Caries Diagnosis in Dental Practices: Results From Dentists in a Brazilian Community

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Clinical Relevance

Dental caries diagnosis is performed by most dentists from a Brazilian community using visual-tactile and radiographic methods.

SUMMARY

The aim of this study was to assess practices related to diagnosis of dental caries among dentists (n=217) from Araraquara, São Paulo State, Brazil. Data on sociodemographic information and practitioner characteristics were collected using a pretested questionnaire, and data on practices related to caries diagnosis were gathered by using a translated and culturally adapted questionnaire from the US National Dental Practice-Based Research Network. Descriptive statistics and regression analyses were used for data analysis. Respondents reported using in most of their patients radiographs (Rx) to diagnose proximal caries (59%), explorer (Ex) for the diagnosis of occlusal caries (64%) and on the margins of existing restorations (79%), as well as air jet (AJ) with drying (92%). Magnification (M) (25%), fiber optic transillumination (FOTI; 14%), and laser fluorescence (LF) (3%) were used in the minority of patients. Regression analysis revealed that the following dentists' characteristics were significantly associated (p<0.05) with the use of diagnostic methods on a greater percentage of their patients: advanced degree (Rx, FOTI), higher percentage of patients with individu-

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alized caries prevention (Rx, FOTI, M), more years since dental school graduation (Ex, M), and work in an exclusively private practice model (LF). In conclusion, most Brazilian dentists from Araraquara reported they most commonly use visual, tactile, and radiographic imaging for the diagnosis of dental caries. Some dentists' characteristics, such as time from dental school graduation and having a postgraduation course, were associated with the use of certain diagnostic methods.

INTRODUCTION

Diagnosis is an outcome of identifying the signs and symptoms of a disease process, based on scientific knowledge of the disease process and its clinical application.[1] The diagnosis is a result of detection and exclusion of diseases, followed by a prognosis and treatment decision.[2]

Dental caries is a dynamic disease process that results from metabolic activity in dental biofilm[3] that demineralizes enamel and dentin over time.[4] It is a preventable disease, but with a skewed distribution in the population and a substantial economic and quality-of-life onus.[5]

Correct caries diagnosis is one of the cornerstones in designing an appropriate treatment decision with no over-/undertreatment. Identifying the methods dentists use during daily clinical practice for caries diagnosis and the factors associated with their use is, therefore, a relevant issue.[6] Studies with dentist members of a dental practice-based research network (PBRN) from the United States, Denmark, Norway, and Sweden have shown that dental explorers and radiographs are still the most commonly used diagnostic methods.[6] In Brazil, little is known about dental practice patterns of Brazilian dentists regarding caries diagnosis, and this is the first paper showing results that used the same questionnaire (after translation and cultural adaptation) used in the countries described above to assess dental practices.

Therefore, the aim of this paper was to assess the practices related to diagnosis of dental caries among dentists from Araraquara, São Paulo State, Brazil.

METHODS AND MATERIALS

Ethical Aspects

All participants provided informed consent prior to participation in this study.

Participants, Recruitment, and Data Collection

The study participants were 217 dentists who met all inclusion criteria: currently practicing in Araraquara; treating dental caries; not retired; and able to provide signed informed consent.

The recruitment process initiated in 2013, enlisting dentists working in Araraquara. As we did not know which dentists met the inclusion criteria, we sent the questionnaires by mail to all dentists (n=801) for whom we had address/contact information. To increase the response rate, the following strategies were used: prepaid return envelope, questionnaires sent to work address; a second copy of the questionnaire to nonrespondents; precontact by telephone; and collection of completed questionnaires at work address.[7] Among those who were found, only 4% did not want to participate and 14% did not meet all inclusion criteria. In 25% of the professionals, we did not know their reason for not participating. For 9% of dentists, the address could not be verified and 21% could not be located.

Data were collected from 2014 to 2015, and the overall response rate was 27%. Most participants were female (60%) and younger than 50 years of age (71%). Sex comparison between participants (60% female) and nonparticipants (54% female) showed no difference between them ($p=0.156$). Information from the Regional Council of Dentistry of São Paulo State showed that dentists from Araraquara were 57% female and 66% younger than 50 years of age, suggesting that the sex and age of participants had similar distributions to dentists from Araraquara (Rocha E, Statistical Data [Internet], Message to the first author, 20 March 2015 [accessed on 20 March 2015]).

Questionnaires

Two paper questionnaires were sent to the dentists: one with questions on academic, demographic, and socioeconomic profile, practice setting, and patient characteristics and another with the translated version of the "Assessment of Caries Diagnosis and Caries Treatment" Questionnaire from the US National Dental PBRN. The Caries Questionnaire contains questions on caries-related diagnostic and clinical decision-making processes for clinical scenarios, caries risk assessment, and use of prevention techniques.

Translation and cultural adaptation of the questionnaire including initial translation, back-translation, committee review,[8] and pretesting

Table 1: *Participant Characteristics by Sex and for the Total Sample*			
Characteristic	**Males (n=86) [Percentage (n) or Mean (SD)]**	**Females (n=131) [Percentage (n) or Mean (SD)]**	**Total Sample (n=217) [Percentage (n) or Mean (SD)]**
Age (missing = 1)	46.5 (13.0)	39.3 (10.4)	42.2 (12.0)
Type of practice			
Private practice	48% (41)	49% (64)	48% (105)
Private/public hybrid	29% (25)	24% (32)	26% (57)
Public health	19% (16)	21% (27)	20% (43)
Other	5% (4)	6% (8)	6% (12)
Years since dental school graduation	23.6 (12.5)	17.0 (10.5)	19.6 (11.8)
Type of dental school			
Public institution	76% (65)	77% (101)	76% (166)
Private institution	24% (21)	23% (30)	24% (51)
Specialization			
No specialization training	40% (34)	37% (49)	38% (83)
Specialization training	60% (52)	63% (82)	62% (134)
Advanced degree[a]			
No advanced degree	78% (67)	63% (83)	69% (150)
Master's degree	2% (2)	9% (12)	7% (14)
Doctorate	20% (17)	28% (36)	24% (53)
Mean percent of patient by age, years[b]			
1-18[a]	18% (21)	27% (28)	23% (26)
19-44	34% (18)	34% (19)	34% (19)
45-64[a]	33% (16)	27% (18)	30% (17)
65+	15% (12)	12% (11)	13% (11)
[a] *Significantly different at p<.05*			
[b] *The percentage for the "patients seen by age" variable represents the average of the percentage of patients reported as seen within each of the age group categories and is followed by the standard deviation.*			

(comprehension of questions with 21 dentists, and test-retest reliability across seven days with 17 dentists. Intraclass correlation coefficient [ICC]: 22 [42%] questions with satisfactory correlation [.040≤ICC≤0.75] and 31 [58%] with excellent correlation [ICC≥0.75], according to Szklo and Nieto[9]) were performed to produce a Brazilian version of the questionnaire.[10]

Measures

Results on dentists' demographic and clinical training and practices are presented in Table 1. Table 2 shows the series of questions about caries diagnostic methods, such as use of radiographs; dental explorer for the detection of primary occlusal caries and secondary/recurrent caries at the margins of existing restorations; air drying (AD) for primary caries; laser fluorescence (LF) for primary caries on occlusal surfaces; and fiber optic transillumination for proximal lesions in anterior teeth. The response choices were 0%, 1%-24%, 25%-49%, 50%-74%, 75%-99%,

and 100%. The percentages for each caries diagnostic method were coded to the categories' median to maintain the interval nature of the data so that parametric statistics could be used: 0% = 0%, 1%-24% = 12.5%, 25%-49% = 37%, 50%-74% = 62%, 75%-99% = 87%, 100% = 100%.[6]

Statistical Analyses

First, practitioner and practice characteristics were tested as predictors of the use of each diagnostic method using the general linear model. These variables included dentist sex (male=0 and female=1), years since dental school graduation, dental school attended as private or public (public=0 and private=1), specialization training completed (general dentistry=0 and specialization=1), received an advanced degree (no advance degree=0, masters=1, doctorate=2), treating primarily pediatric patients (adult or mixed ages=0, pediatric=1), exclusively a private practice model (public health or hybrid private/public health

Table 2:	*Questions to Assess Methods Used to Diagnose Dental Caries*

Instructions. These questions have to do with methods that you may use to diagnose dental caries. Please circle the one number that best corresponds to your answer. Patients can vary substantially from one practice to the next, but we are interested in the patients in YOUR practice.

- When you examine patients to determine if they have a caries lesion on a proximal (mesial or distal) surface, on a posterior tooth, on what percent of these patients do you use radiographs to help diagnose the lesion?

- When you examine patients to determine if they have a caries lesion on the occlusal surface, on what percent of these patients do you use radiographs to help diagnose the lesion?

- When you examine patients to determine if they have a primary occlusal caries lesion, on what percent of these patients do you use a dental explorer to help diagnose the lesion?

- When you examine patients to determine if they have a caries lesion at the margin of an existing restoration (recurrent/secondary caries) on what percent of these patients do you use a dental explorer to help diagnose the lesion?

- When you examine patients to determine if they have a primary caries lesion on the occlusal surface, on what percent of these patients do you use laser fluorescence (for example, Diagnodent®)?

- When you examine patients to determine if they have a primary caries lesion, on what percent of these patients do you use air-drying to help diagnose the lesion?**

- When you examine patients to determine if they have a caries lesion on a proximal (mesial or distal) surface of an anterior tooth, on what percent of these patients do you use fiber optic transillumination to help diagnose the lesion?

- When you examine patients to determine if they have a caries lesion, on what percent of these patients do you use some sort of magnification to help diagnose the lesion?

**Respondents who reported using air-drying were also asked: Approximately how long do you dry the tooth surface? The response choices were: 1-2 seconds, 3-4 seconds, 5 seconds, more than 5 seconds

Participants had the following response choices:

1–Never or 0%
2–1% to 24%
3–25% to 49%
4–50% to 74%
5–75% to 99%
6–Every time or 100%

The percentages for each method used were recoded to the categories' median to maintain the interval nature of the data so that parametric statistics could be used: 0% = 0, 1%-24% = 12.5, 25%-49% = 37, 50%-74% = 62, 75%-99% = 87, 100% = 100.

models=0, private=1), whether caries risk was assessed (not performing caries risk assessment=0 and performing caries risk assessment=1), and percentage of patients who received individualized caries prevention.

Practitioner and practice characteristics that were significant at $p<0.10$ were included in each model in the first step. A stepwise entry model was used with entry set at 0.10 and removal at 0.15 as there was no theoretical rationale for variable entry priority.[11]

RESULTS

Table 3 summarizes the frequency of use of caries diagnostic methods. Air drying was the method used in almost all patients (92%), on average, to diagnose caries. The use of an explorer in occlusal surfaces and in the margin of existing restorations is also common for most patients. The diagnosis of proximal caries using radiographs is performed on average in 59% of the patients. On the other hand, magnification (25%), fiber optic transillumination (FOTI; 14%), and LF (3%) were used in the minority of patients.

Table 4 shows results of linear regressions of the frequency of use of each diagnostic method, using practitioner and practice characteristics as covariates. Significant associations at $p<0.05$ are described below.

As shown in Table 4, dentists who use radiographs to diagnose caries on posterior teeth on a greater percentage of their patients are more likely to have an advanced degree ($p=0.002$ for occlusal lesions and $p<0.001$ for proximal lesions) and provide a higher percentage of patients with individualized caries prevention ($p<0.001$ for proximal surfaces). On the other hand, those with a greater number of years since dental school graduation use radiographs on proximal ($p=0.010$) and occlusal ($p=0.007$) surfaces on a smaller percentage of their patients.

Dentists who use explorers on occlusal surfaces and on the margin of an existing restoration on a greater percentage of their patients have a greater number of years since dental school graduation ($p=0.041$ for occlusal lesions; $p=0.038$ for margin of a restoration). However, those who have received specialty training ($p=0.039$) and those with an advanced degree ($p=0.004$) use explorers on occlusal surfaces on a smaller percentage of their patients.

Dentists who use LF on occlusal surfaces on a greater percentage of their patients are more likely to work in an exclusively private practice model ($p=0.003$).

Dentists who use fiber optic transillumination for proximal caries on a greater percentage of their patients are more likely to have received an advanced degree ($p=0.022$) and provide a higher percentage of patients with individualized caries

Table 3: *Frequency of Use of Caries Diagnostic Method*			
Diagnostic Method	**Not Used at All % (n)**	**Used on All Patients % (n)**	**% Patients, Mean (SD)**
Radiograph proximal (n=217)	1% (3)	21% (46)	59% (34)
Radiograph occlusal (n=217)	23% (50)	4% (9)	27% (29)
Dental explorer occlusal lesion (n=216)	14% (30)	44% (94)	64% (40)
Dental explorer on the margin of an existing restoration (n=217)	3% (6)	54% (118)	79% (32)
Laser fluorescence occlusal (n=217)	90% (196)	<1% (1)	3% (13)
Air drying (n=217)	<1% (1)	78% (170)	92% (20)
Drying time in seconds (n=196)	23% (45)	10% (20)	—
Fiber optic proximal (n=217)	69% (150)	3% (6)	14% (28)
Magnification (n=217)	58% (126)	14% (31)	25% (39)

prevention ($p=0.020$). Female dentists ($p=0.046$) and those having a primarily pediatric dentistry practice ($p=0.027$) use FOTI on a smaller percentage of their patients.

Dentists who use magnification on a greater percentage of their patients have a greater number of years since dental school graduation ($p=0.002$)

and provide a higher percentage of patients with individualized caries prevention ($p=0.013$).

DISCUSSION

In this paper, we identified the methods that Brazilian dentists use to diagnose dental caries and

Table 4: *Linear Regressions of Use of Each Diagnostic Method, With Practitioner and Practice Characteristics as Covariates*			
Variable and Categories	**B (SE)**	**SE**	***p***
Radiograph for proximal caries			
Years since dental school graduation	−0.569	0.220	0.010
Advanced degree awarded	11.360	2.884	<0.001
Individualized caries prevention	0.251	0.070	<0.001
Radiograph for occlusal lesions			
Years since dental school graduation	−0.536	0.198	0.007
Advanced degree awarded	7.946	2.591	0.002
Explorer on occlusal lesions			
Years since dental school graduation	0.545	0.265	0.041
Specialty practice/specialized training	−12.168	5.848	0.039
Advanced degree awarded	−10.162	3.469	0.004
Explorer on the margin of an existing restoration			
Years since graduation from dental school	0.459	0.220	0.038
Performing caries risk assessment	−9.037	5.268	0.088
Use of laser fluorescence on occlusal surfaces			
Practice model (private)	5.931	1.996	0.003
Air drying when diagnosing occlusal caries	—		
Fiber optic transillumination for proximal caries			
Sex (female)	−8.442	4.196	0.046
Advanced degree awarded	5.777	2.493	0.022
Primarily pediatric practice	−11.918	5.359	0.027
Individualized caries prevention	0.142	0.060	0.020
Use of magnification			
Years since graduation from dental school	0.852	0.265	0.002
Individualized caries prevention	0.210	0.084	0.013
B (beta) represents the rate of change of the diagnostic method (one percentage category to the next) as a function of changes in the predictor variable (with dichotomous variables this means comparison between groups, e.g. male to female; for percentage independent variables, this means from one percentage category to the next); it is the slope of the regression line.			

which variables are significantly associated with them, because little is known about dental practice patterns regarding caries management in Brazil.

Diagnostic methods used by dentists in most patients were AD (92%), dental explorer (Ex) for occlusal caries (64%) and for the margin of existing restorations (79%), and radiographs (Rx) (59%) for proximal caries. FOTI (14%) and LF (3%) were used in the minority of patients by the participants. Gordan and others[6] found similar results among PBRN dentists for using dental explorers and radiographs in proximal caries. For FOTI and LF, a systematic review has shown insufficient scientific evidence for diagnostic accuracy of such methods.[12]

The finding that visual-tactile examination was used by dentists in most patients is in accordance with other studies. Most general dental practitioners' from New Zealand preferred conventional visual-tactile (87%) and digital radiography (78%) among several methods for caries detection.[13] For private dental practitioners from Ankara, Turkey, sharp explorers were one of the most commonly used instruments to detect carious lesions.[14]

In fact, Nyvad and others[15] demonstrated that an attentive professional using AD can diagnose most initial carious lesions by visual-tactile inspection. It is a quick and easy method, and when associated with assessment of lesion activity, is the best choice for the diagnosis of caries.[16] However, the use of sharp explorers may cause some damage to the dental surface.[17] In an *in vitro* study comparing ultrastructural defects caused in primary teeth by ball-ended probes and sharp explorers, the findings showed that less damage was caused using ball-ended probes when probing primary dental surfaces.[18] Moreover, professionals tend to over-diagnose the disease when they use a sharp explorer because a "sticking" probe may be entirely due to pit and fissure anatomy.[6]

According to Fontana and others,[19] an explorer should be used very gently to remove debris and plaque, to confirm cavitation when in doubt, to help the assessment of lesion activity and of dental material's integrity and retention. Systematic reviews have showed that visual methods had good accuracy for detecting carious lesions,[20] and they should remain the standard for clinical assessment in dental practice.[21]

Dentists in the current study use proximal radiographs for the diagnosis of proximal caries in almost 60% of their patients (Table 3). These findings, although lower than those reported in other practice-based studies, still show that the majority of dentists use radiographs in their patients for assessment of proximal surfaces as shown by 96% of dentists in the United States[6] and by dentists in Ankara (Turkey) who used radiographs in almost all their patients.[14] One possible explanation for this finding is that 46% of the dentists participating in the current study work in public health settings. A radiographic imaging unit may not be available in some public health settings. In a Brazilian study that investigated dental radiology services in the public health setting, investigators found that 46% of municipalities from the Midwest region of Minas Gerais State did not have a radiographic imaging unit.[22] Another Brazilian study that assessed the weaknesses in public dental service of a city from the South Region, the interviewed dentists reported the lack of X-ray equipment as one of the main criticisms to the public service.[23]

Radiographic examination seems especially suitable for detecting cavitated proximal lesions in dentin. However, for enamel or incipient proximal caries lesions, the method presents low sensitivity and high specificity.[24] According to Pretty and Ekstrand,[25] the reproducibility from bitewing radiographs varies widely and they suggest that radiographs can aid the assessment of dentin proximal lesions, but are not as good as visual inspection for occlusal lesions. Therefore, they argue that radiographic examination is indicated when additional information is needed to aid dentists in the decision-making process. Additionally, it can be used to monitor early proximal lesions.

Another interesting finding is that regression analyses showed an inverse relationship for the use of radiographic imaging and years since graduation from dental school. There are very few studies on radiographic imaging use by Brazilian dentists. Castro and others[26] assessed availability of radiographic imaging to dentists in the city of Belo Horizonte and observed that recent graduates, up to 30 years of age, had more X-ray machines in their offices (72%) than those aged more than 30 years. The authors also found that dentists up to 20 years since graduation showed greater knowledge about radiographic techniques and radioprotection compared with dentists with 21+ years since graduation.

The results of the regression analysis showed that some dentists' characteristics were significantly associated with the use of certain caries diagnostic methods: dentists with an advanced dental degree were more likely to use radiographic imaging and FOTI. Dentists who practiced individualized caries

prevention in their patients were more likely to use radiographic imaging, FOTI, and magnification. Dentists with greater number of years since dental school graduation were more likely to use an explorer and magnification. Dentists who work exclusively in private practice are more likely to use LF (Table 4).

One of the most relevant findings of this study is the frequency of the use of a dental explorer on occlusal lesions and on margins of existing restorations in most patients, as previously mentioned. Regression analyses showed a direct relationship for the use of a dental explorer in occlusal caries lesions and years of graduation from dental school and an inverse relationship between dentists who have postgraduation courses and use of the dental explorer for caries diagnosis. Dentists who have a postgraduation course are most likely to practice dentistry based on current evidence, whereas dentists with more years of graduation from dental school may be more accustomed to traditional methods of caries diagnosis, such as the use of a sharp dental explorer. Indeed, Fontana and others[27] reported that teaching the use of a dental explorer to diagnose occlusal caries was the gold standard for many decades.

Regression analysis also showed a direct relationship between the use of radiographic imaging to diagnose caries on posterior teeth and dentists with an advanced degree, as well as with dentists who provide individualized caries prevention treatment for their patients. These findings were consistent with Gordan and others,[6] who found that dentists who provide individualized caries prevention treatment are more likely to use radiographs to assess proximal caries.

Although other methods such as LF, FOTI, and magnification were not used by most dentists, the regression analyses showed that dentists who use LF on occlusal surfaces on a greater percentage of their patients are more likely to work in an exclusively private practice model. It does make sense because most public services in Brazil do not have these adjunct technologies. In a recent systematic review about the accuracy of LF in in vitro caries diagnoses, the results showed that the method was accurate (sensitivity, 0.71; specificity, 0.81) in predicting caries or healthy surfaces; however, the authors believe that in clinical practice, LF alone is not enough for an accurate caries diagnosis.[28]

Dentists who use magnification on a greater percentage of their patients have a greater number of years since dental school graduation. It seems that older dentists use magnification more frequently

than younger dentists and this could be explained because presbyopia is a common deficiency affecting visual acuity that can begin in the 40s and can be compensated with magnification aids.[29]

The limitations of this study, besides being a cross-sectional design, include that results are from a self-selected group of dentists. Despite the low response rate, the strengths of this study include the similarity for sex and age between study participants and practicing dentists in Araraquara. The study also proved to be feasible as a tool to investigate the current practice of dentistry, and it can be used to compare the results with other dentist populations.

The study findings identified a gap between dentists with more years of clinical experience and the practice of current evidence-based dental care. Future research could assess whether additional training and continuing education courses are indicated to improve the delivery of standard of care in dental offices by dentists who graduated many years ago and who did not complete postgraduate training.

CONCLUSION

In conclusion, most Brazilian dentists from Araraquara reported they most commonly use visual, tactile, and radiographic imaging for the diagnosis of dental caries. Some dentists' characteristics, such as years since dental school graduation and having postgraduation education, were associated with the use of certain diagnostic methods.

Regulatory Statement

This study was conducted in accordance with all the provisions of the local human subjects oversight committee

guidelines and policies of approval of the Research Ethics Committee of the Araraquara School of Dentistry, São Paulo State University (UNESP). The approval code for this study is 78/11.

Conflict of Interest

The authors of this manuscript certify that they have no proprietary, financial, or other personal interest of any nature or kind in any product, service, and/or company that is presented in this article.

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REFERENCES

1. Mohanraj M, Prabhu VR, & Senthil R (2016) Diagnostic methods for early detection of dental caries: a review *International Journal of Pedodontic Rehabilitation* **1(1)** 29-36.

2. Kidd E, & Fejerskov O (2016) Detection, diagnosis and recording in the clinic In: Kidd E, Fejerskov O (eds) *Essentials of Dental Caries* Oxford University Press, New York 48-74.

3. Kidd E, & Fejerskov O (2016) Introduction In: Kidd E, Fejerskov O (eds) *Essentials of Dental Caries* Oxford University Press, New York 1-13.

4. Pitts NB, & Zero DT (2016) White paper on dental caries prevention and management. Retrieved online December 20, 2017 from: https://www.fdiworlddental.org/sites/default/files/media/documents/2016-fdi_cpp-white_paper.pdf

5. Pitts NB, Zero DT, Marsh PD, Ekstrand K, Weintraub JA, Ramos-Gomez F, Tagami J, Twetman S, Tsakos G, & Ismail A (2017) Dental caries *Nature Reviews Disease Primers* **3**:17030. doi: 10.1038/nrdp.2017.30.

6. Gordan VV, Riley JL, Carvalho RM, Snyder J, Sanderson JL, Anderson M, & Gilbert GH; DPBRN Collaborative Group (2011) Methods used by Dental Practice-based Research Network (DPBRN) dentists to diagnose dental caries *Operative Dentistry* **36(1)** 2-11.

7. Tagliaferro EP, Valsecki Junior A, Rosell FL, Silva SR, Riley JL, Gilbert GH, & Gordan VV (2017) Diagnosis and treatment of dental caries by Brazilian practicing dentists *Journal of Dental Research* **96(Special Issue A)** Abstract number 616.

8. Guillemin F, Bombardier C, & Beaton D (1993) Cross-cultural adaptation of health-related quality of life measures: literature review and proposed guidelines *Journal of Clinical Epidemiology* **46(12)** 1417-1432.

9. Szklo M, & Nieto FJ (2000). Quality assurance and control In: Szklo M, Nieto FJ (eds) *Epidemiology Beyond the Basics* Aspen Publications, Gaithersburg, Md 343-404.

10. Tagliaferro EPS, Ridolfi LML, Matos M, Rosell FL, Valsecki Junior A, Silva SRC, & Gordan VV (2017) Tradução e adaptação Brasileira do questionário "Assessment of caries diagnosis and caries treatment" *Arquivos em Odontologia* **53** In press.

11. Cohen J, & Cohen P (1983) *Applied Multiple Regression/Correlation Analysis for the Behavioral Sciences* Lawrence Erlbaum Associates, Hillsdale, NJ.

12. Twetman S, Axelsson S, Dahlén G, Espelid I, Mejàre I, Norlund A, & Tranæus S (2013) Adjunct methods for caries detection: a systematic review of literature *Acta Odontologica Scandinavica* **71(3-4)** 388-397.

13. Jeganath J, Wong A, Chandler N, & Murray C (2016) New Zealand general dentists' usage and views on caries detection methods *New Zealand Dental Journal* **112(3)** 73-79.

14. Vural UK, & Gökalp S (2017) Diagnostic methods for dental caries used by private dental practitioners in Ankara *Nigerian Journal of Clinical Practice* **20(3)** 382-387.

15. Nyvad B, Fejerskov O, & Baelum V (2011) Diagnóstico tátil-visual da cárie In: Kidd E, Fejerskov O (eds) *Cárie Dentária: A Doença e seu Tratamento Clínico* Santos, São Paulo, Brazil 49-68.

16. Nyvad B, Machiulskiene V, & Baelum V (1999) Reliability of a new caries diagnostic system differentiating between active and inactive caries lesions *Caries Research* **33(4)** 252-260.

17. van Dorp CS, Exterkate RA, & ten Cate JM (1988) The effect of dental probing on subsequent enamel demineralization *ASDC Journal of Dentistry for Children* **55(5)** 343-347.

18. Mattos-Silveira J, Oliveira MM, Matos R, Moura-Netto C, Mendes FM, & Braga MM (2016) Do the ball-ended probe cause less damage than sharp explorers? An ultrastructural analysis *BMC Oral Health* **16(39)** 1-7 doi: 10.1186/s12903-016-0197-9.

19. Fontana M, Zero DT, Beltrán-Aguilar ED, & Gray SK (2010) Techniques for assessing tooth surfaces in school-based sealant programs *Journal of the American Dental Association* **141(7)** 854-860.

20. Hoskin ER, & Keenan AV (2016) Can we trust visual methods alone for detecting caries in teeth? *Evidence-based Dentistry* **17(2)** 41-42.

21. Gomez J, Tellez M, Pretty IA, Ellwood RP, & Ismail AI (2013) Non-cavitated carious lesions detection methods: a systematic review *Community Dentistry and Oral Epidemiology* **41(1)** 54-66.

22. Nascimento PBPL, Costa SM, Rímulo ALM, & Almeida AMR (2014) Serviço de radiologia odontológica em municípios da região Centro-Oeste do Estado de Minas Gerais, Brasil *Revista Odontológica do Brasil-Central* **23(64)** 30-34.

23. Bordin D, Fadel CB, Souza CG, Garbin CAS, Moimaz SAS, & Saliba NA (2016) Fragilidades do serviço público odontológico na ótica de cirurgioes-dentistas do município de Ponta Grossa, Paraná, Brasil *Publicatio UEPG: Ciências Biológicas e da Saúde* **22(1)** 48-54.

24. Schwendicke F, Tzschoppe M, & Paris S (2015) Radiographic caries detection: a systematic review and meta-analysis *Journal of Dentistry* **43(8)** 924-933.

25. Pretty IA, & Ekstrand KR (2016) Detection and monitoring of early caries lesions: a review *European Archives of Paediatric Dentistry* **17(1)** 13-25.

26. Castro MAA, Aguiar VLF, Santos CR, Abreu MV, Abdo EN, & Ferreira EF (2013) Avaliação da utilização de

aparelhos de raios-x em consultórios odontológicos em Belo Horizonte, Brasil *Arquivos em Odontologia* **49(4)** 191-197.

27. Fontana M, Cabezas CG, & Fitzgerald M (2013) Cariology for the 21st Century: current caries management concepts for dental practice *Journal of the Michigan Dental Association* **95(4)** 32-40.

28. Rosa MI, Schambeck VS, Dondossola ER, Alexandre MC, Tuon L, Grande AJ, & Hugo F (2016) Laser fluorescence of caries detection in permanent teeth in vitro: a systematic review and meta-analysis *Journal of Evidence-Based Medicine* **9(4)** 213-224.

29. Perrin P, Eichenberger M, Neuhaus KW, & Lussi A (2016) Visual acuity and magnification devices in dentistry *Swiss Dental Journal* **126(3)** 222-228.