Caries increment in Bosnian women associated with caries risk factors according to the Cariogram during pregnancy. A four-year longitudinal study



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DOI 10.23804/ejpd.2022.23.01.13

Abstract

Aim The aim of this study was to determine dental caries increment in women after four years associated with caries risk factors according to the Cariogram during pregnancy.

Materials and methods Study design: The study population consisted of 96 pregnant women between 20 and 42 years of age at the start of the study. After four years, 80 women (83.33% recall rate) were re-examined by the baseline examiner using the same procedure employed at baseline. Caries prevalence was registered according to the WHO criteria and presented by the Decayed Missing and Filled Teeth (DMFT) index. Saliva tests were carried out according to instructions of the manufacturer. Nine factors/variables were entered into the Cariogram to obtain an individual caries risk profile. The chance of avoiding caries was scored into the five Cariogram risk categories.

Results Study participants at higher-risk categories developed more new caries lesions than those at lower risk of caries. Participants with the highest DMFT index according to the Cariogram had the highest caries-related risk factors at baseline, i.e. they had the highest risk for the onset of caries and the highest caries increment after four years.

Conclusion The results suggest that the dental caries increment in women after four years is significantly associated with caries risk factors according to the Cariogram during pregnancy.

KEYWORDS Caries risk factors; Cariogram; Pregnant women; Caries increment; Longitudinal study.

Introduction

Dental caries is a multifactorial disease resulting from a series of chain events that occur where clinical, microbiological, behavioural and social factors are involved [Cagetti et al., 2018]. Due to the change in diet, frequent snacking caused by food craving and oral health negligence, pregnant women are more susceptible to dental caries and gingivitis compared to their non-pregnant counterparts [Wagle et al., 2018]. Several studies reported that bacteria causing caries may have some influence on the pregnancy outcome such as preterm birth and/or low birth weight [Abati et al., 2013; Acharya et al., 2013; Dasanayake et al., 2005; Meurman et al., 2006; Ryalat et al., 2011; Vergnes et al., 2011].

Caries risk assessment is a complex issue because of the multicausal aetiology of caries, numerous and complex relations and interactions between caries risk factors, and dependency of each factor on caries. Nowadays, there are few risk models based on a multifactorial concept [Cagetti et al., 2018; AAPD, 2019]. One of them is Cariogram, a free algorithm software (available on line) based on nine caries-related risk factors. The Cariogram has been used to assess caries risk profiles of preschool children [Gao et al., 2013; Kavvadia and Agouropoulos, 2012], schoolchildren [Campus et al., 2012; Petersson et al., 2010], teenagers, young adults [Cabral et al., 2014; Petersson et al., 2013] and elderly patients [Petersson et al., 2003]. Most research studies are cross-sectional studies although the accuracy of prediction models must be determined in longitudinal studies [Cagetti et al., 2018]. Previous longitudinal studies using the Cariogram were one to two years long [Cagetti et al., 2018; Campus et al., 2012; Gao et al., 2013; Petersson et al., 2010], while only few studies were three [Zukanovic, 2013; Petersson and Twetman, 2015] and five years long [Petersson et al., 2003, 2004]. Most longitudinal studies using the Cariogram were first tested on children [Campus et al., 2012; Gao et al., 2005, 2013; Petersson et al., 2004, 2010; Zukanovic, 2013], and then on adults [Celik et al., 2012; Petersson et al., 2003, 2004; Petersson and Twetman, 2015]. Caries risk assessment has a great potential for improving patient care and for planning a minimally invasive care and recall strategy. This is especially important for pregnant women since preventive measures in dental care should start with generation zero, i.e. pregnant women.

The aim of this study was to determine the dental caries increment in Bosnian women after four years associated with caries risk factors according to the Cariogram during pregnancy.

Materials and methods

This longitudinal study was conducted as a follow-up of a randomised control study previously conducted by Dolic et al. [2017]. The study population consisted of 96 pregnant women between 20 and 42 years of age (average age 27.4 ± 7.2 years)

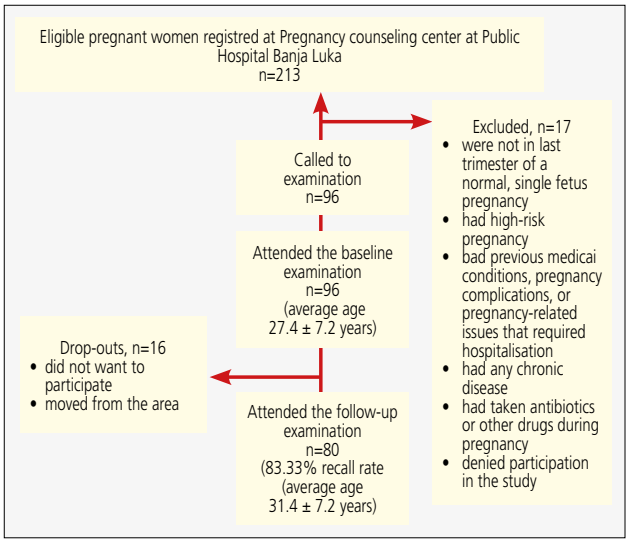


FIG. 1 Flow chart indicating participants and drop-outs.

at the start of the study who were recruited at the Pregnancy Counseling Center of the Public Hospital in Banja Luka, Bosnia and Herzegovina.

Additional details on selection of the baseline material as well as its characteristics have been published earlier [Dolic et al., 2017, 2020]. After four years, 80 women (83.33% recall rate) were re-examined by the baseline examiner using the same procedure employed at baseline. The intra-examiner test and reliability were published earlier [Dolic et al., 2020]. A flow chart presenting the main reasons for drop-out is available in Figure 1. All participants were resident in areas with low natural fluoride level in drinking water (<0.30 mg/l).

The research was conducted in accordance with the 1964 Helsinki declaration and its subsequent amendments or comparable ethical standards. Approval for the study was obtained from the Research Committee of the Faculty of Medicine at the University of Banja Luka, Bosnia and Herzegovina (approval number: 0602-350/07). All participants gave their formal consent before taking part in the study.

A trained and calibrated dental examiner conducted clinical examinations under optimal light in the morning between meals and at least one hour after a meal and after teeth brushing. Data about general health and medication, diet and oral hygiene habits including teeth brushing frequency and use of fluoride were collected through a structured questionnaire for calculation of the individual's caries risk assessed by the Cariogram. Caries prevalence was registered according to the World Health Organization (WHO) criteria [1987] and presented by the Decayed Missing and Filled Teeth (DMFT) index. Caries lesions were determined using standard clinical criteria, a dental mirror and a probe while opacity with or without roughness was the standard applied for the incipient carious lesion. Saliva tests (saliva buffer capacity, Lactobacillus, and Mutans streptococci counts) were obtained from Orion Diagnostica (Espoo, Finland, and handled as per instructions of the manufacturer. Paraffin-stimulated whole saliva was collected over the period of five minutes for the purpose of estimation of excretion rate and shown as ml/min.

In order to obtain the individual caries risk profile, nine factors/variables (caries experience; related diseases; food content based on Lactobacillus test counts; frequency of food intake based on estimated number of meals and snacks per day; dental plaque amount; Mutans streptococci; fluoride regimen based on fluoride exposure; salivary excretion; saliva buffering capacity) were entered into the Cariogram. The chance of avoiding caries was scored into the five Cariogram risk categories: very high risk = 0–20% chance to avoid caries; high risk = 21–40% chance to avoid caries; moderate/medium risk = 41–60% chance to avoid caries; low risk = 61–80% chance to avoid caries; and 'very low risk' = 81–100% 'chance to avoid caries.

The results of the Cariogram risk assessment were not shared with the participant's dentist.

The difference between the caries status at baseline and after four years was assessed and statistically analysed. All data were processed using the SPSS software (version 16.0, Chicago Ill., USA). The X^2 test of contingency was used to compare the differences between groups. The parametric ANOVA and the Student's test for independent samples (if the difference in the variation of the observed characteristics was statistically insignificant) and the nonparametric Mann-Whitney test (if the difference in the variation of the observed characteristics was statistically significant) were used to compare the mean values of the characteristics. Descriptive statistics (Mean; Std. Deviation; ± 95,00%; Minimum; Maximum) of all caries-related factors were calculated for all caries-related groups.

Results

Table 1 shows the four-year mean caries increment (Δ) presented in the five Cariogram categories. As expected, participants at higher-risk categories developed more new caries lesions than those at lower risk of caries. The differences in the mean DMFT between the two study periods were statistically insignificant for very low-risk individuals. On the other hand, this difference was statistically significant for low-risk individuals and very statistically significant for other risk categories.

Table 2 shows the caries increment in women associated with the caries risk factors according to the Cariogram during

Risk group at the baseline	Mean caries increments (Δ)							
	ΔDMFT	SD	p	Minimum	Lower quartile	Median	Upper quartile	Maximum
Very high risk	2.92	2.02	0.000	0	1	3	5	5
High risk	1.83	1.24	0.000	0	1	2	3	4
Medium risk	1.44	1.34	0.000	0	1	1	2	5
Low risk	1.08	1.71	0.042	0	0	0	2	6
Very low risk	0.75	1.22	0.056	0	0	0	1	4
Σ	1.64	1.60	0.000	0	0	1	3	6

SD = standard deviation; p < 0.05, statistically significant

TABLE 1 Mean caries increments (Δ) over 4 years expressed as mean DMFT in the various Cariogram risk categories.

Factors by Cariogram for pregnant women	Score	X1	X2	X1- X2	SD	p	95% CI	
Caries experience	1: better than normal condition for ages	12.86	14.10	-1.24	1.58	0.002	-1.96	-0.52
	2: normal condition for ages	14.07	15.07	-1.00	1.47	0.024	-1.85	-0.15
	3: worse than normal condition for ages	17.69	19.71	-2.02	1.57	0.000	-2.50	-1.55
Diet, Lactobacillus counts	1: 10^4–10^5 CFU/mL	11.82	12.64	-0.82	1.25	0.055	-1.66	0.02
	2: 10^5 CFU/mL	15.60	17.19	-1.60	1.40	0.000	-1.99	-1.21
	3: >10^6 CFU/mL	18.94	21.24	-2.29	2.11	0.000	-3.38	-1.21
Diet, frequency	0: maximum 3 meals per day	12.87	14.00	-1.13	1.68	0.021	-2.07	-0.20
	1: 4–5 meals per day	15.55	16.89	-1.34	1.20	0.000	-1.71	-0.98
	2: 6–7 meals per day	17.40	19.50	-2.10	1.60	0.002	-3.24	-0.96
	3: > 7 meals per day	19.27	22.36	-3.09	2.12	0.001	-4.51	-1.67
Plaque amount	0: PI < 0.4 (very good oral hygiene)	12.47	13.27	-0.80	1.21	0.022	-1.47	-0.13
	1: PI = 0.4–1.0 (good oral hygiene)	13.60	14.93	-1.33	1.91	0.017	-2.39	-0.27
	2: PI = 1.1–2.0 (poor oral hygiene)	16.75	18.64	-1.89	1.47	0.000	-2.39	-1.39
	3: PI > 2 (very poor oral hygiene)	19.21	21.43	-2.21	1.67	0.000	-3.18	-1.25
Mutans streptococci	0: < 10^4/ml	8.50	8.75	-0.25	0.50	0.391	-1.05	0.55
	1: 10^4 – 10^5/ml	14.04	15.20	-1.16	1.49	0.001	-1.78	-0.54
	2: 10^5 – 10^6/ml	16.53	18.24	-1.71	1.33	0.000	-2.15	-1.27
	3: > 10^6/ml	19.23	22.00	-2.77	2.09	0.000	-4.03	-1.51
Fluoride program	0:maximum fluoride program	14.67	15.33	-0.67	1.15	0.423	-3.54	2.20
	1: fluoride supplements	14.73	15.95	-1.23	1.48	0.001	-1.88	-0.57
	2. only fluoride toothpaste	16.27	18.13	-1.85	1.64	0.000	-2.30	-1.41
Saliva secretion	0: > 0.7 ml/min.	15.51	17.10	-1.58	1.54	0.000	-1.94	-1.22
	1: 0.3–0.7 ml/min.	18.25	20.38	-2.13	2.17	0.028	-3.94	-0.31
Saliva buffering capacity	0: pH > 5.5 (blue)	12.73	14.00	-1.27	1.64	0.000	-1.88	-0.65
	1: pH = 4.5–5.5 (green)	16.76	18.14	-1.38	1.16	0.000	-1.91	-0.85
	2: pH < 4.5 (yellow)	18.24	20.45	-2.21	1.72	0.000	-2.86	-1.55

*PI = Silness–Loe plaque index; *p < 0.05, statistically significant; CI = confidence interval; X1- mean DMFT of pregnant women (at baseline); X2- mean DMFT follow up; SD = standard deviation*

TABLE 2 Caries increment in women related to caries risk factors assessed by Cariogram during pregnancy.

pregnancy. Participants with the highest DMFT index according to the Cariogram had the highest caries-related risk factors at baseline, i.e. they had the highest risk for the onset of caries and the highest caries increment after four years.

The differences in the arithmetic mean DMFT compared with the two study periods were statistically significant for each count of the caries level during pregnancy. The differences in the arithmetic mean DMFT compared to the two study periods were very statistically significant ($p < 0.01$) for the Lactobacillus counts higher than 10^5 (answers 2 and 3), for the Mutans streptococci counts higher than 10^4 (answers 1, 2 and 3), for using fluoride toothpaste and for additional fluoride measures (answers 2 and 3) as well as for all counts of saliva buffering capacity during pregnancy (answers 0, 1 and 2). The results were statistically significant ($p < 0.05$) for all counts of food intake frequency, plaque status and saliva excretion during pregnancy. There was no significant increase of the DMFT for the Lactobacillus counts from 10^4 to 10^5 (answer 1), for the Mutans streptococci counts lower than 10^4 and for maximum fluoride exposure (answer 0) during pregnancy.

Discussion

Oral health of pregnant women is an important aspect of their well-being and quality of life. Untreated dental caries associated with discomfort/pain can affect pregnancy and fetus. It would be ideal if pregnant women maintained a healthy oral cavity and if future pregnant women were included in the preventive dental treatment before the start of pregnancy. Unfortunately, this is often not possible because of objective or subjective reasons. Caries risk assessment in pregnant women is particularly important for planning individual preventive and therapeutic procedures that could be carried out during an appropriate period of pregnancy with the aim of minimising caries risk in pregnant women.

Studies on the caries risk assessment in pregnant women are more complex than in children. Unfortunately, many pregnant women do not think that oral health is important during pregnancy. Moreover, it is difficult to keep the study group together for several years. Even if women understand the importance of oral health during pregnancy, they often neglect it after childbirth because of the care for offspring.

According to the Cariogram, most participants in this study were at high risk of caries. It was difficult to compare the results of this research study with other studies because there are no Cariogram risk studies conducted on pregnant women. Celik et al. [2012] reported that the majority of Turkish adults (20–21 years old) had medium and low risk of caries (33% and 24%, respectively) [Gökalp et al., 2010]. The study on adult population in Saudi Arabia showed high prevalence rates of caries risk in adults with several dental restorations [Sonbul et al., 2008].

As seen in Tables 1 and 2, the actual caries counts increased significantly with the increasing risk category which was similar to other studies in young adults. In the five-year study, Petersson et al. [2004] found a higher mean of caries increment per year for at-risk adults/elderly groups. In the first instance, the Cariogram was used in the assessment of a group of 19-year-olds. After

three years participants with the highest risk profile had about seven times more caries lesions compared to those in the lowest risk group [Petersson and Twetman, 2015]. Furthermore, the Cariogram was assessed in a sample of 20- or 21-year-old adults. After two years participants classified at extremely high risk at baseline developed about twice as much caries lesions as those classified at extremely low risk [Celik et al., 2012]. Similar to this study, all previously mentioned studies used the entire Cariogram with the nine caries-related factors. Some studies included factors like Mutans streptococci, Lactobacilli, saliva excretion rate and buffer capacity. Nevertheless, with the exception of one study [Lee et al., 2013], reduced Cariogram versions were significantly associated with caries data in both cross-sectional and longitudinal studies [Cagetti et al., 2018; Petersson et al., 2013; Giacaman et al., 2013].

Individual factors which did not significantly contribute to caries increment in this study include the maximum fluoride program and the lowest counts of Mutans streptococci and Lactobacilli. All other individual factors contributed significantly to caries increment after four years. Celik et al. [2012] found that plaque amount, food intake frequency and saliva excretion were significantly associated with the caries progression in a group of young people. Compared to the study presented in this paper, this discrepancy can be explained by the fact that certain risk factors can be expressed differently depending on the age group. This may be due to the food intake frequency, salivary excretion rate or plaque volume.

It remains a challenge to find the right caries risk assessment for the right age group. At present, all cross-sectional and longitudinal studies, and published reviews have followed different models for the caries risk assessment in different age groups. As a result, study design and outcome measurements have not been standardised yet. A 2018 review of 32 studies (16 on children, 12 on adults and 4 on both groups) evaluated several caries assessment models including Cariogram, Association of Paediatric Dentistry Caries Assessment Tool (AAPD CAT), Caries Management by Risk Assessment (CAMBRA) or PreViser measuring actual caries status and/or caries increment. The authors found that the Cariogram was the only caries risk assessment model used in studies of good quality to assess its efficacy in prediction of caries development. On the other hand, due to the lack of study evidence it was not possible to determine the effectiveness of other standardised Caries Risk Assessment (CRA) models [Cagetti et al., 2018].

This study was limited by a relatively small sample size which was the consequence of the study inclusion criteria and small number of pregnant women in the region of Banja Luka, Bosnia and Herzegovina. The main reason for the use of the Cariogram in this study as well as the strength of the study lie in the findings about the importance of oral health during pregnancy and its potential impact on pregnancy outcomes. Another important aspect is the benefit for newborns. Identification of pregnant women at high risk of caries is fundamental for the prevention of vertical colonisation of Streptococcus mutans from mother to child, which among other risk factors is an important factor for the development of caries in children.

Conclusion

Acknowledging the limitations of this longitudinal study, the results suggest that the caries increment in women after four years is significantly associated with caries risk factors according to the Cariogram during pregnancy.

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