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ORIGINAL ARTICLE

Influence of the microbiological component of Cariogram® for evaluating the risk of caries in children

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ABSTRACT

Objective: To compare the risk for caries in children as determined by Cariogram® software (CS; Stockholm, Sweden) with and without its microbiological component and by a form based on Cariogram® (FBC).

Methods: Children ($n = 28$) aged 3–9 years were included. Data were collected clinically and from anamnesis. The salivary levels of *Streptococcus mutans* (SM) were evaluated. A linear regression model was used to determine which variables were predictive for each type of risk analysis. Caries risk was the dependent variable and the independent variables were caries experience, related disease, plaque amount, diet frequency, salivary levels of SM, fluoride sources and clinical judgment. A paired Student *t*-test was used for the following comparisons: (a) CS with and without SM; (b) CS without SM and FBC; (c) CS with SM and FBC.

Results: The mean dmft/DMFT was 5.56 ± 2.51. There was no difference between the methods ($p < .05$). Regardless of caries risk, the children presented the same levels of SM ($p = .889$). Caries experience, plaque amount, diet frequency and fluoride sources were predictors of caries risk in all assessment methods. Clinical judgment was a significant predictor in CS.

Conclusions: Caries experience, plaque amount, diet frequency and fluoride sources are valuable predictors of caries risk; microbiological tests are not necessary for evaluating caries risk in children, which can be assessed similarly by CS without SM and FBC.

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Introduction

The caries process is a dynamic imbalance between remineralisation and demineralisation, and if more minerals are lost than gained from the hard tissues, a lesion develops as a sign of the disease [1]. For a long time, the general trend in clinical practice has been to manage carious lesions focusing primarily on surgical treatment rather than non-invasive preventive strategies, regardless of a patient's caries risk. This can lead to several replacements over time, with an increasing rate of restoration size and the production of iatrogenic damage. Up to 71% of all restorations are performed on previously restored teeth, with secondary carious lesions as a major cause [2]. Thus, although the carious lesion is repaired, the dental caries is not adequately treated, as the actual cause and risk factors have not been adequately determined.

Recently, the concept of caries management has changed and focuses mainly on the multifaceted nature of caries and biofilm involvement. Currently, success in preventing and managing caries lies with altering the complex dental biofilm, changing the oral factors to favour health [3]. Caries management by risk assessment (CAMBRA) is an evidence-based approach for preventing, reversing, and when necessary, repairing early damage to tooth tissues [4].

Several multifactorial caries risk assessment programmes have been developed and made applicable to children, such as the Cariogram® [5], the caries-risk assessment tool (CAT) [6], the CAMBRA Programme [7] and the National University of Singapore Caries Risk Assessment (NUS-CRA) model [8]. Under each programme, caries risk can be estimated based on a questionnaire, clinical observations and further aided by salivary flow rate and/or microbiological parameters [9]. Among them, the Cariogram® [5], an algorithm-based software programme developed in Sweden in 1997 by the University of Malmö, is the most commonly used, as the programme has been validated in preschool children, schoolchildren, young adults, and the elderly [10–13]. It is based on nine carries-related risk factors, along with physician judgment, and is intended to aid clinicians in performing more objective and consistent dental caries risk assessments [14]. However, despite its availability, the validity of the programme for predicting dental caries still requires more investigations mainly due to its microbiological aspects, which are currently difficult to obtain by clinicians, which leaves them

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in doubt about the clinical potential of the programme. Thus, considerations and knowledge of the formation, progression and definition of carious lesions should be enhanced through the establishment of rigorous criteria, even without microbiological information, to favour diagnosis and treatment, avoiding erroneous approaches to disease prevention [10].

A form based on the Cariogram® proposed by Paris et al. [15] precludes the need for a computer, and excludes the salivary levels of *mutans streptococci*. The possibility of using a risk assessment programme without a microbiological component renders it attractive and accessible to clinicians [10]. This article seeks to test the null hypothesis that the microbiological component does not interfere with the final result of CS by comparing both the software with and without the microbiological aspect, and the form based on the Cariogram®, which excludes the microbiological assessment.

Materials and methods

Study design, setting and sample selection

This cross-sectional study was submitted to and approved by the local Ethical Committee in Research (protocol #244-14) of the Federal University of Rio de Janeiro (UFRJ), Brazil. It is part of a clinical trial (Clinicaltrial.gov #NCT02584218) that aims to investigate the efficacy of sealing caries in children.

This study was conducted at the School of Dentistry of UFRJ, between September 2014 and August 2015. Children aged 3–9 years who sought their first dental appointment at the Paediatric Dental Clinic of UFRJ were eligible for the study. The exclusion criteria were any factor that might influence salivary flow or salivary microbiological counts, such as medications and mouth rinses used in the last month or fixed orthodontic appliance. The children were included after their legal guardians had signed a consent form. A sample of 35 children was selected for this preliminary study.

Training and calibration exercise

The calibration exercise was carried out in two steps (theoretical and clinical). The theoretical step consisted of a discussion of the dmft/DMFT criterion [16] for diagnosing dental caries and visible plaque [17]. A professor of paediatric dentistry (the gold standard) coordinated this step, instructing the dentist on how the examination should be performed. The clinical step was performed on randomly selected children who did not make up the main sample. Each dentist (the professor and the dentist) examined five previously selected children aged 3–9 years. Registration was performed by a third person who was not involved in the study. Data analysis included Cohen's kappa coefficient on a tooth-by-tooth basis for the dmft/DMFT index and a surface-by-surface basis for the plaque index. Inter-examiner agreements were tested by comparing the examiner with the gold standard (kappa inter-examiner agreement value for dmft/DMFT $=0.908 \pm 0.040$; kappa inter-examiner agreement value for visible plaque index $= 0.737 \pm 0.200$).

Data collection

Data were collected from parents/caregivers via interviews performed by an examiner to confirm sociodemographic data, such as the child's gender and age and to collect information about fluoride sources, related disease, cariogenic medication, and sugar consumption and frequency (through a 3-d diet diary). Dental caries prevalence data were obtained according to the dmft/DMFT index [16], and the visible plaque index [17] was investigated.

The dentist performed the examinations with the children sitting on a dental chair under optimal lighting. A plane buccal mirror, probe and air syringe was used in the clinical examination, which was performed only after the examiner had cleaned all tooth surfaces.

Saliva collection and microbiological analysis

The participants underwent unstimulated saliva collection sitting comfortably in the dental chair. The saliva produced in the first 30 s was discarded and saliva was subsequently collected for exactly 5 min. The whole saliva flow rate was recorded. Immediately after obtaining the saliva samples, microbiological tests were performed at the Multidisciplinary Laboratory of Dental Research at the UFRJ School of Dentistry. Saliva samples were thoroughly shaken for 30 s in a vortex mixer to be homogenized and were set aside for 10 min for the foam to settle before being serially diluted. The samples from each subject were serially diluted in sterile saline (10^{-1}–10^{3}). Aliquots (50 μL) of each dilution were streaked on mitis-salivarius agar with bacitracin in duplicate. The plates were incubated at 37 °C for 48 h in microaerophilic conditions to enumerate the viable *S. mutans* cells (colony forming units [CFU]/mL).

Caries risk assessment

Caries risk assessment was performed using the following: CS [5] and a CS-based form (FBC) [15]. Both tools can convert the information collected from each patient into scores. According to the Cariogram® built-in algorithm, each variable of the FBC is weighted at a relevant ratio and the scores are assigned [18].

The CS generates a graph in which the green sector depicts an estimation of the chance of avoiding caries. The chance of avoiding caries, and conversely the risk of caries, are expressions for the same process but are illustrated inversely. When the chance of avoiding caries is high, the caries risk is low, and vice versa [5]. In this study, the evaluation included the following variables: caries experience, related disease, sweetened diet content, frequency of sugar consumption, plaque amount, fluoride sources, salivary levels of *S. mutans*, saliva flow rate and clinical judgment. The FBC included the same variables except salivary levels of *S. mutans* and clinical judgment (Figure 1). The buffer capacity was not included in all analyses.

In CS, a score of zero is the most favourable risk value and the maximum score of three (or two) indicates a high, unfavourable risk value. In the FBC, the scores are given

Variable	Definition	Data needed	Scores		
			Cariogram® software	Form based on Cariogram®	
				Minimum	Maximum
Caries experience	Past caries experience, including cavities, fillings and missing teeth because of caries.	Dmft/DMFT index	0 - 3	0 - 9	11 - 13
Related disease	General disease or conditions associated with dental caries	Medical history, medications	0 - 2	0	2 - 4
Seewetened content of diet	The consumption of fermentable carbohydrates	Diet history	0 - 3	0 - 5	13 - 20
Frequency of sugar consumption	Estimation of number of meals and snacks per day, mean for 'normal days'	Questionnaire results, dietary recall (3 days)	0 - 3	0 - 5	13 - 20
Plaque amount	Estimation of hygiene	Visible plaque index	0 - 3	0 - 4	8 - 15
Fluoride sources	Fluoride availability	Interview with parents	0 - 3	0 - 5	10 - 50
Salivary levels of *S. mutans*	Estimation of levels of *S. mutans* in saliva	Microbiological test with Dish plates	0 - 3	-	-
Saliva flow rate	Estimation of amount of saliva	Saliva collection	0 - 3	0 - 2	5 - 40
Clinical judgment	The clinician opinion about the caries situation	Children with white spot lesion were given an elevated score	0 - 3	-	-

Figure 1. Chart that shows the variables assessed, their definition, and data needed to obtain the information to give scores, according to the method of caries risk evaluation (Cariogram® software and the Form based on Cariogram® software).

according to each variable, and have the same interpretation as the CS. The only difference is the number attributed to each score. Therefore, considering the FBC (Table 1), the following variables/scores were assigned: caries experience (0, caries-free; 9, <population mean; 11, population mean; 13, >population mean); related disease was evaluated based on the cariogenic medication consumed (0, no cariogenic medication; 2, low/seldom use cariogenic medication, less than once a month; and 4, high/frequent use of cariogenic medication, more than or once a month); sweetened diet content was scored based on the type and frequency of sugar (solid or liquid) ingestion (0, almost no sugar consumption; 5, conscious dietary/immediately after meal: low sugar consumption; 13, moderate sugar consumption; 20, very high sugar consumption); thus, this last score is proportionally influenced by the variable frequency of sugar consumption (0, up to 3 times a day; 5, 4–5 times a day; 13, 6–7 times a day; 20, >7 times a day). Plaque amount was scored based on the number of teeth with visible thick plaque (0, <5%; 4, 5–20%; 8, 21–50%; 15, >50%). Fluoride sources took into account the exposure to fluoride, such as fluoridated public water and fluoridated tooth paste (≥1000 PPM fluoride), where scores were 0 (both and regular sources), 5 (both and irregular sources), 10 (only one source) and 50 (no fluoride sources).

As a variable of CS, clinical judgement considered the clinician's impression of the patient's caries situation and also the results of the CS (low, moderate or high risk of caries). In this study, clinical judgment was scored as follows: zero, when the dentist's opinion was better than the Cariogram results and/or the child did not have any active white spot lesions; one, when the dentist's opinion was the same as the Cariogram results and/or the child did not have any active white spot lesions; two, when the dentist's opinion was worse than the Cariogram values and/or the child had one active white spot lesion; three, when the dentist's opinion was worse than the Cariogram values and/or the child had more than one active white spot lesion. The criterion of the presence or absence of white spot lesions as an auxiliary means of judging the child's clinical status was based on the study by Kavvadia et al. [19] with some modifications (number of white spot lesions) by the present authors.

Based on a previous study [9], the CFU counts (CFU/mL saliva) were categorised into four levels in CS: scores of 0, 1,

Table 1. The Cariogram® software-based form used in the study.

Variable (Based on)	Criteria	Scores
Caries experience (Population mean basis)	Caries free	0
	< Population mean	9
	> Population mean	13
Related disease (Cariogenic medication consumed by the child)	No cariogenic medication	0
	< Low/seldom (less than once a month)	2
	High/frequency – (more than or once a month)	4
Sweetened content of diet (Type and frequency of sugar – solids or liquids – ingestion)	Almost no sugar consumption	0
	Low sugar consumption	5
	Moderate sugar consumption	13
	Very high sugar consumption	20
Frequency of sugar consumption (Times a day)	Up to 3 times a day	0
	4–5 times a day	5
	6–7 times a day	13
	More than seven times a day	20
Plaque amount (Number/Percentage of teeth with visible thick plaque)	(< 5%)	0
	(5–20%)	4
	(21–50%)	8
	(> 50%)	15
Fluoride sources (Exposition to fluoride such as fluoridated public water and fluoridated tooth paste ≥1000 PPM fluoride)	Both in regular sources	0
	Both in irregular sources	5
	Only one source	10
	No fluoride source	50

2 and 3 denote an *S. mutans* level of $<10^4$, 10^4–10^5, 10^5–10^6 and $>10^6$, respectively.

After completing the CS assessment (with and without microbiological information), the Cariogram® results were transformed into risk groups according to the chance of avoiding new lesions, i.e. low chance (0–40%)/high risk, medium chance (41–60%)/moderate risk, high chance (61–100%)/low risk [11]. In the FBC, each child was classified as belonging to a low (0–33%), moderate (34–66%) or high risk (≥67%) group after the score of each variable was summed up to result in an individual value.

Statistical analysis

The data were tabulated and analysed using SPSS 20.0 (SPSS Inc., Chicago, IL). The Shapiro–Wilk test was used to verify the normal distribution of the results. Linear regression was performed considering caries risk as a dependent variable; variables presented in CS and FBC (except salivary flow rate and diet contents) were the independent variables for each assessment method: (a) CS with the microbiological aspect; (b) CS without the microbiological aspect; (c) FBC. Thus, linear regression was performed to identify the variables that were predictive for each type of risk analysis. The least significant variables were regressively dropped until only those with $p < .05$ remained in the multivariate model (stepwise backward elimination). Descriptive data were also reported. The paired Student *t*-test was performed to compare the caries risk values obtained after the assessments (a, b and c), and ANOVA followed by the Tukey test for analysing salivary flow rate and salivary levels of *S. mutans* (expressed in $\log_{10}$ scale of CFUmL) according to risk classification. Statistical significance was set at 5% with a 95% confidence interval.

Table 2. The mean of caries risk values (%) of the whole sample ($n = 28$) after each method of assessment.

Method of caries risk assessment	Caries risk values % Mean ± SD
Cariogram® software with salivary levels of *S. mutans* as a variable[a]	49.40 ± 23.73
Cariogram® software without salivary levels of *S. mutans* as a variable[b]	53.80 ± 22.39
Form based on Cariogram® software[c]	49.92 ± 15.60

The values represented by a/b means the 'chance of avoiding caries', which in this case were the same of moderate caries risk values. Thus, the analysis could be performed and no difference was observed between the values provided by all method of caries risk assessment: a × b – $p = .167$; a × c – $p = .846$; b × c – $p = .158$. SD: standard deviation.

Results

Initially, 35 children were selected, but only 28 spit properly; therefore, seven children were excluded from the study. The gender distribution in the sample was 13 girls (46.4%) and 15 boys (53.6%). The mean age was 6.79 ± 1.81 years and the mean dmft/DMFT scores were 5.56 ± 2.51.

The overall mean caries risk values as determined by the assessment methods did not show any statistically significant difference (Table 2). In addition, when the number of children classified as being at low, moderate or high risk of caries by each method was compared separately, no difference ($p = .339$) was observed (Tables 3 and 4). The mean dmft/DMFT and salivary level of *S. mutans*, and the variables distribution according to assessed caries risk by CS and FBC are presented in Tables 3 and 4.

The salivary levels of *S. mutans* did not influence ($p = .937$) the caries risk results (low, moderate and high) determined by CS. The mean salivary flow rate was similar ($p = .278$) in children classified as being at low (1.40 ± 0.40), moderate (1.52 ± 0.54) or high (1.12 ± 0.13) risk of caries by FBC. In the same manner, there was no difference between the salivary

Table 3. The mean of dmft/DMFT and *S. mutans*' salivary levels, as well as the distribution of variables scores, according to the classification of children ($n = 28$) provided by Cariogram® software.

Variable (mean ± SD)	Low risk of caries ($n = 5$)			Moderate risk of caries ($n = 14$)			High risk of caries ($n = 9$)		
dmft/DMFT	1.73 ± 0.50			5.40 ± 1.36			9.55 ± 2.33		
Salivary levels of *S. mutans*	4.60 ± 1.09			4.97 ± 2.03			4.77 ± 1.11		
Variable [*n* (%)]	Min score		Max score	Min score		Max score	Min score		Max score
Related disease/medication	3 (60.0)	1 (20.0)	1 (20.0)	2 (14.3)	10 (71.4)	2 (14.3)	4 (44.4)	0 (0)	5 (55.6)
Plaque amount	0 (0)	3 (60.0) 1 (20.0)	1 (20.0)	0 (0)	5 (38.46) 9 (61.54)	0 (0)	1 (11.1)	3 (33.3) 4 (44.4)	1 (11.1)
Diet contents	0 (0)	2 (40.0) 3 (60.0)	0 (0)	0 (0)	5 (35.7) 9 (64.3)	0 (0)	0 (0)	3 (33.3) 6 (66.7)	0 (0)
Diet frequency	0 (0)	2 (40.0) 3 (60.0)	0 (0)	0 (0)	5 (35.7) 9 (64.3)	0 (0)	0 (0)	3 (33.3) 6 (66.7)	0 (0)
Fluoride sources	0 (0)	1 (20.0) 4 (80.0)	0 (0)	3 (21.4)	3 (21.4) 8 (57.2)	0 (0)	0 (0)	2 (22.2) 7 (77.8)	0 (0)
Saliva flow rate	5 (100.0)	0 (0) 0 (0)	0 (0)	13 (92.9)	1 (7.1) 0 (0)	0 (0)	9 (100.0)	0 (0) 0 (0)	0 (0)
Clinical judgment	0 (0)	4 (80.0) 1 (20.0)	0 (0)	2 (14.3)	8 (57.2) 4 (28.5)	0 (0)	1 (11.1)	4 (44.4) 4 (44.4)	0 (0)

Salivary levels of *S. mutans* are expressed in $\log_{10}$ scale of UFC/mL. No difference was observed between children classified at being low, moderate or high risk of caries, considering the salivary levels of *S. mutans* ($p = .889$, Tukey test).

Table 4. The mean of dmft/DMFT and the distribution of variables scores, according to the classification provided by the Form based on Cariogram® software.

Variable (mean ± SD)	Low risk of caries ($n = 4$)			Moderate risk of caries ($n = 16$)			High risk of caries ($n = 8$)		
dmft/DMFT	1.64 ± 0.52			5.97 ± 2.69			9.07 ± 3.0		
Variable [*n* (%)]	Min Score		Max Score	Min Score		Max Score	Min Score		Max Score
Related disease	2 (50.0)	0 (0)	2 (50.0)	2 (12.5)	12 (75.0)	2 (12.5)	0 (0)	4 (50.0)	4 (50.0)
Plaque amount	0 (0)	3 (75.0) 1 (25.0)	0 (0)	0 (0)	6 (37.5) 10 (62.5)	0 (0)	1 (12.5)	2 (25.0) 3 (37.5)	2 (25.0)
Diet contents	1 (25.0)	1 (25.0) 2 (50.0)	0 (0)	0 (0)	7 (43.75) 8 (50.0)	1 (6.25)	0 (0)	4 (50.0) 4 (50.0)	0 (0)
Diet frequency	1 (25.0)	1 (25.0) 2 (50.0)	0 (0)	0 (0)	7 (43.75) 8 (50.0)	1 (6.25)	0 (0)	4 (50.0) 4 (50.0)	0 (0)
Fluoride sources	1 (25.0)	1 (25.0) 2 (50.0)	0 (0)	1 (6.25)	5 (31.25) 10 (62.5)	0 (0)	0 (0)	2 (25.0) 6 (75.0)	0 (0)
Saliva flow rate	4 (100.0)	0 (0) 0 (0)	0 (0)	15 (93.75)	1 (6.25) 0 (0)	0 (0)	8 (100.0)	0 (0) 0 (0)	0 (0)

flow rates of children classified as low (1.41 ± 0.28), moderate (1.33 ± 0.43) or high (1.52 ± 0.66) risk by CS ($p = .737$) and between the analysis methods ($p = .805$).

The linear regression model identified the variables that actually influenced the caries risk observed. The results are presented in Table 5 and show that the variables caries experience, plaque amount, diet frequency and fluoride sources were predictors of caries risk as determined by CS with and without the microbiological component, and by FBC. In addition, clinical judgment was a significant risk predictor for CS both with and without the microbiological component. The significant variables were included in a forward stepwise multiple regression model for each method, and the CS results demonstrated that the most important variable was caries experience ($p = .037$), followed by clinical judgment ($p = .041$) and plaque amount ($p = .045$). In the FBC assessment, caries experience ($p = .023$) and plaque amount ($p = .028$) were also the most relevant predictors.

Table 5. Variables included in the linear regression model for each method of caries risk assessment used in this study.

Dependent variable	*p* valor
Cariogram® software with microbiological parameter ($R^2 < .802$)	
Caries experience	<.0001
Related disease	.743
Frequency of sugar consumption	.010
Plaque amount	<.0001
Fluoride sources	.011
Salivary levels of *S. mutans*	.611
Clinical judgment	<.0001
Cariogram® software without microbiological parameter ($R^2 < .809$)	
Caries experience	<.0001
Related disease	.595
Frequency of sugar consumption	.011
Plaque amount	<.0001
Fluoride sources	.012
Clinical judgment	<.0001
Form based on Cariogram® software ($R^2 < .806$)	
Caries experience	<.0001
Related disease	.878
Frequency of sugar consumption	.004
Plaque amount	<.0001
Fluoride sources	.015

R^2 means the percentage of variance founded in dependent variable (caries risk result provided by each assessment's method), which is explained by the significant independent variables. For example: $R^2 < .802$ means that approximately 80% of variance in caries risk is explained by significant independent variables included in the model.

Discussion

Risk assessment is an important component in the decision-making process for preventing and managing dental caries [10]. Risk factors and indicators, such as caries experience, sugar consumption, oral hygiene and fluoride source, among others, have been proposed as targets for evaluating the individual risk of caries [10,18]. These factors are included in different risk assessment methods [5–8], which highlights the importance of evaluating the salivary concentrations of *S. mutans* as a potent predictor of future caries. However, not all evaluations include the microorganism count in their variables of analyses [15,18]. The methods adopted this study for evaluating caries risk comprised CS (with and without salivary levels of *S. mutans* as an analysis variable) and a form based on the CS [15].

Based on the results, there was no difference between the caries risk determined by the methods used, which strongly suggests that the microbiological component of CS can be omitted in caries risk evaluation in children.

Although a recent systematic review [20] affirmed that six studies [21–26] demonstrated the importance of *S. mutans* count as an isolated predictor of caries risk, the authors also

found that the accuracy in the majority of these studies was poor [20], which proves that it is not a significant tool in this analysis process. Baca et al. [27] also stated that microbiological tests do not provide information about other cariogenic characteristics, such as the ability to synthesize intracellular and extracellular storage polysaccharides, and added that caries is a multifactorial disease influenced by fluoride, diet and other factors. Thus, microbiological tests and caries history have similar correlation values as predictors of caries [20].

Moreover, the cost of these microbiological techniques may impede their use in countries with weak economies [27]. Thus, the FBC used in this study has advantages, as it is a questionnaire, and includes factors involved in the caries process that can be easily assessed without a computer system, thus allowing its application in a low-income community, for example [18].

Although we detected no significant difference, the number of children classified as being at low, moderate or high risk of caries differed slightly with the assessment methods. It is important to note that the outcome of the CS is the chance (%) of avoiding new carious lesions, and the FBC has different weights for each variable. Thus, more investigations of the proper weighting are required, as stated by Cabral et al. [18], and could be seen as a limitation of this study. Furthermore, the difference could be attributed to the variable clinical judgement, which was not included in the FBC and was a significant predictor in the CS in this study. In 1992, Disney et al. [28] included gut feeling in their model for evaluating caries risk, which is also a subjective assessment of risk level. Together with previous caries experience, gut feeling was as accurate as when the whole model was used in that study [20].

The progression of lesions is potentially influenced by a diverse bacterial group (not only a single species) and by dietary, environmental, socioeconomic and physiological risk factors. Among these, caries experience and the buffering capacity of saliva are considered potential factors for risk assessment [5]. On the other hand, studies that analysed salivary buffer capacity and its correlation with dental caries have reported inconsistent results [29,30]. We did not include the buffering capacity of saliva as a variable. There is evidence [20] that it does not contribute to the prediction of future caries. Furthermore, socioeconomic status was not evaluated, as the Cariogram® does not address these factors directly [5].

In the linear regression model used in this study, all variables included in the CS and the FBC were analysed, except salivary flow rate, as there was no difference between the children when the variable was considered. Cabral et al. [18] also excluded it from their model, as no children in their sample presented clinical aspects of hyposalivation. In addition, all attributed scores for diet content were the same as those for diet frequency, thus only one variable was selected for inclusion in the models.

Our results show that caries experience was the most significant predictor for evaluating caries risk. This outcome is in line with previous studies conducted in the same area [18,23]. However, there was a high prevalence of caries in children classified as moderate risk. Even though this variable was one of the most important caries predictors, it also considered the proportion of filled and missing teeth in the mean dmft/DMFT. Thus, children with high caries experience could present restored and missing teeth, but no cavities. Therefore, we included the presence of active white spot lesions as a criterion so that clinical judgment could be scored more easily, as evaluation of incipient caries is not a subjective tool. Kavvadia et al. [19] stated that the presence of white spot lesions represents a strong predictor of caries, and also incorporated this factor as a criterion for defining clinical judgment.

In the CS, a professional clinical judgment variable allows the examiner to increase or decrease the patient's risk of caries. We observed, even when slightly so, that the number of children ($n = 16$) at moderate risk of caries was higher following analysis by the FBC. We suggest that more studies should be developed with or without the variable clinical judgment in the FBC assessment to clarify this issue, as it was not performed in this study.

Caries risk assessments are essential to arrive at the disease diagnosis and the appropriate clinical treatment decision [31]; this form of evaluation acts as an explanation of what could be corrected to improve the existing imbalance [32]. The children who participated in this study were enrolled in an oral care programme based on minimal intervention strategies according to their caries risk.

In conclusion, we do not support saliva collection for microbial culture for predicting caries. The risk of caries can be accessed through the questionnaire based on CS, which yields the same performance as the CS while saving time and obviating the high cost of saliva collection. In this sense, the Cariogram® without its microbiological aspect and the FBC are practical guides for determining the caries risk of a subject as compared to the version of Cariogram® with all variables included.

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Disclosure statement

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