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Caries prevalence and treatment needs in young people in Portugal: the third national study

R. Calado[1], C.S. Ferreira[2], P. Nogueira[3] and P. Melo[4]

[1]ACES Médio Tejo, Riachos, Portugal / National Oral Health Promotion Program, Directorate-General of Health (DGS), Lisbon, Portugal; [2]Oral health task force of the DGS / Saúde Oral Bibliotecas Escolares, DGS, Lisbon, Portugal; [3]Directorate of Analysis and Information, DGS, Lisbon, Portugal / ISAMB - Faculty of Medicine of the University of Lisbon, Portugal; [4]Portuguese Dental Association, Oporto, Portugal / Oral Public Health, Institute of Public Health, Faculty of Dentistry of the University of Oporto, Portugal

Objective: To evaluate caries prevalence and dental treatment needs in Portuguese children and teenagers, as well as fluorosis prevalence in 12-year-old children, in order to address public oral health program strategies. ***Participants:*** A representative stratified random cluster sample of 3,710 participants of 6, 12, and 18 years old was selected. A questionnaire was applied to determine sociodemographic data and some oral health determinants. The clinical examination was based on the ICDAS criteria, then adapted to DMFS index, and Dean's index for fluorosis. ***Results:*** Caries prevalence at 6, 12, and 18 years old was 45.2%, 47.0%, and 67.6%, respectively. D_5MFT scores were 1.18 (SD 0.06) and 2.51 (SD 0.10), respectively. Treatment needs at 12 and 18 years old were associated with 0.37 (SD 0.03) and 0.75 (SD 0.06) values in the "decayed" (D_5) variable. SiC index at 12 years old was 2.68 (SD 1.68). Sealants were identified in 55% of 12-year-old children and the mean of sealants per individual was 3.61; also, moderate (2.2%) and severe (0.2%) levels of fluorosis were detected. ***Conclusions:*** The oral health situation in Portugal is favorable for young people, resulting in low treatment needs. The National Oral Health Promotion Program should be extended to include 18-year-olds.

Key words: *epidemiology, dental caries, fluorosis, oral health, oral health promotion, national survey, children, adolescents, Portugal*

Introduction

National epidemiological studies evaluate the prevalence of oral diseases in target populations and are very useful for public health, as they provide a precise perspective of the association between oral diseases, their determinants, and treatment needs (World Health Organization, WHO, 2013). Based on the results, adequate strategies to control the prevalence of those diseases can be planned, considering the available economic resources and the existent political will (Petersen, 2008). Those results may also be very useful for evaluating the effectiveness of public health programs that have already been introduced and analyzing their relevance from a cost/benefit perspective (Burgeois *et al.*, 2008; WHO, 1999; Direção-Geral da Saúde, 2005).

Dental caries is the most prevalent oral disease among children and adolescents, increasing progressively with age. It represents an important public health problem with great impact on children's and adolescents' health and well-being, and may also interfere dramatically with their development (WHO, 2003). Fluorosis is another oral health problem that should be monitored to prevent its effects on the patients' quality of life (Bsoul *et al.*, 2005; Patel, 2012). The WHO recommends that national epidemiological studies aimed to evaluate the prevalence of oral diseases in populations should be conducted every five years (WHO, 2013).

The Portuguese Directorate-General of Health (DGS) reported in 2000 and 2008 the results of two important national epidemiological studies on dental caries prevalence, which were conducted in children and adolescents of 6, 12, and 15 years old (DGS, 2000; 2005; 2008). Those results revealed that the oral health situation of Portuguese youngsters has been progressively improving, showing a reduction of caries and treatment needs in permanent and primary teeth, even though less markedly in the latter. From 2000 to 2008, the absence of caries in 6-year-old children improved from 33% to 51% and the dmft index from 3.56 to 2.10. Also, in 12-year-old children, the prevalence of caries-free situations showed a great improvement from 27% to 44% and DMFT decreased from 2.95 to 1.48 (DGS, 2008). Until 2008, the Portuguese National Oral Health Promotion Program (NOHPP) was mainly focused on oral health in schools, the number of dentists in the public health service was residual, and there was no answer for treatment needs. In 2008, the NOHPP was reformulated and improved with the introduction of the "dentist voucher". This current program includes the participation of private dentists who must perform specific tasks in each target group and involves a mandatory intervention of the dentist in oral health promotion, oral diseases prevention, and treatment if needed. This new strategy was first tested in pregnant women and older adults and was then broadened to include all children and adolescents in 2009, with the target groups of 7, 10, and 13 years old. (Ministério da Saúde, 2008; 2009).

Correspondence to: Paulo Melo, Rua Dr. Manuel Pereira da Silva, 4200-393 Porto, Portugal. E-mail: paulomelopt@gmail.com

In Portugal, the fluoride supply is mainly based on fluoridated toothpaste, because there is no artificial or natural water fluoridation, except in Azores, one of the seven regions, where natural water fluoridation exists and is controlled by the authorities.

The third National Study on Oral Diseases aims to understand the current oral health status of the Portuguese population, and determine the effectiveness of the PNOHPP's "dentist voucher". Thus, the present study aims to assess the prevalence and severity of dental caries, as well as the treatment needs in the Portuguese population of 6, 12, and 18 years old. It also aims to determine the national situation regarding fluorosis in 12-year-old children.

Methods

The third National Study on Oral Diseases is a cross-sectional descriptive and analytic research study on the profile of dental caries and treatment needs in Portugal. The study's sample of 3,710 participants was randomly selected, and its size was determined considering the target population of 6-, 12-, and 18-year-old people in Portugal and the dental caries prevalence data from previous studies. The established sample size was calculated to allow 5% of missing participants. A stratified cluster sample of the specific target groups was randomly selected from the student lists of the randomized schools which are covered by the randomized 41 Healthcare Center Groups distributed by the seven Portuguese national health regions of Portugal. Each of the seven health regions corresponds to the administrative provinces (North, Center, Lisbon, Alentejo, Algarve, Azores, and Madeira) and those are subdivided into different numbers of Healthcare Center Groups to cover primary healthcare to all the population. The randomized replacement of sampling units occurred in all situations. The 6- and 12-year-old student's parents or guardians and the participants from the 18-year-old group were all fully informed about this study and gave informed consent.

A questionnaire was applied to determine sociodemographic data. Participating mothers were asked about their occupation, area of residence, and educational background. The area of residence was divided into Urban Area, Mixed Urban/Rural Area, or Predominantly Rural Area, and the educational background in Middle school, High school, and Graduate.

Participating children were subjected to a clinical examination based on the ICDAS II (International Caries Detection and Assessment System) for caries diagnosis (Topping and Pitts, 2009). In a subsequent comparison with the WHO's criteria for the DMF Index a cut-off point at D_5 and above of the ICDAS II (i.e. D_5MFT) was considered to allow the comparison with results from previous Portuguese studies (Iranzo-Cortés *et al*., 2013). The indicators for this study included age, gender, area of residence, educational background, occupation, dental caries experience and severity, treatment needs, fissure sealants prevalence, and levels of fluorosis according to Dean's Index.

The national study was carried out by 16 teams (14 in mainland Portugal and two in the Azores and Madeira Autonomous Regions) composed of 24 experienced dentists/university teachers responsible for the clinical observations, and 52 dental hygienists and/or school health nurses responsible for the interviewing procedures. The teams' intra- and inter-examiner calibration showed a linear weighted kappa of 0.80 and 0.75, respectively, for ICDAS with high and moderate agreement. The intra- and inter-examiner calibration consisted of a first session that included an e-learning program, a theoretical course with images, and a training observation of patients with different ages against a gold standard. The final calibration was performed in a second session with patients with different ages against a gold standard, where each participant observed at least 350 teeth surfaces under the same conditions of study and assessed the seven ICDAS II categories. To assess consistency between observations, each examiner repeated one clinical observation in every 10, during recording stage.

An electronic recording system was developed for data collection. This system was a module of the OHIS online software (Oral Health Information System), which is used in the National Oral Health Promotion Program (NOHPP). In cases where online access was not available, the information was recorded on paper forms and was later entered into the system. Recorded data were exported to the SPSS 21.0 software. The Rao-Scott chi-square test for complex samples was applied at a significance level of 5%.

Results

The final 3,710 participants showed a balanced distribution across the three age groups in the seven health regions of Portugal. Most of the observed patients were female (52%) lived mainly in urban areas (54%) and belonged to families with a middle-school educational background. The number of working mothers was greatest among the youngest children: up to 82% for 6-year-olds (Table 1).

Table 1. Sociodemographic characterization of the participants, by age group.

Age, years	*Gender*		*Area of Residence*			*Educational background**			*Occupation**	
	Male	*Female*	*PUA*	*MURA*	*PRA*	*Middle school*	*High school*	*Graduate*	*Yes*	*No*
6	662	664	754	338	225	----	----	----	1,063	233
12	594	715	676	371	262	551	383	224	968	326
18	525	550	573	267	235	579	256	176	756	297
Overall	1,781	1,929	2,003	976	722	1130	639	400	2,787	856

PUA, Predominantly Urban Area; MURA, Mixed Urban/Rural Area; PRA, Predominantly Rural Area. *Information regarding the participant's mother

The identification of lesions associated with dental cavitated caries (D_5MFT) revealed that the prevalence at 6 years old (45.2%), regarding primary teeth, and at 12 years old (47%) indicated that more than half of the children were caries free (Table 2). At 18 years old, 67.6% had the disease. The D_5MFT index values were 1.18 (SD 0.06) and 2.51 (SD 0.10) at 12 and 18 years old, respectively (Table 2). The 12- and 18-year-olds had 0.37 (SD 0.03) and 0.75 (SD 0.06) "decayed" (D_5) teeth, respectively, and their mean number of filled (F) teeth were 0.74 (SD 0.04) and 1.53 (SD 0.08), i.e. double in the older group.

Table 3 shows that the D_5MFT at 12 years old varies with region, being 1.39 (SD 0.13) in the North and 0.75 (SD 0.09) in Alentejo, with the lowest national value in Madeira, with 0.64 (SD 0.08) (Table 3). The same trend can be seen in 18-year-olds with the worst results in the North, 2.90 (SD 0.19), and the best in Lisbon and Madeira, 1.96 (SD 0.21).

The national mean for the one-third of population with the highest levels of caries – the Significant Caries Index (SIC index) for 12-year-olds, is 2.68 (SD 1.68) and shows an inter-regional variation: 3.53 (SD 1.99) in the North and 2.28 (SD 1.30) in Algarve (south), with the lowest values in Alentejo and Madeira, respectively, with 2.26 (SD 1.30) and 1.92 (SD 1.14) (Table 3).

Public healthcare services have been providing children and adolescents the access to preventive health care against dental caries, which include using fissure sealants. This study verified that, at the age of 18 years, one-third (33.1%) of patients had benefited from that policy while at the age of 12 years more than half of patients were benefiting from it (55.2%). The mean number of sealants applied to permanent first molars (1.28) represented approximately one-third of all these interventions (3.61), which means that approximately two-thirds of sealants were applied in permanent premolars and second molars.

The establishment of dental fluorosis levels in 12-year-old children using the Dean's index revealed that 9.8% had very mild, 4.0% mild, 2.2% moderate, and 0.2% severe fluorosis.

Table 2. DMF indexes in the different age groups, by tooth, dental surface and prevalence of the disease

Age Yrs	*N*	*Tooth /Surf*[1]	D_{1-2} *Est(SD)*[2]	D_{3-6} *Est(SD)*	D_{5-6} *Est(SD)*	*M Est(SD)*	*F Est(SD)*	D_1MF *Est(SD)*	D_1MF *Prev*[3]*(%)*	D_3MF *Est(SD)*	D_3MF *Prev(%)*	D_5MF *Est(SD)*	D_5MF *Prev(%)*
6[4]	1,326	Tooth	0.75 (±0.05)	2.29 (±0.11)	1.37 (±0.08)	0.03 (±0.02)	0.22 (±0.02)	3.30 (±0.12)	68.1	2.54 (±0.11)	57.7	1.62 (±0.09)	45.2
		Surf	1.03 (±0.07)	4.97 (±0.28)	3.35 (±0.23)	0.16 (±0.08)	0.40 (±0.04)	6.56 (±0.31)		5.53 (±0.30)		3.91 (±0.25)	
6	1,326	Tooth	0.20 (±0.02)	0.22 (±0.04)	0.05 (±0.01)	0.00	0.01 (±0.00)	0.34 (±0.03)	17.5	0.14 (±0.02)	9.3	0.06 (±0.01)	4.1
		Surf	0.27 (±0.03)	0.22 (±0.04)	0.10 (±0.03)	0.00	0.01 (±0.00)	0.51 (±0.05)		0.23 (±0.04)		0.11 (±0.03)	
12	1,309	Tooth	1.40 (±0.07)	1.23 (±0.07)	0.37 (±0.03)	0.06 (±0.01)	0.74 (±0.04)	3.36 (±0.12)	76.1	1.96 (±0.09)	59.0	1.18 (±0.06)	47.0
		Surf	3.40 (±0.17)	3.00 (±0.19)	0.81 (±0.09)	0.39 (±0.08)	1.82 (±0.11)	8.61 (±0.34)		5.21 (±0.26)		3.26 (±0.20)	
18	1,075	Tooth	1.84 (±0.08)	2.59 (±0.12)	0.75 (±0.06)	0.23 (±0.03)	1.53 (±0.08)	6.19 (±0.16)	89.0	4.36 (±0.14)	82.6	2.51 (±0.10)	67.6
		Surf	4.36 (±0.20)	6.89 (±0.34)	2.29 (±0.21)	1.40 (±0.16)	3.99 (±0.20)	16.63 (±0.51)		12.28 (±0.46)		7.68 (±0.36)	

[1] Surf., Surfaces; [2] Est(SD), Estimates with standard deviations; [3] Prev, Prevalences as percentages; [4] Primary dentition

Table 3. D_5MFT index (and standard deviations) for the different age groups and regions of Portugal with SiC index at age 12 years

Age	*Index*	*Overall*	*n*	*North*	*n*	*Center*	*n*	*Lisbon*	*n*	*Alentejo*	*n*	*Algarve*	*n*	*Açores*	*n*	*Madeira*	*n*
6*	D_5MFT	1.62 (±0.09)	1,326	1.79 (±0.18)	195	1.99 (±0.18)	194	1.41 (±0.17)	195	1.24 (±0.17)	187	1.09 (±0.15)	186	0.56 (±0.08)	185	1.74 (±0.18)	184
12	D_5MFT	1.18 (±0.06)	1,309	1.39 (±0.13)	192	1.30 (±0.12)	192	1.08 (±0.11)	192	0.75 (±0.09)	184	0.77 (±0.09)	182	0.77 (±0.10)	183	0.64 (±0.08)	182
	SiC	2.68 (±1.68)		3.53 (±1.99)		3.34 (±1.87)		2.83 (±1.90)		2.26 (±1.30)		2.28 (±1.30)		2.30 (±1.51)		1.92 (±1.14)	
18	D_5MFT	2.51 (±0.10)	1,075	2.90 (±0.19)	157	2.69 (±0.21)	157	1.96 (±0.21)	157	2.37 (±0.23)	152	2.62 (±0.25)	150	1.91 (±0.17)	150	1.96 (±0.21)	150

Discussion

This study's results are representative of Portugal as a whole and each of the seven health regions of the country, including the Autonomous Regions of Azores and Madeira. The compliance with a detailed research protocol and the technical quality of the examiners, interviewers, and recorders assures the reliability of results. In this study, ICDAS II was applied which is a visual detection and assessment system for classifying stages of the caries process that also allows evaluating more accurately treatment needs and supports decision-making at both individual and public health levels (Pitts *et al*., 2011).

The evaluation of primary dentition in 6-year-old patients showed a high percentage of caries-free children; however, it seems that the WHO's 2020 objective for this age group will not be achieved (WHO, 1999). This problem may result from the absence of toothbrushing habits in most of the kindergartens and the ineffectiveness in managing the adopted measures for adults information (parents and teachers), food education, and hygiene. The results reveal a need to review processes and implement a wider and more efficient national intervention strategy.

Several national studies show that dental caries prevalence has decreased significantly in permanent dentition and has reached very satisfactory levels, particularly in individuals beneficiating from the activities developed within the National Oral Health Promotion Program (NOHPP) (DGS, 2005).

In the 12-year-old group, the mean teeth affected by caries were very low, and the WHO's target for 2020 has already been achieved (WHO, 1999; 2013). The national evolution of the D_5MFT index components in 12-year-old children revealed a marked tendency to control effectively the existent pathology associated with a more effective management of the emerging problems, which currently is reflected in the mean of 0.74 filled teeth per child (Figure 1). The average of treated teeth in situations where preventive measures could not prevent disease suggests that NOHPP appropriately addresses the treatment requirements of its beneficiaries and is effective in preventing the disease.

The oral health status of 18-year-old adolescents revealed moderate levels of disease, which were lower than those expected by the researchers. The D_{1-2} component presents minimum and maximum values at the ages of 6 and 18 years, respectively, which may suggest that main enamel changes occur in association with dental exposure not only during, but also after teeth maturation (Lynch, 2013; Simmer and Hu, 2001). The D_5MFT improvement compared with previous studies of 15-year-old adolescents is relevant, as a decrease from 3.04 to 2.51 was observed (DGS, 2008). The treatment needs of this group demand the intervention of NOHPP and after these results were considered the intervention was started in 2015.

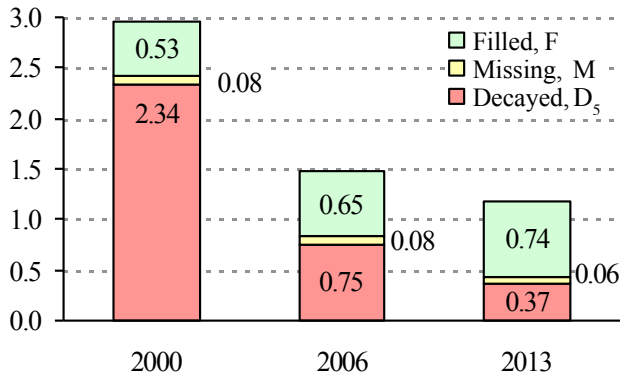

Figure 1. *D_5MFT index components in 12-year-olds, 2000 to 2013*

Thanks to the NOHPP, in the past few years, Portuguese children and adolescents have had easier access to healthcare provided by oral healthcare professionals. Those interventions involved the application of a high number of fissure sealants in permanent teeth and the early treatment of emerging oral diseases. This situation may have been the main factor for the marked improvement in the oral health of these age groups.

The SiC index values follow the variation of the regional DMFT: mainland values decreasing from north to south, and the lowest values being for the Alentejo and Madeira.

Finally, it should be noted that the relatively low values of dental fluorosis identified in this study indicate that this problem does not have a great expression in Portugal, even though it has shown an increase on results from previous studies. Actually, regarding 12-year-old children, compared with the 2006 results, the percentage of mild and very mild levels of fluorosis increased from 7% to 13.8% and the percentage of moderate levels increased from 1% to 2.2%, and intense fluorosis corresponded to 0.2% in both studies (DGS, 2008). Considering those increases, an effort should be made to identify the underlying causes of moderate or severe cases as these might imply greater treatment need. However, the precautionary principle used by public health services had determined, after 2005, the use of systemic fluorides only in children with risk of caries. Nowadays, in community programs, the varnish application in kindergarten (4-6 years old) and the fortnight mouthrinses in primary school (6-10 years old) are recommended. Since 2010, toothbrush practice is increasing in public schools with, for example, 100,000 oral hygiene kits distributed in 2015.

Conclusion

This study revealed that currently a great reduction of disease levels in children and adolescents that benefited from NOHPP has occurred. Thus, it is important for the intervention of NOHPP to include every child up to age 18 years. It is essential to consolidate the beneficial work that has been done, which should ensure good oral health literacy levels. This could provide the appropriate knowledge and abilities to maintain oral health throughout children's lives and reduce treatment needs.

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