Forensic Medicine and the Military Population: International Dental Records and Personal Identification Concerns

Medicina Forense e a População Militar: Registos Dentários Internacionais e Sensibilização para a Identificação Humana

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ABSTRACT

Introduction: The first goal of this research was to perceive the global commitment towards the organization and archiving of dental records and to compare it with each country's security risk rating. The second one was to study dental records in a sample of the Portuguese military population, using the available national dental records.

Material and Methods: An e-mail was sent to representative dentistry associations in several countries, requesting some information concerning the professionals' awareness of this issue. After obtaining permission from the Ethics Committee, the information was collected through the Forensic Dental Symbols® system into the Dental Encoder®, as an extension of a Spanish study, and a generic codification was used (unrestored, restored, missing and crowned teeth).

Results: The most common dental record retention period is ten years after treatment. Observing the samples' dental records (595 files), we found a total of 19 040 analyzed teeth, with the following frequencies: unrestored (89.6%), restored (7.0%), missing (2.2%) and crowned (1.1%).

Discussion: There is a wide range of guidelines on how long dentists should keep dental records. Especially for the military population, dental records must include detailed information concerning each tooth situation, in order to support the process of human identification.

Conclusion: This article reinforces the need for mandatory quality dental records in all countries, which must be efficiently stored and easily accessible in case dental identification is necessary. For the military population, these requirements are especially important, due to the added risks to which this group is subject.

Keywords: Dental Records; Forensic Dentistry; Military Personnel; Portugal

RESUMO

Introdução: Esta investigação teve o intuito de procurar conhecer o comprometimento global relativamente à organização e arquivo dos registos dentários e compará-lo com o risco de segurança de cada país. Por outro lado, procurou-se estudar os processos clínicos de uma amostra da população militar Portuguesa, utilizando-se para o efeito os registos dentários.

Material e Métodos: Foi enviado um *e-mail* para associações dentárias e solicitada informação sobre o tempo de guarda dos registos dentários. Após autorização prévia da Comissão de Ética, a informação foi recolhida através do sistema Forensic Dental Symbols® para Dental Encoder®, como uma extensão de uma investigação realizada em Espanha e utilizada a codificação genérica (dentes sãos, com restaurações, ausentes e coroas).

Resultados: Globalmente, dez anos após o último tratamento, foi o procedimento mais comum relativamente ao tempo de guarda dos documentos. Após observação dos registos dentários da amostra (595 militares) verificou-se um total de 19 040 dentes analisados, com as seguintes frequências: dentes sãos (89,6%), com restauração (7,0%), ausentes (2,2%) e coroas (1,1%).

Discussão: Existe grande variedade de orientações sobre quanto tempo têm que ser guardados pelos profissionais de saúde os seus registos. Nos registos dentários da população militar deve-se incluir informação detalhada de cada dente, de maneira a suportar o processo de identificação humana.

Conclusão: Este artigo reforça a necessidade de registos dentários de qualidade em todos os países, com manutenção eficiente para a identificação humana. Na população militar torna-se especialmente importante, devido ao facto de este ser um grupo sujeito a riscos acrescidos.

Palavras-chave: Odontologia Forense; População Militar; Portugal; Registos Dentários

INTRODUCTION

Forensic medicine is the discipline that deals with legal issues supported by medical facts. Personal identification is fundamental as far as medical legal issues are concerned. Biological criteria must be unique, unchanged and perennial.[1-3] They include a number of attributes that characterize the individual, making him/her unique and

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distinguishable from others. Such characteristics may be psychological (such as character or intelligence), functional (behaviour, gestures, locomotion, sensibility, voice, writing) and physical (race, gender, age, stature, malformations, scars, tattoos, professional signs, biotype). Whereas psychological and functional characteristics contribute to the uniqueness of individuals while they are alive, physical characteristics remain even after their death.[4]

Several authors suggested two types of identification: reconstructive – whenever a probable identification can be suggested based on age, gender, race and height – and comparative, based on a match with previously existing records.[5,6]

No less important are the legal and social aspects of death; we believe that, for all families, whatever their cultural and religious origins, it is important to determine what happened and where their loved ones are; The need for the corpse's identification takes on social and ethical importance, as it is part of the grieving process followed by most religions and cultures. Legal and financial aspects can also be particularly relevant when considering situations of inheritance, pension or life insurance.[7]

Basic sciences, such as anatomy and histology must be developed in order to support forensic medicine. Anatomy concerns include cadaveric dissection, problem-based workshops, plastic models, computer software packages, living anatomy and radiological anatomy.[8,9] These learning methods are key approaches for acquiring important knowledge, very useful for the implementation of best practices and innovation in forensic medicine, in relation to bite mark analysis, body trauma assessment, malpractice assessment and human identification.[10] Histology is used to investigate post-mortem bone modifications, trauma, pathologies, age estimation and to discriminate human and non-human bones.[11]

Teeth are incredibly strong and can withstand temperatures up to 1200 Celsius degrees. A careful dental examination can produce data such as the person's age, gender and size, and provide a number of anatomical references that can allow for both identification and exclusion. However, the use of a comparative approach requires high-quality, complete and carefully filled dental records.[12]

Fingerprinting, the most extensively accepted method of human identification, is useless whenever bodies are disfigured, decomposed, burned or fragmented. The anatomical comparison of teeth to previously available records is one of the most important alternatives used for human identification.[12-14]

The physical, chemical and biological characteristics of dental arches make them valuable anatomical elements in case of severe aggression. Military corpses are often exposed to adverse scenarios. Occasionally their identification is only possible through teeth. Forensic odontology enables a comparison between *ante-* and *post-mortem* dental records, providing one of the best ways for establishing personal identification - sometimes it is the only method of identification or exclusion.[4,15,16]

Portugal has actively contributed to United Nations peace operations in four continents. Over the last 15 years, Portugal has deployed more than 30 000 military personnel abroad in 18 missions.[17]

Conflict risk and post-conflict injury among the military population has been discussed for decades, with regard to mortality and morbidity concerns, and includes information about the different types of aggressors (criminals, protesters or terrorists).[18]

Military health risks have been associated to post-conflict injury and related mortality such as: mental health disorders, traumatic brain injury, suicide, rheumatology injuries, increased cancer risk, alcohol and drug addiction.[19-22] Conflict risks include: military trauma, spine injuries, acute pain, physical and sexual abuse, pandemic diseases and in some cases, death.[23-27]

Due to exposure to these diverse types of danger, the military population has an increased probability of requiring corpse identification. Where *ante-mortem* dental records have been carefully prepared, human identification can be successful even if other elements are missing. Additionally, the cost-effectiveness ratio is very favourable when such method is available. Human identification using previous dental records has proven extremely useful, particularly in mass disasters or extreme situations, such as wars, earthquakes, aeronautical accidents or shipwrecks.[27]

This research had two goals. The first was to understand the commitment towards the organizing and archiving of dental records in a worldwide set of countries, seeking a potential relationship with each country's security risk rating, and to get a perception of the awareness to this issue. The second was to study dental records in the Portuguese military population, based on available national dental records and their value for personal identification.

MATERIAL AND METHODS

A questionnaire on the organization and archival of dental records and on the professional's awareness was sent via email to representative dentistry organizations in the five continents. The addresses used for the survey on the professional's awareness of dental record organization were obtained from the official web page of FDI (World Dental Federation). The associations that took the survey are listed on Table 1.

When considering the countries' risk rating, we used the International SOS classification provided for travellers: 'extreme', 'high', 'medium', 'low' and 'insignificant' risk.[28]

For the study of dental records among the Portuguese military population, we used a sample of 595 individuals whose last dental observation/treatment was between January 2010 and July 2011, provided by the Regional Military Hospital of Porto, Portugal, after obtaining authorization from the relevant authorities (ethics committee of the D. Pedro V Military Hospital, Porto).

The information was collected in the form of 'Forensic Dental Symbols®' into the Dental Encoder® database.[29,30]

Table 1 - List of associations

Austria	Osterreichische Zahnärztekammer
Belgium	Chambres Syndicales Dentaires
Denmark	Association of Public Health Dentists in Denmark
Finland	Finnish Dental Association
France	Association Dentaire Française
Netherlands	Nederlandse Maatschanppij tot bevordering der Tandheelkunde
Ireland	Irish Dental Association
Iceland	Icelandic Dental Association
Italy	Associazione Italiana Odontoiatri
Luxembourg	College Medical du Luxemburg
Norway	Norwegian Dental Association
Lithuania	Lithuanian Dental Chamber
Portugal	Ordem dos Médicos Dentistas
Spain	Consejo General de Colegio de Odontólogos y Estomatólogos de España
Sweden	Swedish Dental Association
Switzerland	Société Suisse d'Odonto-stomatologie
United Kingdom	British Dental Association
United States	American Dental Association
Canada	Canadian Dental Association
Argentina	Confederación Odontológica de la República Argentina
Brazil	Associação Brasileira de Odontologia
Colombia	Federación Odontológica Colombiana
Costa Rica	Colegio de Cirujianos Dentistas de Costa Rica
Paraguay	Federación Odontológica del Paraguay
China (Hong Kong)	Hong Kong Dental Association
Israel	Israel Dental Association
Russia	Russian Dental Association
Taiwan	Dental Association of Thailand
Turkey	Turkish Dental Association
Guinea-Bissau	Associação Dentária de Guiné-Bissau
South Africa	South African Dental Association
New Zealand	New Zealand Dental Association
Tasmania	Australian Dental Association

Table 2 - Dental classification types

Unrestored	Includes the clinical conditions of healthy teeth, cavities without restoration (regardless of affected surfaces), root fragments, fissure sealants and partially erupted teeth
Restored	Includes the clinical conditions of restored dental pieces, whatever material used or the surface involved
Missing	Includes the clinical conditions of missing dental pieces, unerupted teeth, agenesis and crowns for removable dentures
Crown	Includes the clinical conditions of dental parts carrying a unit fixed prosthesis, bridge pillar or fixed prosthesis pontic or implant crown

In this study we included individuals up to 63 years old, even though the cut-off age for missions is 49. Non-military personnel and incomplete dental records, such as illegible dental situation or missing characterization elements, such as age or gender, as well as ages below 18 years, were excluded.

With respect to dental condition, a dental coding system (generic code) was used,[29,30] which classifies dental characteristic into four types, as listed in Table 2.

For statistical inferences, we first performed a

Kolmogorov-Smirnov test for each variable, to assess the normality of distribution and the results did not allow concluding that distribution is normal. When the distribution is not normal, it is better to use non-parametric tests, but if the sample is of a large size, it is possible to consider the normality of the distribution. In this work, we used both types of tests – we used the analysis of variance, popularly known as ANOVA and the *t*-Student test for independent samples, or the Kruskal-Wallis and Mann-Whitney tests, which are, respectively, the corresponding non-parametric tests. The conclusion was the same for all cases. All tests were performed with a 95% confidence level, which, consequently, implies a *p*-value under 5% to reject the null hypothesis.

RESULTS

Thirty three representative dentistry associations in several countries, located across the five continents,

Table 3 - Dental record archival and organization related to the country's risk rating in the five continents

	Country	Risk rating	Dental record Archival and Organization
EUROPE	Austria	Low	10 years (required)
	Belgium	Low	30 years (recommended)
	Denmark	Insignificant	10 years
	Finland	Insignificant	10 years after patient's death 100 years in case of no knowledge of patient's death or 10 years after last treatment
	France	Low	10 years (required)
	Netherlands	Low	15 years (required) or more if deemed necessary
	Ireland	Low	10 years (required)
	Iceland	Insignificant	Forever (required)
	Italy	Low	Not required
	Luxembourg	Insignificant	10 years (required)
	Norway	Insignificant	Forever (required)
	Lithuania	Low	15 years (required)
	Portugal	Low	5 years (recommended)
	Spain	Low	5 years minimum (required)
	Sweden	Insignificant	10 years (required)
	Switzerland	Insignificant	10 years (required)
	United Kingdom	Low	Minimum 11 years after last visit or 25 years of age (required) or Forever (recommended)
AMERICAS	United States	Low	Between 1 and 10 years (required) – varies by state
	Canada	Low	Not required
	Argentina	Low	10 years after patient's death
	Brazil	Medium	4 to 10 years after last treatment or 28 years (required)
	Colombia	Medium	8 years (required)
	Costa Rica	Low	Not required
	Paraguay	Low	10 years
ASIA	China (Hong Kong)	Low	3 years (required)
	Israel	Medium	Forever (required)
	Russia	Medium	75 years (required)
	Taiwan	Low	10 years (recommended)
	Turkey	Low	2 years
AFRICA	Guinea-Bissau	High	Not required
	South Africa	Medium	Forever (minimum 11 years)
OCEANIA	New Zealand	Low	10 years (required)
	Tasmania	Low	7 years or 25 years (required)

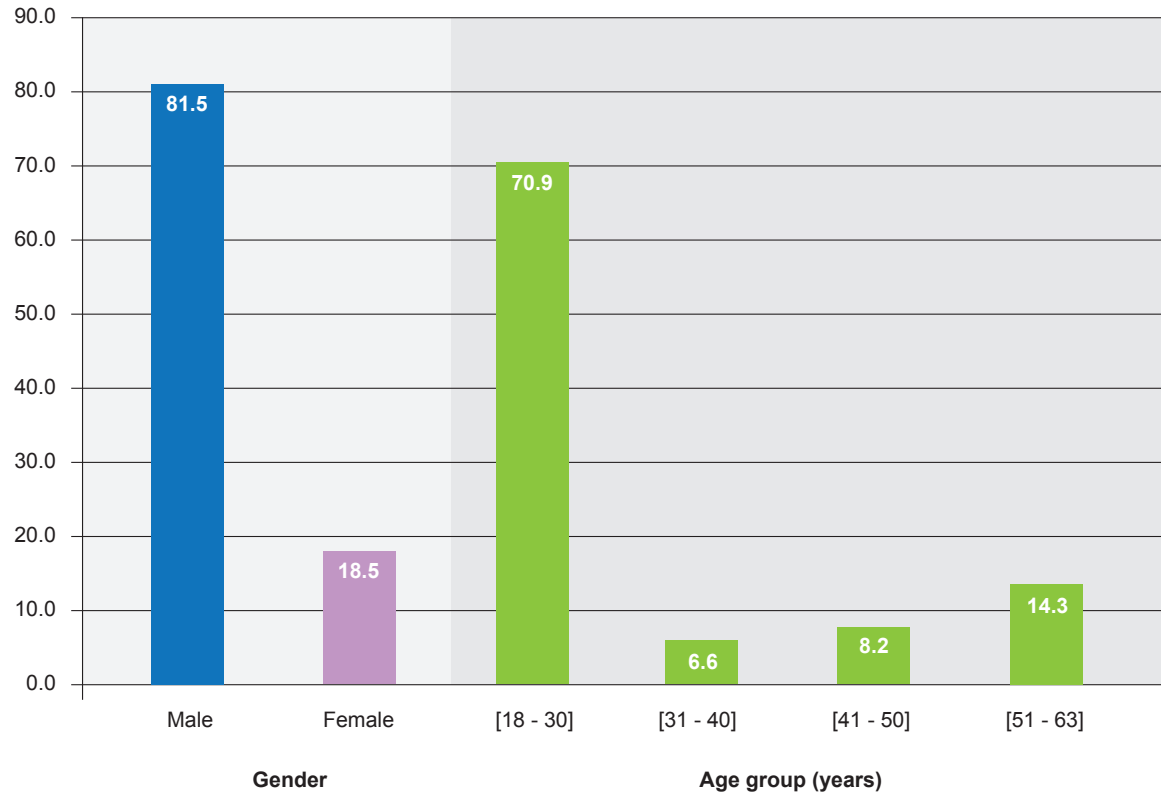

Figure 1 – Socio-demographic distribution (Gender / Age Group)

provided feedback, as shown in Table 3.

Of a total of 33 responses, 17 (51.2%) came from European countries, 7 (21.2%) from the American continent, 5 (15.2%) from Asia, 2 (6.2%) from Africa and 2 (6.2%) from Oceania.

The responses collected had considerable differences: Three countries (9.1%) require keeping dental records forever and five (15.2%) countries do not require that any type of dental record is kept. One country recommends keeping such records for a minimum of 11 years, two recommend 15 years, one 30 years and one 75 years. The most common figure is 10 years or less, with 20 responses – i.e. 20 countries reported requiring or recommending the keeping of dental records during that period.

Additionally, the risk rating of the countries that replied to the data collection emails was predominantly low (20 countries), followed by insignificant (7 countries), medium (5) and lastly, high (1 country).

With regard to the study of the Portuguese military population, Fig. 1 shows the socio-demographic distribution (Gender / Age Group).

There is a predominance of males (485; 81.5%) over females (110; 18.5%). A chi-square test confirms that this difference is significant ($p < 0.001$). Ages were between 18 and 63 years. Fig. 2 shows the oral condition distribution within each Gender / Age Group.

Oral condition frequencies were analyzed in this study, divided into four groups: All teeth unrestored; At least one restoration; At least one missing tooth, and At least one crown. In our sample, the most frequent oral condition is restored (males: 347; females: 81), followed by missing (males: 170; females: 38), crowned (males: 71, females: 16) and unrestored (males: 34, females: 10). The chi-square test was performed to analyze the differences in oral condition between males and females. Results (p-value = 0.000) indicate that a difference exists only for unrestored teeth in the second quadrant. In this case, females have more unrestored teeth than males.

None of the military personnel in the 31 - 40 age group, either males or females, have all teeth unrestored.

The ANOVA statistic test was carried out to analyze the differences in teeth condition between the age groups. The results showed that in the 18 - 30 age group, the crown code frequency is considerably lower than in other age groups.

We determined the correlation between the several teeth conditions and results show that there is a weak correlation between the four quadrants for all types of condition.

This study included 32 teeth from 595 military personnel. Our sample, which represents a total of 19 040 teeth, was analyzed with a generic codification and the following distribution was found: unrestored 89.6% (17 060 teeth), restored 7.0% (1338 teeth), missing 2.2% (427 teeth) and crowned 1.1% (215 teeth).

In this sample, 1980 teeth that have been subject to medical interventions are represented, including restored 67.6% (1338 teeth), missing 21.6% (427 teeth) and crowned 10.9% (215 teeth).

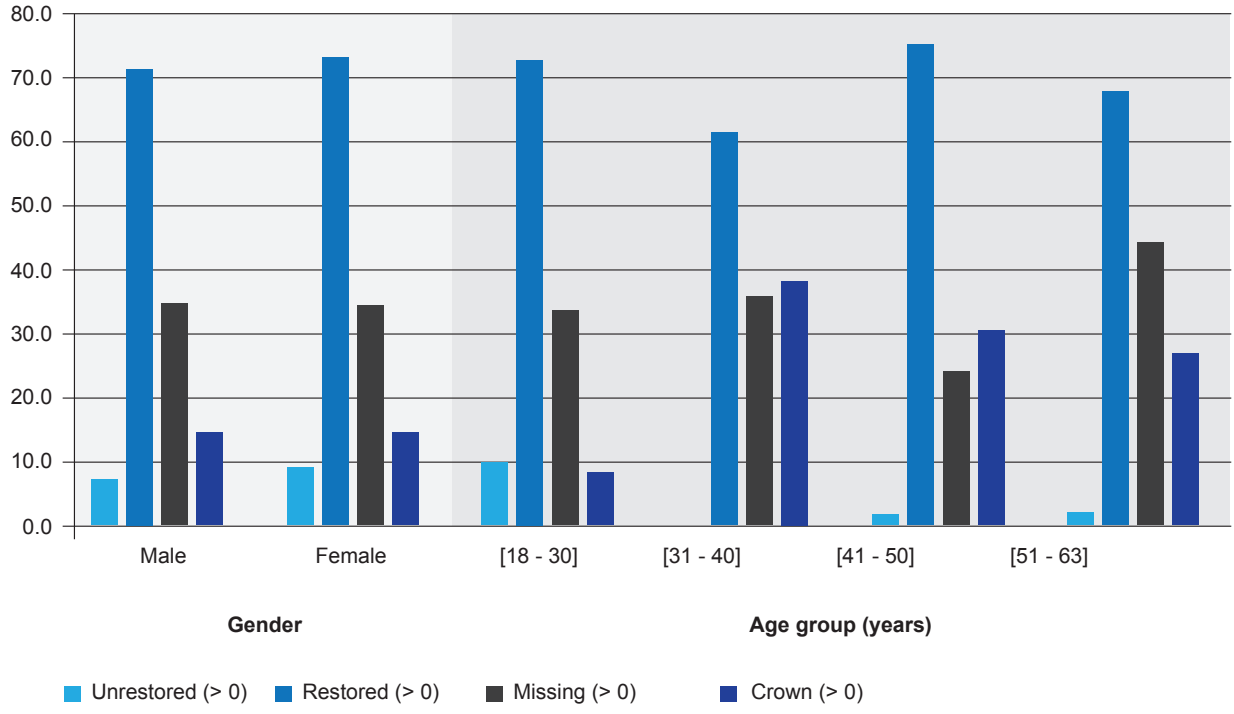

Figure 2 – Oral condition by Gender / Age Group

DISCUSSION

There was a very wide range of responses from Dental Associations about how long dentists should keep dental records. In most countries, the period of time is established after the last intervention. Some countries define specific additional deadlines in case of children, with minimum ages for keeping dental records.

The most common requirement for the retention of dental records is 10 years after the last treatment. Countries with particular extended period requirements are: Israel, Russia, Finland, Iceland, Norway, South Africa and Argentina. Some of these countries have a high/medium risk rating and give special importance to such procedures.

Some countries with more lenient or missing regulations (Guinea-Bissau and Brazil) should be more alert, given their medium and high risk rating. They are not prepared to keep dental records for a significant period of time even though the probability of needing them is higher.

Some authors have studied the qualitative and quantitative impact of dental records in human identification in a mass disaster in Asia in 2005.[31] Victims from Europe (76.4%), North America (76.5%), Oceania (86.7%) and Africa (75.0%) were identified mainly through dental comparison. The identification rate of missing persons with dental records was significantly higher than that of those without ($p < 0.01$). Most of the victims identified by their dental records were returned to their home country within four months after the disaster. Dental records were the primary identifier in 46.2% of identifications. However, among the Thai citizens reported missing, only 2.0% were identified using dental identification; 18.1% had dental charts and 0.8% had dental X-rays. It should also be noted that only 7.4% of Thai dental records could be used for dental identification and one-third of Thai victims remained unidentified.[31]

In this Portuguese military sample, generic coding was used, as it is more reliable and entails less subjectivity (unrestored, restored, missing or crown). It was also useful to correct many common errors intrinsic to the observer, such as failure to specify the treated surfaces, type of material used, etc. This generic coding system allows grouping cases with similar clinical conditions within the same category, such as all restorations or absence of dental pieces. Thus, this narrower coding tends to reduce and rectify some common errors intrinsic to the observer, such as incorrect delimitation of restored surfaces, the type of material used, the reason for absence of teeth – extraction or no eruption –, the distinction between abutment and pontic fixed prosthesis, among others. This coding system simulates the process of collecting dental data performed by medical forensic dentists.

It would also be important to have more diversity and to specify some additional variables, such as oral hygiene, nutrition, smoking habits and other key factors for oral health results. Additionally, comparison with other samples, namely collected in other countries, would also be useful.

The military population is subject to added health risks during missions (both peace maintenance and war scenarios) and is required to receive dental care shortly before deployment, which increases the potential value of the corresponding records.

There was a wide difference between men and women. Our sample's gender distribution is quite similar to military population records referenced by other authors.[32,33] The percentage of females in this sample (18.5%) is similar to

Table 4 - Results by Gender/Age group

Oral condition	Gender		Age group				Gender		Age group			
	Male	Female	[18 - 30]	[31 - 40]	[41 - 50]	[51 - 63]	Male	Female	[18 - 30]	[31 - 40]	[41 - 50]	[51 - 63]
Unrestored	34	10	41	0	1	2	7.0%	9.1%	9.7%	0.0%	2.0%	2.4%
Restored	347	81	309	24	37	58	71.5%	73.6%	73.2%	61.5%	75.5%	68.2%
Missing	170	38	144	14	12	38	35.1%	34.5%	34.1%	35.9%	24.5%	44.7%
Crown	71	16	34	15	15	23	14.6%	14.5%	8.1%	38.5%	30.6%	27.1%

that of others (14.3%). In 2008, the Portuguese Defense Ministry, through Dispatch nº 101 of 6 July 2008, determined that military forces institute recruiting regulations that uphold gender equality for all grades and specialties, which certainly contributed to the increasing ratio of females of younger ages.[32]

The reason why there are records of non-military persons among military hospital dental records is that the Military Hospital provides differentiated health care to the military forces as well as to their families, disabled militaries and also provides health care to other patients under subsequent additional agreements.[33]

Access to dental care treatment, provided by the National Health Service, is not freely available to the entire Portuguese population.[34,35] This is not the case for military personnel, who have free access to privileged dental care. In 2012, military health services included seven dentists in the army.[35] On the other hand, the younger generations were exposed to increased awareness of the requirement to receive dentist care and dental treatments, which had a visible effect on their oral health condition.

In our sample, the most frequent oral condition is 'restored', followed by 'missing', 'crowned' and 'unrestored' (Table 4).

Oral diseases are a significant public health problem, being considered by FDI as an essential component of the general health status.[36] It is estimated that about 50% of the Portuguese population does not have access to oral health care, the main root cause for this being financial constraints.[34,35,37]

CONCLUSION

National awareness of the importance of good and properly filled out dental records is not widespread worldwide. This article reinforces the need for mandatory quality dental records in all countries, which must be efficiently stored and easily accessible in case dental identification is necessary.

There are two key factors contributing to an effective human identification through dental records. The first is the regularity of oral health follow-ups and the second is the quality of the dental records, which is the responsibility of health professionals.

This study also indicates the need for an increased sample size in order to be achieve a more accurate representation of the military population, in order to better characterize the diversity of dental treatment records. It is also important to collect data from others sources, to generate more diversity and to specify some additional variables, such as oral hygiene, nutrition, smoking habits and other key factors for oral health results.

Additionally, comparison with other samples, namely collected among the military forces of other countries, would also be useful.

Despite some limitations, this study leads us to emphasize the potential of the analysis of dental records for personal identification concerns.

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PROTECTION OF HUMANS AND ANIMALS

The authors declare that the procedures were followed according to the regulations established by the Clinical Research and Ethics Committee and to the Helsinki Declaration of the World Medical Association.

DATA CONFIDENTIALITY

The authors declare having followed the protocols in use at their working center regarding patients' data publication.

CONFLICTS OF INTEREST

The authors declare that there are no conflicts of interest.

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