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Dentists' knowledge about osteoporosis and their ability to identify the disease

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Abstract

Background: Osteoporosis is an underdiagnosed condition, and its seriousness is not considered until severe complications arise. This study aimed to evaluate general dentists' knowledge about osteoporosis and their ability to identify patients with this disease by assessing mandibular cortical width (MCW) and mandibular cortical index (MCI) on panoramic dental radiographs using a visual method.

Methods: In this cross-sectional study, an email questionnaire regarding the diagnosis and prevention of osteoporosis was sent to 20,773 dentists in 2016. Those who completed the questionnaire were invited to participate in radiomorphometric training and then to analyze the MCI and MCW of 114 panoramic radiographs of postmenopausal women who underwent both panoramic radiography and bone densitometry. Based on the radiomorphometric indices and while blinded to the densitometry results, the dentists determined whether they would indicate densitometry for these patients.

Results: The response rate was 2.3%: 485 dentists completed the questionnaire, and 50 evaluated panoramic radiographs using the MCW and MCI. All of them reported some knowledge about osteoporosis, but 41.6% demonstrated a misleading conceptualization of the disease. Approximately 90% reported minimal access to this information during graduation, and only 27.0% were exposed to the topic during their postgraduate studies. Interest in osteoporosis prevention was expressed by 70.7% of the respondents, and interest in learning the radiomorphometric indices was expressed by 99.0%. The sensitivity in the detection of low bone mineral density through the MCW and MCI was 52.9%, and the specificity was 64%.

Conclusions: Brazilian dentists demonstrated insufficient knowledge about osteoporosis and a low ability to detect osteopenia or osteoporosis by applying radiomorphometric indices.

Keywords: Osteoporosis, Radiography, Dental education, Educational methods

Background

Osteoporosis is characterized by microstructural deterioration and loss of bone mass, leading to decreased bone strength and quality and an increased risk of fragility fractures. Osteoporosis is typically an underdiagnosed condition, and the identification of affected individuals before the condition is established and a fracture occurs is a major challenge.

Dual-energy X-ray absorptiometry (DXA) scans are currently considered the standard diagnostic approach for osteoporosis, and peripheral imaging techniques, such as peripheral quantitative tomography, peripheral DXA, quantitative ultrasound methods, and peripheral magnetic resonance imaging, have been used as screening tests to identify individuals who are most likely to benefit from further bone density testing. In this context, an increasing number of studies have proposed the use of quantitative/qualitative indices on dental panoramic radiographs to identify low bone mass [1, 2]. Assessment of the trabecular pattern of the mandible using panoramic radiographs has been considered a valid tool for

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identifying individuals with osteoporosis, as a substantial number of patients are subjected to dental radiographs each year for diagnostic and treatment purposes [3]. Therefore, it would be of great clinical benefit if dentists could identify patients at a high risk for osteoporosis using these radiographs. In the academic environment, radiomorphometric indices applied to panoramic radiographs have been used to estimate osteopenia and osteoporosis based on established cutoff values [4].

As shown in the large European multicenter study OSTEODENT [5, 6], much interest was expressed on the cortical bone layer at the lower border of the mandible. In this study involving five European centers between 2003 and 2005, mandibular cortical width (MCW) was considered an alternative method for assessing bone changes related to osteoporosis in panoramic X-rays of patients who had undergone radiographic evaluation for the usual dental reasons, not as a formal risk assessment tool [5, 6].

Strategies have been implemented to encourage dentists' involvement in general health promotion activities, particularly for diabetes and cardiovascular diseases [7, 8]. Regarding osteoporosis, few studies have addressed dentists' knowledge, and most of these studies are related to mandibular osteonecrosis and its association with bisphosphonates [9, 10].

In this study, we aimed to investigate dentists' knowledge about the prevention and diagnosis of osteoporosis and to verify their ability to detect this disease by applying a simple visual method for evaluating radiomorphometric cortical indices on panoramic dental radiographs.

Methods
Participants
This cross-sectional study included general dentists with ≥2 years of registration at the Regional Dentistry Council of the State of São Paulo (CROSP). After approval by its internal scientific council, CROSP released an e-mail message to 20,733 actively practicing dentists requesting information about their general profile (age, gender, years since graduation), excluding those specialized in dental radiography. The participants were then directed to a structured questionnaire regarding osteoporosis.

The dentists who answered the questionnaire were invited to evaluate the panoramic dental radiographs of 114 postmenopausal female patients, consecutively selected from the Osteoporosis Ambulatory of the Outpatient Clinic for Osteometabolic Diseases in the Rheumatology Division of Federal University of São Paulo (UNIFESP) between January 2016 and January 2017. These women (age range 50–78 years) were concomitantly imaged with panoramic radiographs and DXA of the spine and femur. There were 38 women in each of the following conditions: normal DXA, osteopenia and osteoporosis.

The study was approved by the Ethics Committee of UNIFESP - CEP # 2.193.407. After providing written informed consent, patients underwent mandibular panoramic radiography and DXA of the spine and femur. Electronic signed consent was obtained from the dentists who agreed to participate in this research.

Questionnaire
To evaluate the knowledge about osteoporosis, we used a structured questionnaire [11] previously applied to Brazilian physicians [12]. From a total of 27 questions, 14 items related to medical specialties, such as treatment, were removed, and five other items were added: three about previous osteoporosis knowledge selected from the BRAZOS questionnaire [13] and two regarding the methods used to evaluate osteoporosis on panoramic dental radiographs. Thus, the final questionnaire had a total of 18 questions.

Distribution and collection of the questionnaire
For the approach through e-mail, CROSP requested voluntary participation by dentists through a message that included a link to the online Survio™ survey platform (SurveyGizmo, Boulder, CO). The participant was then directed to an online interface displaying the research questionnaire. The e-mail message was sent only once to each CROSP member, and the platform remained open for 6 months. The interested members could access the platform only once during this period. No advantages or remuneration was offered to the participants.

Acquisition and evaluation of panoramic radiographs
The panoramic radiographs were obtained with an Eagle 2D panoramic OP 3000 2D (Dabi Atlante, Ribeirão Preto, Brazil) by the same experienced operator, with the patient in a standardized position predefined by the equipment.

The modified visual method for evaluating cortical indices, such as the MCW and the mandibular cortical index (MCI), was used in this research [14] by 50 dentists who agreed to be trained on both indices through e-learning classes using Klickmembers™ (Klickpages information technology and services, DF, Brazil). This platform includes video classes and secure-access exercises. For training purposes, restrictive access for each dentist was provided by means of an individual password for a period of 7 to 10 days. After completing all classes and clarifying any lingering doubts, those 50 dentists were invited to assess the panoramic radiographs in this study and to answer the following question: "Would you recommend DXA to this patient?" The possible answers were "yes", "no", and "I do not know".

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In a small room provided with individual X-ray illuminators, there was a box containing the panoramic radiographs of the 114 postmenopausal women. The dentists were asked to randomly select 10 radiographs per turn for visual evaluation of the MCW and MCI while blinded to the DXA results, and then to return the radiographs to the box. Finally, we obtained 1170 views, with an average of 26 views per dentist.

Statistical analysis

The results are expressed as frequencies and percentages. Correlations between radiomorphometric indices and bone density were analyzed using the Spearman correlation coefficient test. The kappa coefficient was used to assess the agreement between the dentists' opinions based on the panoramic radiographs and the DXA results. We used SPSS software version 22.0 (Chicago, IL, USA), and the significance level was 5%.

Results

The response rate of the 20,733 contacted dentists was 2.3%: 485 of them answered the questionnaire, and 50 agreed to evaluate the 114 panoramic dental examinations of postmenopausal female patients. Figure 1 shows a flow chart detailing the response outcomes for the delivered questionnaires. Among the 20,733 dentists invited, 15,840 were nonresponders, 4893 (23.9%) opened their e-mails, 902 (4.3%) accessed the platform, and only 485 (2.3%) answered the full questionnaire.

The demographic characteristics of the dentists are shown in Table 1. The majority of the responders (82.1%) had > 15 years of dentistry practice experience. The frequencies of the responses to osteoporosis questions by the general dentists are presented in Table 2. Although 41.6% of the dentists had a misleading concept of osteoporosis, most of them knew that bone densitometry was used to diagnose osteoporosis and identified the commonly affected age groups. In addition, 58.6% were not aware of which dentistry methods were available for the diagnosis of osteoporosis. Nevertheless, 99% demonstrated interest in learning these techniques. The dentists' responses to information about osteoporosis obtained during graduation and postgraduate courses are presented in Table 3. Most dentists had little or no exposure to this topic, but 58.8% of them rated the access to information about osteoporosis as "easy".

The 50 previously trained dentists randomly and blindly analyzed these radiographs, completing 1170 views. The correlation of bone mineral density status and the radiomorphometric indices was 0.326 for MCI and 0.283 for MCW ($p < 0.01$). The agreement between the dentists' opinions and the densitometry results is presented in Table 4. The dentists' evaluations had a sensitivity of 52.9% and a specificity of 64.0%.
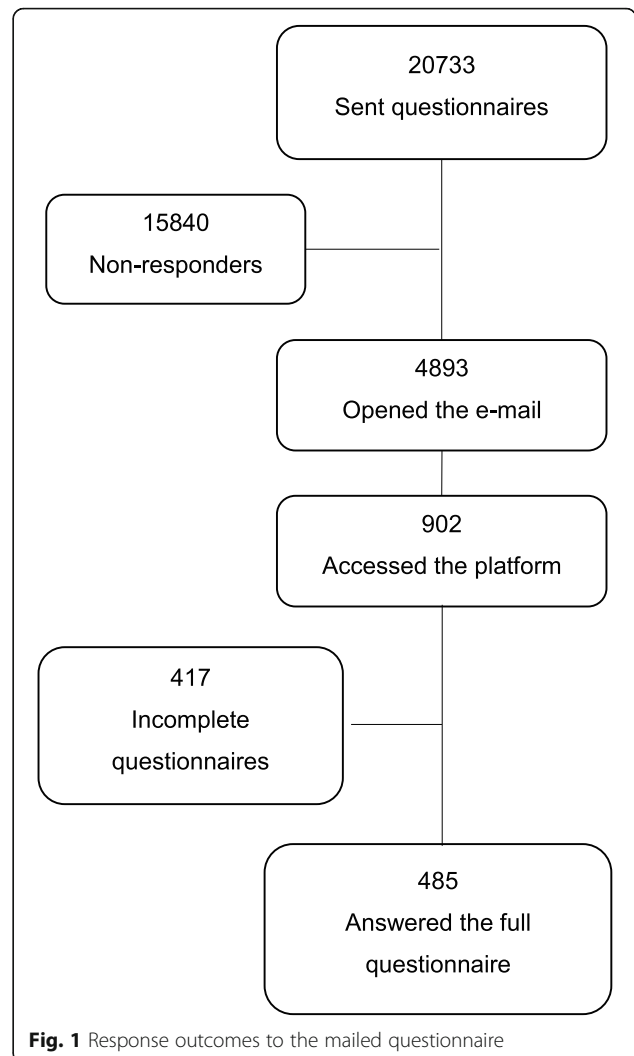

Fig. 1 Response outcomes to the mailed questionnaire

Discussion

This study showed a low return rate for the questionnaire and, among the responders, superficial knowledge about osteoporosis and a low ability to evaluate cortical indices on panoramic dental radiographs.

Only 4.0% of the 20,733 dentists accessed the platform, and 2.3% completed the questionnaire. This low return

Table 1 Demographic characteristics of the dentists

	Number	**%**
Gender		
Male	201	41.1%
Female	284	58.6%
Years since graduation		
0–5	17	3.5%
5–10	24	4.9%
10–15	46	9.5%
> 15	398	82.1%

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Table 2 frequencies of response to osteoporosis questions by general dentists

Question	Answer	Frequency
Have you heard about osteoporosis?	Yes	485 (100%)
	No	0 (0.0%)
Which of these phrases best define osteoporosis?	Stronger bones, rich in calcium	0 (0%)
	Fragile bones that break easily	283 (58.4%)
	Lack of calcium in the bones	202 (41.6%)
From the tests below, which is the main one to diagnose osteoporosis?	Outpatient visit	3 (0.6%)
	X-ray	3 (0.6%)
	Computed tomography	3 (0.6%)
	Urine analysis	0 (0.0%)
	Blood test	8 (1.6%)
	Bone densitometry	466 (96.1%)
	Magnetic resonance imaging	2 (0.4%)
Which are the appropriate age group(s) to start screening for osteoporosis?	Childhood (0–8 years)	0 (0%)
	Preteen (8–12 years)	1 (0.2%)
	Teen (12–19 years)	0 (0.0%)
	Early adulthood (19–40 years)	1 (0.2%)
	Mid-life (40–66 years)	230 (47.4%)
	Elderly (> 66 years)	253 (52.2%)
Do you know any method in dentistry that can indicate the presence of osteoporosis in the patient?	Yes	201 (41.4%)
	No	284 (58.6%)
Would you like to know a method to identify osteoporosis using panoramic maxilla and mandible X-rays?	Yes	480 (99.0%)
	No	5 (1.0%)
Are you interested in advising your patients on this disease preventively?	Yes	480 (99.0%)
	No	5 (1.0%)

rate is in accordance with a previous *survey* carried out by our group [12], in which we administered a similar questionnaire to 11,000 Brazilian general practitioners (GPs) and achieved a response rate of 3%. International surveys have achieved higher return rates than these Brazilian surveys. In a study involving GPs from the United Kingdom, 1153 out of the 2515 sent questionnaires were answered, resulting in a response rate of 46% [11]. A Canadian survey achieved a response rate of 30% by using an online questionnaire focused on a dentistry theme of interest: osteonecrosis of the jaw [15].

A systematic review compared the performance on electronic questionnaires and face-to-face interviews among health professionals and demonstrated a variable response rate, with better results for the presential ones. The return rates of the questionnaires sent via e-mail were between 0.3 and 70% [16]. There was no difference in the quality of the results obtained by electronic survey with those obtained with other methods. In contrast, another systematic review reported that surveys with electronic questionnaires had a lower return rate than those conducted by other routes [17] and that there is great variation between the methods used for online and in-

person surveys, impeding a clear idea about this topic. The authors suggested that monetary incentives did not influence the return rate of the questionnaires. Therefore, the low return rate of our questionnaire cannot be attributed to its straightforward design that lacked any incentives or rewards. We assume, unfortunately, that there is a lack of interest among our dentists in osteoporosis and its consequences, as we previously observed in the study with Brazilian GPs, who also demonstrated low interest in this subject [12].

Surveys on topics closer to dentistry clinical practice typically have a higher return rate than those regarding osteoporosis. Research involving dental trauma achieved a return rate of 9.6% [18], while that involving pins in endodontically treated teeth achieved a return rate of 68% [19], and that involving toward composite resins achieved a return rate of 68% [20].

The responses obtained in our study indicate that dentists, even with many years of dentistry practice experience (> 15 years), have superficial knowledge about osteoporosis, with 41.6% considering that the best phrase to define osteoporosis was a "lack of calcium in bones". This is a popular but incorrect concept since in

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Table 3 Frequencies of responses to questions about exposure to information on osteoporosis

Question	Answer	Number (%)
How would you rate your knowledge about osteoporosis acquired in *dentistry* school?	None	238 (49.1%)
	Minimal	204 (42.1%)
	Excessive	0 (0.0%)
	Sufficient	43 (8.9%)
How would you rate your knowledge about osteoporosis acquired during postgraduate training?	None	167 (58.4%)
	Minimal	188 (38.8%)
	Excessive	12 (2.5%)
	Sufficient	118 (24.3%)
How would you rate the access to information about osteoporosis?	Very difficult	9 (1.9%)
	Difficult	144 (29.7%)
	Very easy	47 (9.7%)
	Easy	285 (58.8%)
What type of information regarding osteoporosis are you interested in?	Prevention	343 (70.7%)
	Treatment	64 (13.2%)
	Services	18 (3.7%)
	Research	60 (12.4%)

osteoporosis, there is microstructural deterioration and loss of bone mass. Exposure to the topic in the graduate coursework was practically nil. When asked about the possibility of using tools for diagnosing osteoporosis on panoramic radiographs, most (99.0%) were interested; however, 58.6% had no knowledge about these techniques. Although it is very important to target middle-aged and postmenopausal women for osteoporosis screening and prevention programs, 52.2% of dentists considered the elderly age group to be most appropriate to screen for osteoporosis.

There are few studies in the literature on the specific knowledge of dentists about osteoporosis. A recent qualitative study based on focus group discussions analyzed the knowledge and attitudes of 17 Swedish dentists toward patients with osteoporosis [21]. Dentists from both public and private practice expressed insufficient knowledge of what osteoporosis is, how it is diagnosed and treated, and its consequences. Knowledge on the topic was lacking and almost entirely limited to academia. Interestingly, dentists were more familiar with

Table 4 Agreement between the dentist's opinion and the DXA results regarding osteoporosis

DXA	Dentist's opinion			Total
	Yes	No	Do not know	
Yes	421	299	75	795
No	100	240	35	375
Total	521	539	110	1170

Kappa (S.E.) = 0.209 (0.023), *p* < 0,001
Agreement (%): for "Yes" = 52.9% (sensitivity) and for "No" = 64.0% (specificity)
DXA dual-energy X-ray absorptiometry

osteoporosis studies involving osteonecrosis of the jaw, periodontitis, and absence of teeth than with those involving osteoporosis itself [15].

There is a tendency to encourage dentists to refer patients for DXA based on the changes noted in panoramic radiographs [22]. The OSTEODENT multicenter study aimed to identify the most valid and effective radiographic index or the combination of radiography and the Osteoporosis Index of Risk (OSIRIS) applicable for dentists to diagnose osteoporosis. Although the MCW demonstrated better efficacy than the MCI in the detection of osteoporosis, the OSIRIS showed higher diagnostic validity than radiographic measurements [6]. This indicates that measurement of the MCW should be viewed as an alternative possibility for risk assessment among patients who have undergone radiography for usual dental reasons [6]. The same group from Manchester reported a good correlation between the radiomorphometric indices MCW and MCI obtained manually on panoramic radiographs by well-trained observers and computerized measurements [5].

A systematic review and meta-analysis [23] noted that manual measurement of the MCW could introduce operator-related bias. Nevertheless, the costs and complexity of semi or totally computer-driven techniques of panoramic radiograph analysis are little applicable to general dental practice and to the reality of many dental care scenarios. In addition, computer software that automatically detects the mandibular cortex on panoramic radiographs and then measures its width requires fully trained evaluators and high-precision electronic instruments [5], but this level of training and digital

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instruments are not part of routine dental practice. Artificial intelligence might be a new perspective in the diagnosis of osteoporosis, making this easier and perhaps affordable in the future [24, 25].

Currently, there is a tendency to apply simplified visual methods for MCI and MCW analysis to identify patients with osteoporosis [4, 14]. In our study, 50 general dentists measured the MCW and MCI indices on a negatoscope by using the simplified method [14], mimicking usual clinical practice. Under these conditions, we obtained a sensitivity of 52.9% and a specificity of 64.0% between the dentists' opinions and the DXA results regarding osteoporosis. Depending on the author, the sensitivity of a dentist's evaluation of osteoporosis varies between 67 and 87%, and the specificity varies between 70 and 86% [23]. Compared with our results, the higher agreement obtained in studies conducted in the academic environment shows that, aside from being simple, the radiomorphometric analysis on panoramic radiographs requires a certain degree of expertise and experience to obtain consistency in the results. These competences cannot be acquired by a general dentist when evaluating routine panoramic radiographs after an online training course. Considering that dentists have an opportunity to make unique contributions by early identifying osteoporotic patients based on their oral and dental health problems, such as reduced jawbone density, destruction of periodontal tissue, tooth loss, and temporomandibular disorders, their acquisition of fundamental skills in osteoporosis assessment during their regular course of study is imperative. The same lack of familiarity with osteoporosis has also been observed among GPs in previous studies, and the results provide important information to guide new actions targeted to these physicians [11, 12].

The present study has some limitations. First, the majority of the panoramic radiographs belonged to patients being treated with bisphosphonates, which can result in changes to the mandibular cortical structure, thereby introducing bias [26, 27]. Second, the performance of the dentists might have been influenced by the effectiveness of the training method; and third, the radiographs were obtained by the same operator, which does not reflect daily practice. This research intended to motivate dentists to refer patients to medical evaluation and not to make the diagnosis of osteoporosis and is in line with the necessity to increase the interest of these professionals in health-related topics not restricted to dental specialties.

Conclusions

We observed that dentists in São Paulo city have insufficient knowledge about osteoporosis and that their performance in detecting patients with osteopenia and osteoporosis by using a simple visual method to evaluate the MCW and MCI on panoramic radiographs was lower than that described in the literature. As these indices are correlated with bone mineral density and can represent an appropriate instrument for decision making, greater educational efforts must be made to promote knowledge about osteoporosis among dentists. This perspective may motivate dentists to actively participate in the fight against and prevention of this silent and devastating disease.

Authors' contributions
RVF contributed to conception, design, data analysis, and interpretation, drafted and critically revised the manuscript. SR contributed to conception, design, data acquisition, analysis, and interpretation, drafted and critically revised the manuscript; VLS contributed to conception and data acquisition, critically revised the manuscript. All authors gave final approval and agreed to be accountable for all aspects of the work.

Declarations

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