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Research Article

Dental Diversity Patterns: Relevance in Portuguese Military Population

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Abstract

This research's purpose was to build a dental database of a Portuguese military population, to know the frequency and distribution of different medical conditions or pathologies found in each dental piece. In order to meet the goals, this study was based on a sample of 1636 professional military people of the Portuguese Armed Forces. Dental data was collected using the Forensic Dental Symbols® and Dental Encoder® database, Microsoft Excel, and SPSS v.23. Teeth were named following the FDI notation system. The analyzed sample population was composed of 83.4% of men and 16.6% of women. The age group with most individuals was 23 - 27 years with a frequency of 32%. The most frequent code in the 32 teeth was "unrestored". The younger group (≤32 years) had healthier teeth and less missing teeth. Although inconclusive, the dental condition allows individuals classification based on age. The short variability of dental conditions found in the sample, which reflects the population under study, restricts the analysis and, hence, the number of inferences that could be drawn. Studying more heterogenic populations could provide more conclusive results and extraction of additional knowledge from the sample.

Keywords: Dental Diversity; Military Population Data; Dental Records; Human Identification; Forensic Odontology

Introduction

The Portuguese Civil Code states, in Article 66, paragraph 2, that: "The rights recognized by the law to the unborn child dependon his orher birth" and, in Article 69, paragraph 2, that: "A person whose corpse was not found or identified is presumed dead, when the disappearance took place in circumstances that leave no doubt as to his or her death" [1].

Humans are exposed to multiple situations in their daily life, both in a professional and personal scope,despitebeing civils, military people or military people in civil activity.Thus, they maybe exposed to natural or human-made disasters at any moment.

Nowadays, the Portuguese Military Forces assume a major role by participating in international missions and making

commitments to comply with the significant responsibilities taken by Portugal before its peers in the North Atlantic Treaty Organization (NATO), European Union (EU), and United Nations (UN). Therefore, high proficiency and assurance are required in the preparation of the Military Forces beyond the operational training, including an accurate assessment based on the selection criteria standards defined by NATO [2]. One of the main criteria outlined by NATO for militaries to be considered qualified in the recruitment stage is their oral health situation. Before recruitment, soldiers must fulfill NATO's minimum oral health requirements, according to the "NATO Guide for Assessing Deployability for Military Personnel with Medical Conditions" [3]. The mentioned NATO Guide states thatmilitary personnelmust fulfill Dental Fitness Classes 1 or 2 (Dental Fitness Class 1: no dental treatment required and no further dental appointments required for existing conditions – fully capable; Dental Fitness Class 2: military personnel whose existing dental condition is unlikely to result in a dental emergency within 12 months).That classification is aimed to prioritize dental care, minimize the number of emergencies due to dental problems, and emphasize the importance of oral health for all military forces, both active and in reserve [4].

Ideally, only militaries with Dental Fitness Classes 1 and 2 should be selected; however, the detailed definition of each class and final assessment differs between countries. Many countries have standard operational policies that include some conditions within Class 3 as acceptable. Others do not require a strict classification by clinical personnel for risk assessment. In the case of doubt, when assigning a classification, the highest classification should be considered [5].

A dental examination to determine military people's Dental Fitness should also be done when they are being selected for missions, and dental records should be completed according to the established form by the health entity performing the assessment.

Military personnel's Dental Fitness is assessed and determined by dentists in a military base during dental visits (which occur periodically, before missions, in urgencies or for a specific treatment). Dental Fitness is considered acceptable for all military personnel when their oral care is not expected to require assistance or improbable treatments in the following 12 months [6].

By definition,militaries with Dental Fitness Classes 3 or 4 (Dental Fitness Class 3: military personnel who have a dental condition that is likely to cause a dental emergency within 12 months or adental condition that is currently under care, but likely to result ina dental emergency if treatment is not completed; Dental Fitness Class 4:military personnel who require an annual examination, have an undetermined dental status, have no dental record,or have an incomplete dental record) should not be selected.

Military Dental Medicine may provide multiple types of action: preventive measures, assistance, expertise assessment, and operation support. All these actions are essential both in Military Bases and foreign operations and are highly related to each other. As a preventive measure, epidemiological surveillance of oral and dental health is conducted to maintain the population's oral health. Assistance is provided to determine oral and dental diagnoses, proceed with urgent treatments, and ensure military personnel's readiness for functions. Expertise assessment is required to support the Chief of Health Services concerning oral health and involves assessing all suffered lesions and determining incapacity for service due to oral-dental conditions.

Therefore, it is particularly important to evaluate the oral condition of military personnel because they are additionally exposed to serious injuries whose negative impact on identification is potentially higher.

The purpose of this research was to build a dental database of a Portuguese military population to know the frequency and distribution of different medical conditions or pathologies found in each dental piece. Based on the collected data, the probability of the different tooth patterns occurring and their variability in the reference population group were determined. These data were used to calculate the frequencies of the various tooth patterns in the population and, using statistical models, to determine the certainty degree obtained in the identification of an individual based on dental condition.

Material and Methods

A sample of 1636 professional military personnel of the Portuguese Armed Forces was used to pursue this research's goal. This study was carried out in compliance with the personal data protection law, according to the international recommendations of

the World Medical Association for clinical research gathered in the Helsinki Declaration. Data collection and usage were conducted with the permission of the Ethics Committee of the D. Pedro V Military Hospital, Porto, Portugal, thus fulfilling the personal data protection law. Dental data was collected using the Forensic Dental Symbols® and Dental Encoder® database [7-9], Microsoft Excel, and SPSS v.23. Teeth were named following the FDI (World Dental Federation) notation system.

Dental classification in this study followed the general proposal by Martinez-Cicón, which is based on four types of teeth. To record dental characteristics, a dental coding system was used as reported in a previous study to classify characteristic into four types: 1, Unrestored, which includes healthy teeth, cavities without restoration (regardless of the surfaces involved), root fragments, fissure sealants and partially erupted teeth; 2, Restored, which includes restored teeth regardless of the material used or the surfaces involved; 3, Missing, which includes missing teeth, unerupted teeth, agenesis and crowns in removable dentures; and 4, Crown, which includes teeth with a single fixed prosthesis, bridge pillar or fixed prosthetic pontic or implant crown.

Using that general codification, similar clinical conditions were grouped into the same category. For instance, all restorations and all missing teeth were grouped together. This summarized coding system limits and corrects potential interpretation differences between observers associated within correct delimitation of restored surfaces, types of material used, reason for missing roots(extraction or unerupted), distinction between the abutment and the pontic of fixed prosthesis, among others. This coding system is a simulation of the collection method used by forensic dentists or dentists.

For statistical inferences, we first performed a Kolmogorov-Smirnov test, for each variable, to verify normality of distribution; the results did not indicate that the distribution was normal. When the distribution is not normal, nonparametric tests are recommended; however, when the sample is very large, the normality of distribution can be considered. Thus, in this work, both types of test were used: the analysis of variance (ANOVA) and the t-Student test for independent samples, and the Kruskal-Wallis and Mann-Whitney tests, which are the correspondent nonparametric tests. The conclusion was the same for all cases. All tests were performed with a 95% confidence level, which implies a p-value lower than 5% to reject the null hypothesis.

Results

For frequency analysis, individuals were grouped by sex, age group, and dental condition to understand the source of the collected data.

Table 1 represents distribution by sex and age group in the Portuguese military population. The population is mostly male, as confirmed by the sample, with 83.4% of men and 16.6% of women.

Sex	**#**	**%**
Male	1365	83.4%
Female	271	16.6%
Age Group	**#**	**%**
18-22	234	14.3%
23-27	524	32%
28-32	193	11.8%
33-37	56	3.4%
38-42	66	4%
43-47	102	6.2%
48-52	147	9%
53-57	129	7.9%
>57	185	11.3%

Table 1: Distribution by sex and age group (in years) in the Portuguese military population.

The age group with most individuals is 23-27 years, showing the highest incidence of Portuguese military population – 32%. Following that age group are groups 18-22 years and 28-32 years, with 14.3% and 11.8% of the population, respectively. A significant percentage of the population – 58.1% – was under 33 years old. The lowest percentage was 3.4%, found in age group 33-37 years, followed by 4% in 38-42 and 6.2% in 43-47.

Table 2 presents the distribution by tooth and dental condition of the Portuguese military sample.

The most frequent code in the 32 teeth was “unrestored.” The frequency of unrestored teeth varied between 97.8% in teeth 33 and 42 and 75.6% in teeth 36 and 46. Regarding restored teeth, their frequency was highest in teeth 47 (13.9%) and 36 (13.4%), and was lowest in teeth 42 (0.8%), 43 (0.9%), and 31 (0.9%). The “missing” code was most frequent in teeth 18 (6.4%) and 48 (5.7%) and least frequent in teeth 13, 11, 21, and 33, all with 0.4%. Crowns were most frequent in teeth 46 (7.2%) and 36 (7.0%), while teeth

18, 28, 38, and 48 had very few or no occurrences of crowns, with values between 0.1% and 0.0%.

Dental Condition Tooth	Unrestored		Restored		Missing		Crown	
	#	%	#	%	#	%	#	%
18	1486	90.8%	44	2.7%	105	6.4%	1	0.1%
17	1397	85.4%	184	11.2%	34	2.1%	21	1.3%
16	1313	80.3%	210	12.8%	44	2.7%	69	4.2%
15	1383	84.5%	151	9.2%	32	2.0%	70	4.3%
14	1398	85.5%	134	8.2%	24	1.5%	80	4.9%
13	1546	94.5%	64	3.9%	6	0.4%	20	1.2%
12	1509	92.2%	78	4.8%	8	0.5%	41	2.5%
11	1486	90.8%	103	6.3%	6	0.4%	41	2.5%
21	1476	90.2%	95	5.8%	7	0.4%	58	3.5%
22	1509	92.2%	79	4.8%	9	0.6%	39	2.4%
23	1543	94.3%	55	3.4%	10	0.6%	28	1.7%
24	1431	87.5%	105	6.4%	34	2.1%	66	4.0%
25	1403	85.8%	130	7.9%	34	2.1%	69	4.2%
26	1288	78.7%	211	12.9%	61	3.7%	76	4.6%
27	1406	85.9%	173	10.6%	40	2.4%	17	1.0%
28	1493	91.3%	52	3.2%	90	5.5%	1	0.1%
48	1475	90.2%	68	4.2%	93	5.7%	0	0.0%
47	1333	81.5%	227	13.9%	47	2.9%	29	1.8%
46	1236	75.6%	213	13.0%	69	4.2%	118	7.2%
45	1473	90.0%	108	6.6%	19	1.2%	36	2.2%
44	1547	94.6%	56	3.4%	11	0.7%	22	1.3%
43	1595	97.5%	15	0.9%	12	0.7%	14	0.9%
42	1600	97.8%	13	0.8%	10	0.6%	13	0.8%
41	1586	96.9%	23	1.4%	14	0.9%	13	0.8%
31	1593	97.4%	15	0.9%	15	0.9%	13	0.8%
32	1584	96.8%	20	1.2%	15	0.9%	17	1.0%
33	1600	97.8%	16	1.0%	7	0.4%	13	0.8%
34	1549	94.7%	50	3.1%	8	0.5%	29	1.8%
35	1464	89.5%	117	7.2%	22	1.3%	33	2.0%
36	1236	75.6%	220	13.4%	66	4.0%	114	7.0%
37	1337	81.7%	202	12.3%	56	3.4%	41	2.5%
38	1475	90.2%	82	5.0%	78	4.8%	1	0.1%

Table 2: Distribution by tooth and dental condition.

K-means clustering analysis was performed with two and three clusters to search for grouping patterns with similar conditions. Clustering with two groups resulted in one group with 300 and other with 1336 members. With three clusters, sample distribution resulted in groups with 320, 1298, and 18 members. Because with three clusters one group had very few cases, the analysis followed the two-cluster division.

Tables 3 show, respectively, sex and age group proportions in each cluster. In order to know if the clusters were related to the several age groups and sex, a chi-square test was performed for each variable. The results showed differences regarding age groups (p-value = 0.000) but none for sex (p-value = 0.602).

Sex		**Cluster 1**	**Cluster 2**
Male	#	1105	260
	%	82.7%	86.7%
Female	#	231	40
	%	17.3%	13.3%
Age Group			
18-22	#	222	12
	%	16.6%	4.0%
23-27	#	463	61
	%	34.7%	20.3%
28-32	#	167	26
	%	12.5%	8.7%
33-37	#	45	11
	%	3.4%	3.7%
38-42	#	45	21
	%	3.4%	7.0%
43-47	#	79	23
	%	5.9%	7.7%
48-52	#	92	55
	%	6.9%	18.3%
53-57	#	91	38
	%	6.8%	12.7%
>57	#	132	53
	%	9.9%	17.7%

Table 3: Sex and Age group (in years) distribution in each cluster.

Individuals less than 33 years old were most related to one cluster and individuals over 48 years old were most related to the other cluster. Age groups between 33 and 47 were not specifically highly related to any of the clusters, with similar proportions in each of them.

Cluster 1 has a younger group, more unrestored teeth, and fewer missing teeth, while Cluster 2 has older individuals, fewer healthy teeth, and more missing teeth.

Considering the differences in frequencies shown in Table 3, the Kolmogorov-Smirnov test was performed to verify the normality of data, in order to decide the type of test to use. The results showed that there was no normality (p-value = 0.000), and, thus, a Wilcoxon test (a nonparametric test that is equivalent to the parametric t-Student test for paired samples) was performed for all combinations of teeth pairs. Results showed that the difference was not significant, meaning that dental condition does not vary much between teeth.

Teeth were grouped into the two clusters' patterns as shown in table 4.

	1Q	**2Q**	**3Q**	**4Q**
Cluster 1	1,2,3,8	1,2,3,7,8	1,2,3,4,5,8	1,2,3,4,5,8
Cluster 2	4,5,6,7	4,5,6	6,7	6,7

Table 4: Standardization of dental condition.

Teeth 11, 21, 31, 41, 12, 22, 32, 42, 13, 23, 33, 43, 18, 28, 38, and 48 were found only in Cluster 1, while teeth 16, 26, 36, and 46 were found only in Cluster 2. Teeth 14, 24, 34, 44, 15, 25, 35, 45, 17, 27, 37, and 47 were found in both clusters, even though the second molar from the second quadrant was only in Cluster 1.

In Cluster 1, which had a higher number of younger people, teeth 11, 21, 31, 41,12, 22, 32, 42, 31, 32, 33, and 43 were healthier than 18, 28, 38, and 48, which are usually more absent. In Cluster 2, which had a higher number of older people, teeth 16, 26, 36, and 46 were the most frequently restored and the least healthy, due to the previously mentioned reason.

The ratio of each tooth's dental condition was also analyzed by age group (Table 5).

Age Group	Tooth condition	U	R	M	C
18-22	Average	0,9345	0,0503	0,0142	0,0013
	Stand. Dev	0,0569	0,0472	0,0191	0,0043
23-27	Average	0,9039	0,0703	0,0190	0,0077
	Stand. Dev	0,0681	0,0492	0,0202	0,0096
28-32	Average	0,9087	0,0648	0,0123	0,0200
	Stand. Dev	0,0630	0,0474	0,0133	0,0173
33-37	Average	0,8965	0,0703	0,0126	0,0229
	Stand. Dev	0,0815	0,0451	0,0214	0,0387
38-42	Average	0,8719	0,0790	0,0168	0,0371
	Stand. Dev	0,0945	0,0582	0,0214	0,0389
43-47	Average	0,8500	0,1058	0,0223	0,0242
	Stand. Dev	0,0899	0,0633	0,0223	0,0275
48-52	Average	0,8526	0,0752	0,0161	0,0590
	Stand. Dev	0,0816	0,0506	0,0145	0,0491
53-57	Average	0,8674	0,0645	0,0226	0,0471
	Stand. Dev	0,0745	0,0385	0,0202	0,0416
>57	Average	0,8419	0,0616	0,0439	0,0542
	Stand. Dev	0,0525	0,0290	0,0216	0,0300

Table 5: Average and Standard Deviation for Distribution of dental condition by age group (in years). Legend: u - unrestored; r - restored; m - missing; c – crown.

Considering ratio as a variable (continuous quantitative variable), significant differences were searched in the proportions of the various age groups. Again, the Kolmogorov-Smirnov test showed no normality (p-value = 0.000), and the Wilcoxon test was conducted to verify if the observed difference was significant in the sample. Each age group was compared with all others (two by two), and no significant differences were found in the results.

The results of this analysis do not allow establishing a pattern of tooth condition based on age group.

Discussion

A chi-square test confirmed that the prevalence of the male sex with 83.4% (1365 men) was significant. This difference may result from the fact that military service was mandatory for men until recently, while it was not common for women.

Our sample's sex distribution is coherent with the military population records referred by some authors [10,11]. Our sample's female proportion (16.6%) was coherent with the reported for the military population, where, in 2011, from a total of 17,592 military personnel, 2520 were female, thus representing 14.3% of the population. In 2008, the Portuguese Ministry of Defense, according to the law Dispatch No. 101 from July 6th, 2008, determined that the recruitment of candidates to military forces should respect sex equality and involve accessing all grades and specialties; certainly, that law strongly contributed to the female ratio growth in younger ages10. Since 2003, Portugal abolished the mandatory military service, becoming optional to the whole population.

Considering the "unrestored" code, teeth with the highest frequency were the lower antero lateral teeth. These teeth are less exposed to dental caries processes that would require restorations because they do not have the occlusal surface, and are less subjected to direct injury because they are protected by the upper jaw. On the opposite side, the inferior first and second molars are more likely to suffer diseases that require treatments from dentists.

The "restored" code was most common in the first and second molars due to their anatomical occlusal surface and their considerable role in the chewing process. Teeth with the lowest rates of restoration were the lower antero lateral teeth due to the same reasons as mentioned above in the "unrestored" code.

The "missing" code was most frequent in the third molars. That finding may be associated with those teeth's anatomical conditions and late eruption, as well as with their subsequent eruption. On the other hand, the teeth with the lowest missing frequencies were canines and incisors, which are less frequently affected by pathological processes and, thus, are less subject to extractions. Furthermore, due to aesthetic reasons, those teeth are less frequently extracted and an increased effort is made to keep them.

Regarding the "crown" code, it should be highlighted that it was infrequent in all teeth. First molars stood out in this category probably because they are the first permanent teeth to erupt early, being the most susceptible teeth to suffer from diseases that require dentist's treatments. Additionally, due to their anatomical oclusal surface, first molars may require early prosthetic intervention. On the contrary, the teeth that had crowns least often were the third molars. This low frequency may be justified by the fact that crowns are very unusually held in those posterior teeth and when teeth are conveniently positioned, the patient and the dentist usually choose to extract this tooth prior to its rehabilitation.

The younger group (≤32 years) had healthier teeth and fewer missing teeth, which may result from the many prevention programs that have emerged recently in Portugal. Following previous oral healthcare programs with very restricted access since 1999, in2009, the Portuguese political health strategy changed and increased its scope. The National Oral Health Promotion Program ("cheque-dentista" – dentist voucher) was created to reach some groups with high risk of caries. This program includes curative and preventive treatments and provides financial support for oral care using private resources. That program was initiated by decree No. 301/2009of March 24th, published in the Portuguese Official Government Gazette, 1st series, No. 58, of March 24th, 2009. Additionally, the Portuguese Ministry of Health has been developing strategies to improve awareness, promotion, and prevention on oral healthcare within the public health system.

In Portugal, although oral health is included in primary health care, as previously mentioned, it is primarily provided by private entities, with few or no public support. This situation is a considerable obstacle to the accessibility to oral health care, especially to the population with poor economic conditions, which is a significant group in Portugal [12,13].

Some studies conducted in military populations show that the prevalence of dental emergencies increases with age, being least frequent in the age group 20-30 years and most frequent in the group >51years [5].

Two clusters resulted from the standardization of dental condition, for all quadrants. Cluster 1 was more associated with younger people, and Cluster 2 was more associated with older people. This distinction may be important for the medical and legal areas for human identification, particularly in the age group > 48 years. That is the age from which a more significant difference between the younger and older population is observed. This observation resulted from the analysis of the two age groups in pairs mentioned above.

The fact that incisors and upper canines are healthier may result from younger people being more aware of aesthetic needs and, thus, following preventive measures for their oral health.

Very frequently, dental pieces and their specific characteristics are extremely useful for human identification. For instance, in the 2004 Asian tsunami, experts from many countries conducted human identification based on the study of their teeth. Forensic odontology was responsible for 70.3% of the identifications alone and 5.4% in combination with fingerprints study [14]. According to the Disaster Victim Identification (DVI), forensic odontology is one of the three primary identifiers, along with fingerprints and DNA, and, thus, a multidisciplinary team of experts is required in a disaster situation [14-17].

Human or natural disasters are events that affect the lives of multiple individuals at a given time and place. Examples of such disasters are hurricanes, tornados, floods, earthquakes, and also human-made disasters, such as terrorist attacks or wars, and all these may affect a large number of people [18]. However, the most common problem faced by a forensic team during human identification is the poor state of conservation of the unidentified bodies and the incomplete presence of remains, which may delay the identification process; in these situations, an oral autopsy maybe a solution [19].

Conclusion

The Portuguese military population was characterized based on their dental condition. It was found to be a very homogeneous population with reduced variability. This finding means increased complexity for the identification of patterns that allow the identification of clearly distinct groups within the population.

Although statistical tests were inconclusive, the dental condition allows individuals classification based on age. It is possible to clearly distinguish two age groups (under 33 years and over 47 years), with the interval between 32 and 48 years being a transition zone. In this sense, this work indicates that it is possible to infer with considerable confidence whether the individual's age is higher than 32 years or lower than 48 years, based on their mouth's dental condition.

The "sex" variable did not reveal any significant differences.

The sample analyzed in this study is representative of the Portuguese military population, and, thus, extrapolation of the results is possible.

The short variability of dental conditions found in the sample, which reflects the population under study, restricts the analysis and, hence, the number of inferences that could be drawn. Studying more heterogenic populations could provide more conclusive results and the extraction of additional knowledge from the sample.

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