Original Research

Perspective and practice of root caries management: A multicountry study – Part II: A deeper dive into risk factors

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Abstract

Background: The potential of an improved understanding to prevent and treat a complex oral condition such as root caries is important, given its correlation with multiple factors and the uncertainty surrounding the approach/material of choice. Deeper insights into risk factors may improve the quality of treatment and reduce the formation of root surface caries.

Aim: The present work aims to gain knowledge about dentists' opinions and experiences on assessing the risk factor related to the development of root caries and to help identify any overlooked factors that may contribute to less efficacious clinical outcomes.

Methodology: A questionnaire related to root surface caries was distributed among practicing dentists in nine different countries, namely the United Kingdom, Libya, Jordan, Saudi Arabia, Egypt, Brazil, India, Malaysia, and Iraq. Questionnaire responses were analyzed, and the results were compared among the groups.

Results: Dentists around the world ranked the oral hygiene status of patients as the most important factor in the development of root surface caries. Patients with poor oral hygiene, active periodontal disease, reduced salivary flow, and gingival recession are perceived to have a higher risk of developing new root surface caries. There is a greater focus on prevention in the UK and greater levels of untreated dental disease in other countries, especially those recovering from civil wars.

Conclusion: This work identified some overlooked factors that may have contributed to the less efficacious clinical outcomes reported in the literature. It is hoped that this deep dive into risk factors coupled with the findings presented in Part I of this study will be used as a basis for a more comprehensive investigation into the management of patients with root surface caries.

Keywords: Dental practice; prevention; questionnaire; risk factors; root caries

INTRODUCTION

Root caries is a multifactorial disease that exhibits softened, brownish, and irregular tissue on the root surface in the proximity of the cementoenamel junction.[1] Various risk predictors of root caries have been identified in two recent systematic reviews of observational longitudinal[2]

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and cross-sectional[3] studies, namely age, socioeconomic status, gingival recession, oral hygiene status, and smoking.

The prevalence of caries has been decreasing in the general population, and therefore, the number of dental restorations and missing teeth has been reduced.[4] As a function of an increased number of retained teeth, and as shown by the UK Adult Dental Health Survey of 2009,[5] the percentage of people with loss of gingival attachment is on the increase in the UK. The percentage of people with exposed root surfaces is also on the increase indicating that, regardless of the etiology or pathogenesis, gingival recession is an increasing problem with age. Hence, more teeth are exposed to root surface caries lifelong, paired with an increasing lifespan of the individual.[6] As such, root caries is becoming an issue of dental public health concern among the elderly patient population, especially those with suboptimal oral hygiene, impaired dexterity, and reduced salivary flow.

An understanding of the risk factors is important for the diagnosis, prevention, and adequate treatment of root surface caries. Dentists should routinely document the caries risk status of their patients and track any changes over time.[7] Moreover, given the high rate of failure of root surface restorations, recognition of the risk factors can enhance the predictability of failure and its possible avoidance.

The root surface exposure is often associated with substandard esthetics, dentinal sensitivity, and carious and noncarious cervical lesions and an increase in the amount of exposed root surface would therefore increase the risk of root surface caries. Root surface exposure resulting from gingival recession is a complex phenomenon that may pose significant therapeutic problems to the dentist. Several studies reported age as a risk factor for the development of root surface caries based on the fact that the amount of gingival recession increases with age.

In the scientific literature, there was no conclusive evidence that could have indicated a direct association between root surface caries and the number of teeth present in the oral cavity. It has been well established that the most accurate indicator of developing carious lesions in the future is previous caries experience.[8] In case of root caries, previous caries experience remains to be a consistent and significant risk factor. Therefore, clinically, it is important to provide a thorough caries risk assessment for patients who have carious and/or restored root surfaces.

Recent systematic reviews have documented positive associations between smoking and new root caries.[2,3,9] This may be because smokers accumulate markedly more dental calculus than nonsmokers and are more prone to periodontal diseases. Although some negative effects have been reported, it is difficult to imagine reasons for causation in case patients choose to try to quit smoking.[10] Similar associations were found with sociodemographic factors and the level of oral health knowledge as individuals at a lower socioeconomic or education level are more likely to have suboptimal oral health knowledge and behavior.[11]

The variations among dentists on what is perceived as a risk factor in the development of root surface caries are mainly due to their training and expertise which reflect the choices they make in their practice in terms of preventive measures to be taken and the outline for the management of such cases to ensure the best clinical outcome for their patients. Thus, every effort needs to be made to enable the perception of the risk factors from the viewpoint of dentists from all around the world in such a manner as to assist with the development of novel prevention and treatment of root surface caries. This can only be ascertained by surveys, personal testimonies, and observation. Therefore, this paper presents a questionnaire survey of dentists' perception of the most important risk factors in the development of root caries. Responses were obtained from nine different countries to get a wider range of opinions and perspectives.

METHODOLOGY

A multicountry cross-sectional survey was designed for distribution to qualified dentists from nine countries (UK, Libya, Jordan, Saudi Arabia, Egypt, Brazil, India, Malaysia, and Iraq). The questionnaire was distributed by e-mail using an online survey service platform (Google Forms) with tracking disabled. E-mails were sent out to 400 registered dentists in each of the 9 countries. Potential participants were selected at random from the official dental online registers database in each country. No tracking of nonresponders nor participants was possible and therefore responses were anonymous, and no follow-up was possible. Only registered dentists were included. Inclusion in the study was random with no reason to include or exclude any particular participant other than the desire to have representative data from all countries.

The questionnaires explored the experiences and views of root caries of qualified dentists in those countries. The questionnaire consisted of two sections: the first section explored the prevalence of the disease, diagnostic and detection methods, intraoral distribution, management, and follow-up (presented in Part I of this study as a separate article).[12] The second section explored the risk factors and lifestyle habits related to increased risk of developing root surface caries [Figure 1].

A relational database was developed using Paradox (Paradox Version 3.5, Borland International) for input of data and

	Part I
1	Date of birth Selection options: Calendar date selector
2	How long have you been practicing dentistry? Selection options: Answer box
3	From your clinical experience please indicate at what age people are most susceptible to root surface caries? Selection options: Childhood, Adulthood, Elderly
4	In your experience, please indicate who are more susceptible to root caries? Selection options: Males, Females, No difference
5	Does your practice base have a large proportion of patients prone to root surface caries? Selection options: Yes, No
6	How do you usually detect root surface caries? Selection options: Visually (inspection), Tactile (probing), Dental radiographs (X-ray), Other (please specify)
7	In your experience, which surface of a tooth is most commonly affected with root caries? Selection options: Labial (Buccal) surface, Interproximal surface, Palatal (Lingual) surface
8	In your experience which anterior tooth/teeth is most commonly affected by root surface caries? Selection options: Upper Central, Upper Lateral, Upper Canine, Lower Central, Lower Lateral, Lower Canine
9	In your experience which posterior tooth/teeth is most commonly affected by root surface caries? Selection options: Upper First Premolar, Upper Second Premolar, Upper First Molar, Upper Second Molar, Upper Third Molar, Lower First Premolar, Lower Second Premolar, Lower First Molar, Lower Second Molar, Lower Third Molar
10	Which method (s) do you usually use to manage root surface caries? Selection options: Monitoring with prevention instruction, Dietary advice, Topical Fluoride, Restoration, Other (please specify).
11	Which restorative material do you most commonly use to restore a tooth with root surface caries? Selection options: Amalgam, Glass ionomer, Composite, Resin modified glass ionomer, Compomer, Other (please specify)
12	Is bleeding from the gingival tissues normally a problem in restoring root surface caries? Selection options: Never, Sometimes, Frequently
13	After you restore a tooth with root caries, what method of finishing do you use for the restoration? Selection options: Hand finishing (sharp knives or scalers) at placement visit, Rotary finishing at placement visit Hand finishing (sharp knives or scalers) at recall visit, Rotary, finishing at recall visit, Others (please specify)
14	After you treat the root caries do you follow up your patients? Selection options: Yes. if yes specify, for how long in the next question below, No, Sometimes
15	Follow up Duration if yes in the previous question. Selection options: Answer box
16	In your experience what is the average lifespan of the restoration you most commonly use for the restoration of root caries? Selection options: Less than a year, I to 5 years, More than 5 years
	Part II
17	In deciding which method you use to manage root surface caries tick those factors that influence your selection of the management method? Selection options: Patients oral hygiene, Diet, Patients age, Tooth type, Severity of the lesion, Other (please specify)
18	In your experience which lifestyle events are associated with root surface caries development? (tick all that apply) Selection options: Bereavement Retirement, Giving up smoking, Loss of job, Change in diet, Other (please specify)
19	From your experience, indicate which of the following factors you feel are important in the development of root caries. Please circle one number on each line, where 1=very important, 2=quite important, 3=fairly important, 4=not at all important. Selection options: Number of teeth present, Degree of crowding Presence of a partial denture, Cigarette smoking Total amount of sugars consumed Frequency of sugar intake, Oral hygiene status, Physical disability, Mental disability/senility, Active periodontal disease, Consumption of alcohol, Consumption of fizzy drinks, Overhanging restorations, Poor crown margins, Gingival recession, Reduced salivary flow, Presence of erosion, Presence of abrasion cavity, Poor general health

Figure 1: Questionnaire items and selection options (Part I of this questionnaire was presented as a separate article)

interrogation. Statistical analyses were undertaken using GraphPad Prism (Graph Pad Software Inc., Version 9, San Diego, USA). Differences were tested using the Chi-squar test. $P < 0.05$ was considered significant.

RESULTS

In response to the invitation to participate in the study, a total of 1209 responses were received. The number of responses from each country was as follows: UK (134), Libya (120), Jordan (135), Saudi Arabia (118), Egypt (133), Brazil (155), India (138), Malaysia (168), and Iraq (108). The responses were gathered between December 14, 2019, and January 14, 2020.

Based on the data from dentists' responses, the factors influencing the selection of treatment modality for root caries included oral hygiene, diet, age, tooth type, and severity of the lesion. Chi-square testing revealed a significant difference in responses ($\chi^2 = 144.2$, $P < 0.0001$). Severity of the lesion and oral hygiene were the most influential factors for the selection of management methods in all countries. However, patients' diet influenced to a greater degree the management of the root surface lesions in the UK as compared to all other countries (23.86% UK cf. 3.3%–11.2% other countries).

Regarding the lifestyle-related factors that respondents reported to have the greatest impact on the development of root surface caries, there was no significant difference in responses ($\chi^2 = 20.7$, $P = 0.0973$). In all countries, retirement, bereavement, giving-up smoking, and deterioration of general health were the factors most thought to give rise to root caries. Surprisingly, diet as a risk factor was considered by dentists outwith the UK and Brazil to be relatively unimportant.

Respondents were asked to select the most important factors that play a role in the development of root caries.

Table 1 summarizes the relative ranking of importance of risk factors in the development of root caries according to country. The rankings did not statistically differ in the cases of oral hygiene state, physical disability, and mental disability/senility. However, there was a statistically significant difference between the rankings of all other factors.

In general, the respondents ranked highest in the oral hygiene status of patients followed by the presence of active periodontal disease, reduced salivary flow, and gingival recession. Interestingly, the total amount of sugar consumption and the frequency of sugar intake were only highly ranked among respondents from the UK and Brazil.

DISCUSSION

Before discussing the findings of this work, it is important to clarify why this multicountry survey was undertaken. Its first purpose was to contrast and compare the root caries management practices in nine different locations around the world (presented in Part I of this study as a separate article).[12] The second function of the survey was to shed some light on what can be learned from practicing dentists around the world that would advance the control of root surface caries and to help identify any overlooked factors that may contribute to less efficacious clinical outcomes.

In analyzing the findings, it is perhaps important to underscore a factor that seems to be overlooked by most respondents, and that is – diet. It has been well-documented in the literature that the consumption of sugars is associated with the development of root caries, especially in teeth with gingival recession.[2,13-15] It is therefore surprising to note that respondents, except those from the UK and Brazil, perceived diet to be a relatively insignificant factor despite its association with dental caries. It is worth mentioning however that collagen degradation within the dentinal tubules can provide a source of nutrients for the cariogenic bacteria. Therefore, the invading microorganisms involved in root caries may be less dependent on carbohydrates than earlier thought.[1]

While the reported risk factors considered by dentists from around the world to be responsible for the development of root surface caries varied considerably, the "oral hygiene status" factor was predominantly and consistently chosen by respondents as the most important factor in all nine participating countries. To compare the responses from nine countries to each other and to other studies in the available literature, it is worthwhile to formulate a ranking system. One way of doing this, as we have attempted to demonstrate in this paper, is to multiply the rank of importance assigned to each criterion by the percentage, giving a weighting of 3 to the 'very important" rank, 2 to the "quite important" rank, and 1 to the "fairly important" rank.

This empirical comparison was undertaken for the findings of the present work and also for the UK-based questionnaire by McCombes[16] in an endeavor to standardize the comparison. A measure of the agreement between the rankings of risk factors provided by participating dentists is shown in Table 2. As a crude assessment of differences in

Table 1: The relative ranking given to the risk factors and the significance level of difference among responses from all 9 countries

Factor	Significance level	χ^2, *P*	Ranking								
			UK	LB	JO	SA	EG	BR	IN	MY	IQ
Number of teeth present	****	103.8, <0.0001	18	18	19	19	19	18	19	19	18
Degree of crowding	****	111.3, <0.0001	14	5	15	17	14	5	17	12	14
Presence of a partial denture	****	103.6, <0.0001	8	17	10	16	11	9	12	10	2
Cigarette smoking	****	92.41, <0.0001	15	9	9	11	13	15	8	17	10
Total amount of sugar consumed	****	189.5, <0.0001	4	13	13	18	17	7	18	13	16
Frequency of sugar intake	****	120.3, <0.0001	2	8	6	12	9	2	13	9	4
Oral hygiene status	NS	27.29, 0.2912	1	1	1	1	1	1	1	1	1
Physical disability	NS	34.25, 0.0804	6	12	8	6	6	12	7	2	6
Mental disability/Senility	NS	29.69, 0.1954	5	6	7	3	5	6	5	5	7
Active periodontal disease	***	57.00, 0.0002	11	2	3	7	3	8	4	4	3
Consumption of alcohol	****	115.3, <0.0001	17	10	18	13	18	19	14	18	17
Consumption of fizzy drinks	****	119.3, <0.0001	9	19	17	9	16	14	11	14	19
Overhanging restoration	****	80.49, <0.0001	13	14	11	8	10	11	9	6	15
Poor crown margins	****	69.15, <0.0001	12	7	5	10	2	3	10	3	8
Gingival recession	**	49.59, 0.0016	10	3	2	5	4	13	2	7	5
Reduced salivary flow	***	56.04, 0.0002	3	4	4	2	7	4	3	11	12
Presence of erosion	****	113.1, <0.0001	16	15	16	15	12	17	16	16	11
Presence of abrasion cavity	****	122.2, <0.0001	19	16	14	14	15	16	15	15	13
Poor general health	**	50.00, 0.0014	7	11	12	4	8	10	6	8	9

System of ranking: The percentage was multiplied by the rank of importance assigned to each factor, for response levels of 1 = very important, 2 = quite important and 3 = fairly important, giving a weighting of 3 to the "very important" rank, 2 to the "quite important" rank, and 1 to the "fairly important" rank. Level of significance, as identified by Chi-square testing, is shown as ****$P < 0.0001$, ***$P < 0.001$, **$P < 0.01$, *$P < 0.05$. NS: Not significant

responses, a numerical value from 0 to 18 was obtained by subtracting the weighted values of each risk factor group calculated using the proposed ranking method mentioned above. If the difference value is 0, it indicates that there is perfect agreement between the groups. Empirically, a difference of 3 or smaller can be considered as agreement.

From the values in Table 2, it can be seen that there is general agreement between the present UK results and those generated 20 years ago[16] with the exceptions of poor crown margins, overhanging restorations, and poor general health. In case of poor general health, this was considered to be of lesser importance by UK dentists 20 years ago. Nowadays in the UK, several plans have been implemented to help assign routine preventive oral health care and dental domiciliary care to patients that are elderly or have significant, competing medical comorbidities which collectively have increased the access of the elderly to dental care.[17]

Poor crown margin and overhanging restorations were considered to be of greater importance by UK dentists 20 years ago. An explanation for this might be that the new state of the art of digital dentistry has improved dental restoration outcomes and might have played a role in lessening the likelihood of suboptimal margin finish of crowns.[18] In the past few years, the pace of research has accelerated further, and recently, chairside addition of bioactive molecules to conventional glass ionomer has been reported in the UK as an endeavor to improve mechanical properties, biocompatibility, and clinical durability of root surface glass ionomer restorations.[19]

It is worth mentioning that possible changes in the views of practicing dentists regarding root caries may have occurred since 1999, the year in which the first UK-based study was conducted.[16] This change can also be attributed to the significant influx of non-UK trained dentists into the UK over the past two decades.[20]

It is also interesting to note the general agreement between the responses from the UK and those from Brazil. In 2017, Brazil and the UK have begun a collaborative network in dental research and teaching that aimed to share the knowledge on minimally invasive restoration techniques and advance the partnership that has already existed between the dental academic institutions in both countries.[21] If one assumes that such collaborations prompted very similar responses in both the countries, then it is sensible to recommend that dental academic institutions around the world should adopt similar collaborative initiatives for a more comprehensive and up-to-date understanding of evidence-based practices and guidelines.

It is clear that there are several differences between the UK and non-UK responses, with non-UK dentists ranking the importance of active periodontal disease, higher than those in the UK. Conversely, the UK respondents assigned higher importance to the frequency and amount of sugar intake. In the opinion of the authors, these observations perhaps reflect the greater emphasis upon prevention in the UK and the greater levels of untreated dental disease in other countries.

CONCLUSION

This questionnaire survey revealed what dentists from 9 different countries regarded as the most important risk factors contributing to the development of root surface

Table 2: The level of agreement between the weighted rankings of UK dentists from the present study, the 1999 study, and those from the countries being compared (perfect agreement if the difference value is 0 and the worst possible disagreement if the difference value is 18)

Risk factors according to importance (present UK study)	Level of agreement								
	UK 1999	LB	JO	SA	EG	BR	IN	MY	IQ
Oral hygiene status	2	0	0	0	0	0	0	0	0
Frequency of sugar intake	0	6	4	10	7	0	11	7	2
Reduced salivary flow	2	1	1	1	4	1	0	8	9
Total amount of sugar consumed	1	9	9	14	13	3	14	9	12
Mental disability/Senility	1	1	2	2	0	1	0	0	2
Physical disability	2	6	2	0	0	6	1	4	0
Poor general health	6	4	5	3	1	3	1	1	2
Presence of a partial denture	1	9	2	8	3	1	4	2	6
Consumption of fizzy drinks	1	10	8	0	7	5	2	5	10
Gingival recession	2	7	8	5	6	3	8	3	5
Active periodontal disease	0	9	8	4	8	3	7	7	8
Poor crown margins	5	5	7	2	10	9	2	9	4
Overhanging restorations	7	1	2	5	3	2	4	7	2
Degree of crowding	1	9	1	3	0	9	3	2	0
Cigarette smoking	2	6	6	4	2	0	7	2	5
Presence of erosion	2	1	0	1	4	1	0	0	5
Consumption of alcohol	1	7	1	4	1	2	3	1	0
Number of teeth present	2	0	1	1	1	0	1	1	0
Presence of abrasion cavity	0	3	5	5	4	3	4	4	6

caries. Perceptions and beliefs between the UK and non-UK dentists exhibit some commonality although differ in the emphasis on diet. Patients with poor oral hygiene, active periodontal disease, reduced salivary flow, and gingival recession are perceived to have a higher risk of developing new root surface caries. Oral hygiene status was the most important risk factor in all countries. It is hoped that this deep dive into risk factors coupled with the findings presented in Part I of this study will be used as a basis for a more comprehensive investigation into the management of patients with root surface caries.

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Conflicts of interest

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