook, A.H.; Griffin, R.C.; Townsend, G.; Levisianos, Y.; Russell, J.; Smith, R.N. Variability and patterning in permanent tooth size of four human ethnic groups. *Arch. Oral Biol.* **2009**, *54*, 79–85. [CrossRef] [PubMed]
15. Rao, N.G.; Rao, N.N.; Pai, M.L.; Kotian, M.S. Mandibular canine index—A clue for establishing sex identity. *Forensic Sci. Int.* **1989**, *42*, 249–254. [CrossRef]

16. Machado, V.; Botelho, J.; Pereira, D.; Vasques, M.; Fernandes-Retto, P.; Proença, L.; Mendes, J.J.; Delgado, A. Bolton ratios in Portuguese subjects among different malocclusion groups. *J. Clin. Exp. Dent.* **2018**, *10*, e864–e868. [CrossRef]
17. Moons, K.G.M.; Altman, D.G.; Reitsma, J.B.; Ioannidis, J.P.A.; Macaskill, P.; Steyerberg, E.W.; Vickers, A.J.; Ransohoff, D.F.; Collins, G.S. Transparent reporting of a multivariable prediction model for individual prognosis or diagnosis (TRIPOD): Explanation and elaboration. *Ann. Intern. Med.* **2015**, *162*, W1–W73. [CrossRef] [PubMed]
18. Khangura, R.; Sircar, K.; Singh, S.; Rastogi, V. Sex determination using mesiodistal dimension of permanent maxillary incisors and canines. *J. Forensic Dent. Sci.* **2012**, *3*, 81. [CrossRef]
19. Phulari, R.S.; Rathore, R.; Talegaon, T.; Jariwala, P. Comparative assessment of maxillary canine index and maxillary first molar dimensions for sex determination in forensic odontology. *J. Forensic Dent. Sci.* **2017**, *9*, 110. [CrossRef]
20. Zorba, E.; Moraitis, K.; Manolis, S.K. Sexual dimorphism in permanent teeth of modern Greeks. *Forensic Sci. Int.* **2011**, *210*, 74–81. [CrossRef]
21. Zorba, E.; Moraitis, K.; Eliopoulos, C.; Spiliopoulou, C. Sex determination in modern Greeks using diagonal measurements of molar teeth. *Forensic Sci. Int.* **2012**, *217*, 19–26. [CrossRef] [PubMed]
22. Glas, A.S.; Lijmer, J.G.; Prins, M.H.; Bonsel, G.J.; Bossuyt, P.M.M. The diagnostic odds ratio: A single indicator of test performance. *J. Clin. Epidemiol.* **2003**, *56*, 1129–1135. [CrossRef]
23. Acharya, A.B.; Mainali, S. Univariate sex dimorphism in the Nepalese dentition and the use of discriminant functions in gender assessment. *Forensic Sci. Int.* **2007**, *173*, 47–56. [CrossRef] [PubMed]
24. Mujib, A.B.R.; Tarigoppula, R.K.V.N.; Kulkarni, P.G. Gender determination using diagonal measurements of maxillary molar and canine teeth in davangere population. *J. Clin. Diagn. Res.* **2014**, *8*, 141–144. [CrossRef]
25. Viciano, J.; Lõpez-Lázaro, S.; Alemán, I. Sex estimation based on deciduous and permanent dentition in a contemporary spanish population. *Am. J. Phys. Anthropol.* **2013**, *152*, 31–43. [CrossRef]
26. Acharya, A.B.; Angadi, P.V.; Prabhu, S.; Nagnur, S. Validity of the mandibular canine index (MCI) in sex prediction: Reassessment in an Indian sample. *Forensic Sci. Int.* **2011**, *204*, 207.e1–207.e4. [CrossRef]
27. Acharya, A.B.; Prabhu, S.; Muddapur, M.V. Odontometric sex assessment from logistic regression analysis. *Int. J. Leg. Med.* **2011**, *125*, 199–204. [CrossRef]
28. Thapar, R.; Angadi, P.V.; Hallikerimath, S.; Kale, A.D. Sex assessment using odontometry and cranial anthropometry: Evaluation in an Indian sample. *Forensic Sci. Med. Pathol.* **2012**, *8*, 94–100. [CrossRef]
29. Filho, I.E.M.; Lopez-Capp, T.T.; Biazevic, M.G.H.; Michel-Crosato, E. Sexual dimorphism using odontometric indexes: Analysis of three statistical techniques. *J. Forensic Leg. Med.* **2016**, *44*, 37–42. [CrossRef]
30. Filipovic, G.; Kanjevac, T.; Cetenovic, B.; Ajdukovic, Z.; Petrovic, N. Sexual dimorphism in the dimensions of teeth in serbian population. *Coll. Antropol.* **2016**, *40*, 23–28. Available online: http://www.ncbi.nlm.nih.gov/pubmed/27301233 (accessed on 7 May 2020).
31. Bolton, W.A. Disharmony in tooth size and its relation to the analysis and treatment of malocclusion. *Angle Orthod.* **1985**, *28*, 113–130.
32. Machado, V.; Botelho, J.; Amaral, A.; Proença, L.; Alves, R.; Rua, J.; Cavacas, M.A.; Delgado, A.S.; Mendes, J.J. Prevalence and extent of chronic periodontitis and its risk factors in a Portuguese subpopulation: A retrospective cross-sectional study and analysis of Clinical Attachment Loss. *PeerJ* **2018**, *6*, e5258. [CrossRef] [PubMed]
33. Botelho, J.; Machado, V.; Proença, L.; Alves, R.; Cavacas, M.A.; Amaro, L.; Mendes, J.J. Study of Periodontal Health in Almada-Seixal (SoPHiAS): A cross-sectional study in the Lisbon Metropolitan Area. *Sci. Rep.* **2019**, *9*, 1–10. [CrossRef] [PubMed]