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Original Article

Caries Risk Assessment by CAMBRA in Children Attending a Basic Health Unit

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Abstract

Objective: To determine the caries risk by Caries Management by Risk Assessment (CAMBRA) for children with mixed dentition attending a Basic Health Unit (BHU), identifying the main dental caries disease indicators, risk factors and protective factors.

Material and Methods: The sample consisted of 89 children of both genders aged 8-12 years. Clinical and bitewing radiographic examinations were performed by a calibrated examiner, as well as the filling of the adapted CAMBRA form. Dental caries disease indicators, risk factors and protective factors of all subjects were determined. Chi-square test and multivariate logistic regression analysis for all CAMBRA variables were applied ($p < 0.05$).

Results: Caries risk was considered high in 38.2% of patients, moderate in 32.6% and low in 29.6%. The most frequent disease indicator was white spot lesion on smooth surfaces (73.0%), the most common risk factor was visible biofilm (78.7%) and protective factor was fluoridated water (100.0%). Children with “moderate risk” and “high risk” had risk of visible cavities or radiographic penetration of the dentin (OR=14.689; OR=574.363, respectively) compared to patients with “low risk”.

Conclusion: Caries risk determined as “high” and “moderate” were classifications most observed among children attending BHU. White spot lesions on smooth surfaces were the most frequent dental caries disease indicators and visible plaque on tooth surface and community water fluoridation were the most significant risk factors and protective factors, respectively.

Keywords: Risk, Dental Caries, Child, Public Health Service.

Introduction

The caries risk assessment consists in determining the possibility of disease incidence, as the number of new non-cavitated or cavitated caries lesions during a certain period [1]. The Brazilian Association of Pediatric Dentistry emphasizes the importance of assessing the risk and the caries activity in the contemporary clinical care of infants, children and adolescents [2].

Studies have suggested that the dental caries risk assessment should be carried out by analyzing the factors involved in the disease, such as social, behavioral, microbiological, environmental and clinical factors [3,4].

In this context, CAMBRA (Caries Management by Risk Assessment) was developed at a conference held in 2002 in California, USA, defining caries indicators, as well as risk and protective factors to guide therapy and treatment planning based on evidence for both children and adults and for communities. CAMBRA classifies the caries risk into "low", "moderate" or "high." If pathologic risk factors are prevalent, dental caries progresses, while if protective factors are prevalent, the dental caries process is reversed and paralyzed [5-10].

In CAMBRA, caries indicators are observations about history and activity; risk factors are those that contribute to the disease; and protective factors are biological or therapeutic factors that can offset the risk factors for dental caries. The goal of CAMBRA is the rapid, simple and precise identification of patients at higher risk for the disease so that proper planning can be implemented. This method has been used since 2008 in an American University as part of the clinical and didactic teaching to standardize the caries risk classification of patients determined by both faculty and students [11].

CAMBRA has been considered a good clinical tool and easy to be used in daily dental practice [9]. However, to date, no studies were found in literature evaluating its use in children, as well as in the Brazilian public health. It is noteworthy that this assessment would facilitate user access to dental services in primary care, ensuring universality and equity [12], with individual approaches for the prevention and treatment of the disease by organizing the demand in primary care.

The aim of this study was to determine the caries risk by adapted CAMBRA in the public dental service for children with mixed dentition treated at a Basic Health Unit (BHU), identifying key caries disease indicators and risk and protective factors.

Material and Methods

A convenience sample of all children aged 8-12 years treated within a three-month period was used. Thus, 89 norm reactive children of both sexes in mixed dentition attending the Barcelona Basic Health Unit (BHU), municipality of Serra, ES, Brazil, participated in this study between May and July 2013. As standard protocol, two bitewing radiographs were performed on all patients at the beginning of dental treatment for the detection of caries lesions. It is noteworthy that during this

period, this UBS scheduled 2 dental care and 1 emergency services per day by an experienced pediatric dentist who worked 20 hours / week with children and adolescents aged 0-18 years.

The CAMBRA caries risk assessment form is composed of a hierarchy of disease indicators and risk and protective factors. Caries indicators are observations on its history and activity; risk factors are the factors that caused or contributed to the disease or that will contribute to its manifestation in the future; protective factors are biological or therapeutic measures that can collectively offset caries risk factors because the more serious are the risk factors, the greater must be the protective factors to maintain the patient in balance or reverse the caries process [5].

In this research, the CAMBRA caries risk assessment form was used for children from the age of 6 years and adults, as proposed in a previous study [5]. This form has been adapted for children treated at UBS. Among the risk factors, the following items were not considered: bacterial count for *S. mutans* and lactobacilli in saliva, drug use and exposed roots. Bacterial count was not performed due to the complexity and costs involved for conducting a large-scale microbiological culture, requiring laboratory infrastructure and human resources, which prevents its implementation [13]. Items use of licit and illicit drugs and exposed roots were not considered by the age group assessed.

Among the protective factors, the following items were disregarded: fluoridated toothpaste with 5,000 ppm of daily F, chewing gum or lozenges with Xylitol 4x / day in the last 6 months, toothpaste containing calcium and phosphate during the last 6 months and evaluation of stimulated salivary flow (> 1 ml / min). These protective factors were not assessed in this study, as these products are normally imported and of difficult access by the general population. Salivary flow rate (ml / min) was not measured due to the difficulty in collecting stimulated saliva and for the time demand in public service.

The caries risk assessment of a patient occurs in two phases: the first is to determine the disease indicators and the risk and protective factors of each patient. The second phase is characterized as a judgment based on indicators and identified factors by classifying the patient as high, moderate or low risk. The high risk classification is based on positive response to at least one of the four disease indicators (visible cavities or radiographic penetration of the dentin, radiographically visible proximal caries lesions involving only enamel, white spots on smooth surfaces, restorations in the past 3 years), and the patient should not be currently in professional therapeutic treatment to control the disease. In the absence of disease indicators, the sum of risk factors overlapping the protective factors, the individual will be classified as moderate risk. Classification of low risk is determined by the predominance of protective factors.

For the evaluation of disease indicators and CAMBRA risk factors, clinical and radiographic examinations were performed. Clinical examination was carried out in two steps by a single examiner calibrated for the ICDAS visual criteria (International Caries Detection and Assessment System), with scores ranging from 0 to 6.

The examiner's training started with the 90-minute online course (ICDAS e-learning program) developed by ICDAS Foundation and available at <http://www.icdas.org/> and reading and discussion of articles on ICDAS visual criteria along with an experienced and calibrated researcher who was responsible for the calibration procedures. For *in vitro* calibration, an examination in 100 posterior teeth according to the ICDAS criteria was carried out. This examination was performed twice, with an interval of one week between tests. Notes were recorded in adequate forms. Disagreements between examiner and researcher, considered the gold standard, were observed during reassessment and the results were discussed up to reaching a consensus. Subsequently, *in vivo* calibration was performed, in which five children were examined twice with an interval of one week between tests. First, the child received professional tooth brushing, shortly after, the child was examined by the examiner and then by the researcher responsible for the calibration. Notes were recorded by an Oral Health Technician. The weighted Kappa statistical test was applied to evaluate the inter-observer (Kappa = 0.80) and intra-examiner (Kappa = 0.82) reproducibility.

First, the presence of visible biofilm was evaluated according to the biofilm index after drying the tooth surface with a triple syringe, relative isolation and good lighting. Biofilm was classified as fine when it could only be identified after drying the tooth surface, while thick biofilm was that easily observed, firmly attached to the tooth surface [14].

Then, after professional prophylaxis with pumice, Robinson toothbrush and water, the presence of clinically visible cavities in dentine (scores 5 and 6 of ICDAS), active white spots (scores 1 and 2 of ICDAS) on smooth surfaces, restorations held in the last three years and deep pits and fissures were evaluated. During clinical examination, the risk factor "inadequate salivary flow by observation" was evaluated by the examiner considering some clinical aspects. In the early stages, hyposalivation is characterized by decreased salivary volume, and saliva is presented thick and scattered. Dryness of lips and absence of salivary production by salivary gland palpation were observed. The oral mucosa becomes dry and atrophic, and patients could gradually demonstrate dysgeusia, dysphagia and dysarthria [15,16].

Participants were x-rayed in conventional apparatus using the interproximal technique, by the same examiner in Spectro 70X device (Dabi Atlante, Ribeirão Preto, São Paulo, SP, Brazil), set at 70 kV and 8 mA and exposure time of 0.8 seconds. Periapical film of 22 x 35 mm (Eastman Kodak, Rochester, USA) and radiographic positioner (Jon Han-Shin, Jon Ind., São Paulo, SP, Brazil) were used. Radiographs were evaluated in light box (fluorescent lamp 32W, luminance 1500 nits, Jon Ind., São Paulo, SP, Brazil), with no magnification in partially darkened room. Radiolucent images in enamel on proximal surfaces and in dentin on occlusal and proximal surfaces were recorded in the patient's form by calibrated examiner.

The calibration procedure was performed with 50 bitewing radiographs of children who did not participate in this study. Two tests were carried out with an interval of one week between them by the examiner and the experienced and calibrated researcher with the aid of a light box in partially darkened room. Subsequently, it discussion for consensus was held. The criteria proposed previously

were used for evaluation of carious lesions in radiographic images [17]: (R0) without radiolucency (R1) radiolucency on the outer half of the enamel, (R2) radiolucency on the inner half of the enamel, near the dentinoenamel junction (R3) radiolucency on the outer half of the dentin, and (R4) radiolucency on the inner half of the dentin. The weighted Kappa statistical test was applied to evaluate the inter-observer (Kappa = 0.84) and intra-examiner (Kappa = 0.87) reproducibility.

Data were tabulated on Excel for Windows spreadsheets. Analyses were performed using SPSS - Statistical Package for Social Sciences (version 18.0). Chi-square tests (χ^2) were performed to verify the association of variable "visible cavities or radiographic penetration of the dentin" and other variables of caries indicators, risk factors and protective factors. Variables that were significantly associated ($p < 0.05$) were included in the multivariate logistic regression model (odds ratio) as independent variables, adopting a stepwise backward model considering "visible cavities or radiographic penetration of the dentin" as dependent variable. The significance level was 5%.

This study was approved by the Research Ethics Committee of the Cruzeiro do Sul University (017/2013).

Results

Table 1 presents the descriptive analysis of each of the variables associated with adapted CAMBRA. In caries indicators, white spots on smooth surfaces were observed more frequently (73.0%); the most common risk factor was visible biofilm (78.7%) and the most common protection factor was community water fluoridation (100.0%). The results show that "high" caries risk classification was the most common (38.2%), followed by "moderate" (32.6%) and "low" (29.6% of cases).

Table 1. Descriptive analysis of the disease indicators of adapted CAMBRA risk and protective factors in 89 children aged 8-12 years old treated at UBS in Serra, Brasil, 2013.

Variable		n	%
Caries disease indicators			
Visible cavities or radiographic penetration of the dentin	No	42	47.2
	Yes	47	52.8
Radiographically visible proximal carious lesions involving only enamel	No	49	55.1
	Yes	40	44.9
White spots on smooth surfaces	No	24	27.0
	Yes	65	73.0
Restorations in the last three years	No	47	52.8
	Yes	42	47.2
Risk Factors			
Thick biofilm visible on the tooth surface	No	19	21.3
	Yes	70	78.7
Frequent snacks (> 3 times a day between meals)	No	22	24.7
	Yes	67	75.3
Deep pits and fissures	No	30	33.7
	Yes	59	66.3
Inadequate salivary flow by observation	No	89	100.0
	Yes	0	0.0
Saliva reduction factors (drugs / radiation / systemic)	No	89	100.0
	Yes	0	0.0
Orthodontic appliances	No	84	94.4
	Yes	5	5.60
Protective Factors			
Community water fluoridation (home, school)	No	0	0.0

	Yes	89	100.0
Fluoridated toothpaste at least 1x / day	No	66	74.2
	Yes	23	25.8
Fluoridated toothpaste at least 2x / day	No	23	25.8
	Yes	66	74.2
Mouthwash with fluoride (0.05% NaF) 1x/day	No	89	100.0
	Yes	0	0.0
Fluoride varnish in the last 6 months	No	82	92.1
	Yes	7	7.9
Professional ATF in the last 6 months	No	51	57.3
	Yes	38	42.7
Prescription / use of chlorhexidine for 1 week in the last 6 months	No	89	100
	Yes	0	0
Caries risk	Low	26	29.2
	Moderate	29	32.6
	High	34	38.2

Significant associations were found by the chi-square test between dependent variable "visible cavities or radiographic penetration of the dentin" and variables "proximal carious lesions in radiographically visible enamel (not dentin)" ($p = 0.003$), "restorations in the last 3 years" ($p < 0.001$), "fluoride toothpaste at least 1x / day" ($p = 0.019$) and "fluoride toothpaste at least 2x / day" ($p = 0.038$), "professional ATF in the last 6 months" ($p = 0.009$) and "caries risk" ($p = 0.003$). Thus, these variables were included in the logistic regression model as independent using variable "visible cavities or radiographic penetration of the dentin" as dependent.

Table 2 shows the logistic regression results. It was observed that in Model 1, including all variables, only variable "caries risk" (moderate and high) showed significant associations, obtaining a high risk in relation to the low category for the positive value of "visible cavities or radiographic penetration of the dentin". After adjustment of models by the Stepwise Backward method, Model 5 showed that the same categories showed significant differences in the same direction. Thus, individuals with "moderate caries risk" were 14.689 times more likely to belong to category "visible cavities or radiographic penetration of the dentin" and those with "high caries risk" were 574.363 more likely to belong to category "visible cavities or radiographic penetration of the dentin" in relation to individuals with "low caries risk".

Table 2. Backward Stepwise logistic regression models using the indicator of caries "visible cavities or radiographic penetration of the dentin" of the adapted CAMBRA as dependent variable in 89 children aged 8-12 years attended at a UBS of the municipality of Serra, Brasil, 2013.

Model	Variable	P	Odds Ratio	CI 95%	
				Lower	Upper
1	Radiographically visible proximal caries lesions involving only enamel	0.128	0.285	0.057	1.436
	Restorations in the last three years	0.816	0.842	0.198	3.575
	Fluoridated toothpaste at least 1x / day	1	-	-	-
	Fluoridated toothpaste at least 2x / day	1	-	-	-
	Professional ATF in the last 6 months	0.213	4.615	0.416	51.181
	Caries risk (Moderate)	0.006	53.211	3.107	911.312
	Caries risk (High)	<0.001	1651.142	52.895	51541.108
2	Radiographically visible proximal caries lesions involving only enamel	0.101	0.26	0.052	1.3
	Restorations in the last three years	0.835	0.857	0.201	3.648
	Fluoridated toothpaste at least 1x / day	0.249	2.443	0.534	11.171
	Fluoridated toothpaste at least 2x / day	0.203	4.818	0.427	54.336
	Professional ATF in the last 6 months	0.006	54.735	3.14	954.201
	Caries risk (Moderate)	<0.001	1838.384	57.767	58504.602
3	Radiographically visible proximal caries lesions involving only enamel	0.104	0.265	0.054	1.311
	Restorations in the last three years	0.254	2.328	0.545	9.946

	Fluoridated toothpaste at least 1x / day	0.208	4.772	0.419	54.373
	Fluoridated toothpaste at least 2x / day	0.006	53.061	3.073	916.289
	Professional ATF in the last 6 months	<0.001	1678.999	58.313	48342.999
	Caries risk (Moderate)	0.085	0.248	0.051	1.212
	Caries risk (High)	0.212	4.556	0.421	49.284
4	Radiographically visible proximal caries lesions involving only enamel	0.005	56.791	3.486	925.083
	Restorations in the last three years	<0.001	1920.468	69.424	53125.96
	Radiographically visible proximal caries lesions involving only enamel	0.094	0.265	0.056	1.253
5	Caries risk (Moderate)	0.002	14.689	2.683	80.424
	Caries risk (High)	<0.001	574.363	48.363	6821.205

Discussion

Dental caries risk assessment is an essential component in the treatment decision process for the control of dental caries. Several risk factors and indicators have been proposed as targets to evaluate the development of new carious lesions, with variations according to age [18]. Risk assessment protocols that include the assessment of indicators / risk factors are used to indicate the risk of an individual to have diseases in order to develop appropriate treatment plans [19]. Previous study reported that the caries risk assessment identifies pathological factors and suggests protection strategies that can prevent carried disease progression and / or restore health [6].

In the present study, it was observed among variables of caries indicators related to CAMBRA, higher frequency of white spots on smooth surfaces; the most common risk factor was visible biofilm on the tooth surface and the protective factor was community water fluoridation. Thus, the presence of white spots and the presence of biofilm are important indicators for future caries activity and if there is non-surgical therapeutic intervention, there will be a higher chance of lesion progression and dental caries development [5].

The CAMBRA form considers only white spot lesions on smooth surfaces. Typically, these lesions are located on areas more prone to biofilm accumulation, as the occlusal and cervical surface [20]. Thus, the location of white spot lesions is considered a risk factor for dental caries.

The presence of visible, white and sticky biofilm features an increased caries disease risk [21]. In the CAMBRA form, the most frequently observed risk factor was visible biofilm on the tooth surface. Viewing a thick biofilm suggests increased caries risk, since its presence on this carious lesion is a strong indicator for its activity. Biofilm control is an effective way to interrupt the injury [22]. Hygiene guidance should be directed to individual needs, especially in areas with active caries lesions [23], and their remineralization will only be effective when there is a change of oral hygiene habits [24].

It is noteworthy that sucrose is the main factor for biofilm development [25], promoting its cariogenic effect by the constant maintenance of $\text{pH} \leq 5.0$. Thus, if biofilm is not disorganized, the frequent acidic environment will result in demineralization of the tooth enamel and therefore in dental caries. Moreover, the acidic conditions in the biofilm favors the growth of more acid-resistant bacteria such as *S. mutans* and lactobacilli [26,27]. In addition to the presence of visible biofilm as a risk factor, the habit of consuming snacks between meals was also observed in most children in this study. According to the current guideline on sugar consumption by children of the World Health

Organization (WHO), the recommendation is that the daily consumption does not exceed 10% of calories daily consumed in a healthy diet. Greater health benefits can be achieved if the daily sugar consumption is reduced to 5% of calories (or about 25g of sugar per day). It is noteworthy that most of the sugar consumed by the Brazilian population is in the form of ultra-processed foods such as ready meals, spices, processed juices and soft drinks. In addition to the reduction of dental caries, other benefits of controlling the daily intake of sugars are improved weight control, prevention of overweight and obesity and chronic diseases, especially diabetes [28].

The risk factor "inadequate salivary flow by observation" was absent in 100% of the sample. It is important to emphasize that all children were healthy, with no history of continuous medication use and without systemic diseases. This salivary flow assessment by observation is qualitative and therefore depends on the examiner's experience.

This study showed the presence of community water fluoridation in the city of Serra, Brazil, as protective factors. According to samples collected at the UBS by the VIGIAGUA program (Water Quality Monitoring) and analyzed by LACEN / ES (Central Public Health Laboratory of Espírito Santo), the fluoride concentration was 0.66 mg / L. It was observed that in developing countries, the use of fluoridated water is still needed [29]. Fluoridation of public water supplies is an important means of fluoride use in Brazil, in cities with water treatment (Federal Law 6.050 of 05/24/74) [30]. However, inequalities are still observed, with more intense advancements in the Southern and Southeastern regions of the country, which concentrate most of the country's wealth, being insufficient in the Northern and Northeastern regions [31]. In this context, if CAMBRA could be applied to populations living in those regions where there is no community water fluoridation, the main protective factor would be different from that observed in the present study. The use of fluoride varnish and guidance on hygiene and diet, associated with fluoridated water and use of fluoridated toothpaste are important in the preventive care context [32].

The caries risk was "high" in 38.2% of the sample analyzed, "moderate" in 32.6% and "low" in 29.6% of cases. Thus, individuals with "moderate caries risk" are 14.689 more likely of having caries in dentin and individuals with "high caries risk" are 574.363 more likely than individuals with "low caries risk". Some authors also found that patients were more likely of having caries in dentin when they were classified as "high caries risk" [9]. They also pointed out that CAMBRA is a good clinical tool and easy to be used in daily dental practice, but argue that future studies are needed to determine whether patients who received treatment had lower caries rates after a monitoring period. In the study with children treated at UBS, difficulties for the application of the adapted CAMBRA to assess caries risk were not observed.

Adaptations were made in the form used for the Brazilian population in terms of public health. The bacterial count of *S. mutans* and lactobacilli in saliva was not considered, as there are differences in the microbial composition of saliva and biofilm present on the tooth surface [33,34]. Furthermore, the problems and costs for conducting a large-scale microbiological culture should be emphasized, requiring laboratory infrastructure and human resources, which prevents its

implementation [35]. Among the protective factors, the following items were disregarded: fluoridated toothpaste with 5,000 ppm of daily F, chewing gum or lozenges with xylitol and toothpaste containing calcium and phosphate (CPP-ACP), as they are not usually found in the Brazilian market. Thus, CAMBRA can be applied in different populations with different oral health status, not discouraging its applicability. To date, studies evaluating the CAMBRA in the Brazilian reality have not been found in literature, which led to this preliminary study.

As in this study, some researchers perceived the barriers to bacterial count and inclusion of salivary tests and assessed the caries risk in children using the full and reduced Cariogram® model (without using microbiological and salivary tests) and concluded that it is possible to predict future caries events even when these resources are not available [36].

Limitations of this study included the cross-sectional design, not considering child monitoring and caries risk over time, the possibility of bias of responses obtained in the form by parents / guardians and the lack of inclusion of all factors originally proposed by CAMBRA that could influence the differentiation between "moderate" and "low" caries risk. It is important to remind that when using the adapted CAMBRA in the Brazilian public dental service, professionals must have good sense to establish control and prevention measures of caries in children classified as "moderate" and "low" caries risk such as dietary guidance, use of fluorides and disruption of biofilms. Furthermore, longitudinal and prospective future studies with the use of original and adapted CAMBRA should be carried out.

According to previous report, caries risk assessment should be the basis for planning and treatment, and this evaluation should be routinely incorporated in periodic oral examinations [8]. In addition, intervention covering the combination of actions in multiple aspects of the carious process should be encouraged and monitored by CAMBRA [7]. Considering dental caries as a public health problem, caries risk assessment is of great importance in contemporary dental practice, because it is a disease that can be controlled. Caries risk assessment allows identifying high-risk patients, defining appropriate preventive measures, assisting in the development of the treatment plan and establishing individualized return interval for each patient.

Conclusion

In this study, "high" and "moderate" caries risk classifications identified by adapted CAMBRA were the most observed among children treated at UBS. White spots on smooth surfaces were the most frequent dental caries indicators, and visible biofilm on the tooth surface and community water fluoridation were the most observed risk and protection factors, respectively.

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