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Association of clinical parameters, oral hygiene, and dietary practices with active caries lesions among children with early childhood caries

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ORIGINAL RESEARCH

Association of Clinical Parameters, Oral Hygiene, and Dietary Practices with Active Caries Lesions among Children with Early Childhood Caries

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Abstract

Aim: To find whether there is an association of clinical parameters, dental attendance pattern, oral hygiene, and dietary practices with the presence of active caries lesions among children with early childhood caries (ECC).

Materials and methods: In this cross-sectional study, 171 children of 3–5 years of age with at least one decayed/filled tooth surface were examined. The presence or absence of visible plaque and decayed, missing, or filled-surface (dmfs) score were recorded. Each tooth surface was scored as per International Caries Detection and Assessment System (ICDAS) II criteria followed by supplemental lesion activity assessment (LAA) criteria, which was used to classify the lesions as active/inactive. A structured questionnaire regarding oral hygiene, dietary practices, and dental visit frequency was filled by parents of the children.

Results: Of the 740 surfaces examined, 82.6% were active caries lesions. Previous dental visit, sweet score, presence of visible plaque, and ICDAS score above 4 were significantly associated with active carious surfaces.

Conclusion: Factors associated with active caries lesions are the presence of visible plaque on the tooth surface, cavitation extending to dentin, and higher frequency of sugar consumption by the child.

Clinical significance: Improper oral health practices can contribute to the activity of the caries lesions. Parental education on oral health practices, particularly plaque control measures, decreasing sugar exposures in the diet, and regular visits to the dentist for completion of the restorative therapy may help to render the lesions inactive.

Keywords: Child, Dental caries activity, Preschool, Risk factors.

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Introduction

Early childhood caries (ECC) which is defined as "the presence of one or more decayed (non-cavitated or cavitated lesions), missing (due to caries), or filled tooth surfaces in any primary tooth in a child under the age of six,"[1] is a disease that not only affects the oral health of the child but also has an impact on the overall quality of life of the children and their parents.[2]

Early childhood caries is known to be a disease of multifactorial etiology, with a complex interaction among biological, social, and behavioral risk factors.[3] Hence, management of this condition includes preventive measures to control the risk factors.[2] Clinically, caries lesions can be categorized as active or inactive lesions. A lesion with an ongoing mineral loss owing to metabolic changes in the plaque biofilm is designated as caries active. Assessment of caries activity of the lesion aids in guiding the treatment plan and predicting its prognosis.[4] A targeted approach toward active carious lesions in the management of ECC should be a clinician's priority as these lesions are highly progressive.[5] It is, therefore, important to assess the risk factors associated with the activity of caries lesion. The role of oral health practices such as oral hygiene, dietary practices, and dental attendance pattern which are known to influence the occurrence of ECC,[6] in the activity of caries lesions is not established. In addition, clinical parameters such as plaque levels and severity of the lesion can influence the activity of the caries lesion.[5] The plaque biofilm is known to play an important role in dental caries. The bacterial composition of the plaque biofilm may vary depending on whether the lesion is cavitated or non-cavitated, extending to enamel or dentin.[7] Knowledge regarding the level of active caries lesions in a given population and the risk factors which render the lesion active will help to develop a targeted intervention and prevention plan for the child patients to render the existing caries lesions inactive.[5,8]

Hence, this study was carried out to find whether there is an association of clinical parameters such as plaque and severity of the caries lesions; oral health practices such as dental attendance pattern; oral hygiene; and dietary practices with the presence of

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active caries lesions among children with ECC. In addition, the study also aimed to determine the proportion of active caries lesions among children with ECC.

Materials and Methods

It was a cross-sectional study involving children of kindergarten schools of Mangaluru city, in the Dakshina Kannada district of Karnataka, India. The study was carried out over a period of 3 months between June 2016 and August 2016.

The sample size was calculated as 684 carious tooth surfaces, assuming the presence of active lesions in 54%[5] of the population and 5% error, at 95% confidence interval. Assuming the presence of an average of four caries surfaces per child[9] and all primary teeth are present in the population to be studied, the number of children to be examined was determined as 171.

Children aged 3–5 years with one or more decayed (cavitated or non-cavitated) tooth surfaces in any primary tooth were included. Children with syndromes or chronic systemic diseases, lack of cooperative behavior during examination, at least one missing primary tooth, and whose parents did not consent for the study were excluded.

Institutional Ethics Committee approval was obtained prior to the onset of the study (letter ref.: MCODS/16028 dated May 14, 2016, issued by Institutional Ethics Committee, Manipal College of Dental Sciences, Mangaluru). A written permission was obtained from school authorities prior to the study. A written informed consent was obtained from parents or guardians of the children prior to their participation in the study. The study was carried out in accordance with the ethical standards as laid down in the 1964 Declaration of Helsinki and its later amendments.

A list of kindergarten schools in the city of Mangaluru was drawn, and two kindergarten schools were selected using simple random sampling technique. A total of 500 informed consent forms were distributed in the kindergarten classes of both the schools, and 270 parents agreed to participate. In total, 171 children were selected after screening for inclusion and exclusion criteria.

Survey Procedure

The oral examinations were done in the respective schools using a focusable flashlight. The child was made to lie down on a table, while the examiner was positioned behind the child's head. The instruments used during examination included mouth mirror, gauze, and World Health Organization (WHO) probe. Standard universal precautions for infection control were taken during examination of each child. Examination included recording of decayed, missing, or filled-surface (dmfs) index.[10] The presence/absence of visible plaque on all the surfaces of decayed teeth was recorded by visual examination of the teeth.[11]

Each tooth surface was then scored as per ICDAS II coding which gives the extent of severity of caries lesions.[12,13] The ICDAS II scores were classified based on their severity as enamel lesions (codes 1–3) and dentinal lesions (codes 4–6).[14] The tooth surface was then given a score by the supplemental LAA criteria to assess the activity of the carious surfaces.[15] A chairside assistant recorded the scores as per the examiner's observations.

The LAA is a summation of three clinical parameters associated with the lesion: (i) clinical appearance (ICDAS II), categorized as brown, white, or cavitated lesion; (ii) caries surface present in a plaque stagnation/non-plaque stagnation area; and (iii) texture of the caries surface characterized as rough/soft or smooth/hard as felt by the ball-ended WHO probe. Each clinical parameter was given a point, and a total of the scores for the three clinical parameters was obtained. Any decayed surface with a score of 4–7 was described as caries inactive. Surfaces with a sum of greater than 7 were described as caries active.[13,15]

All examinations were done by two trained examiners. Training was done using the ICDAS criteria manual[16] and an e-learning program at https://www.iccms-web.com, carried out all examinations. In addition, clinical examination of 10 children with caries lesions (not involved in the study) was carried out until a good inter-examiner agreement was reached. The differences were discussed and sorted out using clinical photographs of the caries lesions. Ten randomly selected children were examined twice by the examiners for inter-examiner reproducibility during the course of the study. Intra-examiner reliability was checked for every tenth child during the study. Intra- and inter-examiner reproducibility was assessed using Cohen's κ statistics. The κ coefficient for inter-examiner reproducibility was 0.91, while the intra-examiner weighted κ values were 0.87 and 0.83.

Parents of the children were asked to complete a structured questionnaire covering oral hygiene practices, dietary practices, and dental attendance pattern. The reliability and validity of the questionnaire was tested prior to the study. Prior to administration, the test–retest reliability of the questionnaire was assessed by administering the questionnaire to 10 parents who were not part of the study. Retest was done after 1 week from the day of initial administration of the questionnaire. The questionnaire was examined for validity by two subject experts. The test–retest reliability values were in the range of 0.8–1.

Questionnaires were distributed to the children, in the school, to be filled by parents at home in a period of 3 days. Any incompletely filled forms were returned to the parents requesting for completion, so that all the questionnaires were fully completed. To evaluate the association between dietary habits and active caries surfaces, a 24-hour diet chart was given to parents. Appropriate instructions were provided to write everything consumed at each meal and between the meals. The sugary items consumed were categorized into liquids (like beverages), solid and sticky foods (like cakes), and slowly dissolving foods (like candies). Each sugar exposure was then multiplied by 5 for liquids, 10 for solid and sticky, and 15 for slowly dissolving foods. A sweet score was then obtained by adding the values obtained for each category. A sweet score of 5 or less was designated as "Excellent," a score of 6–10 as "Good," while a score of 15 or above belonged to the "watch out zone." Thus, Excellent score indicated low frequency of consumption of sugar-containing foods.[17]

Statistical Analysis

Data were analyzed using Statistical Package for Social Science (SPSS), version 17 software (SPSS, Inc., Chicago, IL, USA). Descriptive statistics were calculated. Chi-square test was applied to know the association of the factors with the presence of active caries lesions, as a part of univariate analysis. Factors found to be significant in the univariate analysis were entered into the multivariate logistic regression analysis to know the association of the dependent variable with independent variables, when presented simultaneously. Odds ratio was determined at 95% confidence interval, and for both the tests, $p < 0.05$ was considered significant.

Results

A total of 740 carious tooth surfaces (502 teeth) of 171 children were examined in the study. The sample consisted of 65 boys

and 106 girls. The mean age of the study population was 4.6 years. There was no statistically significant association of age and gender with the presence of active caries surfaces (Table 1). The proportion of active caries surfaces in the study population was found to be 82.6% (624 surfaces).

Oral Hygiene Practices

Most of the children brushed two times a day using a toothbrush (99%), of which majority (98%) were supervised by adults. Brushing teeth twice a day or more, use of fluoridated toothpaste and regular nighttime brushing were statistically significantly more among children with active caries surfaces. Majority of the parents reported being unaware of the presence of fluoride in their children's toothpaste (Table 2).

Feeding/Dietary Practices

Most of the children were breast-fed during infancy. Method of feeding the child (bottle-fed or breast-fed) and use of bovine milk with sugar or sweetened fruit juice as the feeding drink just before the child fell asleep were statistically significantly associated with active caries surfaces. The frequency of consumption of sugar-containing food as assessed using sweet score was also found to be significantly associated with active caries surfaces. The percentage of active caries surfaces was higher among children in the "watch out zone." Majority of the parents reported that their child was breast- or bottle-fed up to more than 1 year of age. No statistically significant association was found between duration of feeding and active caries surfaces (Table 3).

Dental Attendance Pattern

The percentage of children who had previously visited the dentist was significantly higher among those with active caries surfaces. Fluoride application by the dentist did not show any statistically significant association with the presence of active caries surfaces. More than 80% never underwent any fluoride application by the dentist (Table 4).

Clinical Parameters

The presence of visible plaque on the tooth surface was significantly associated with active caries surfaces. Also, the degree of severity of caries lesion as given by the ICDAS score was significantly associated with active caries surfaces. Majority of dentinal lesions (ICDAS II codes 4–6) were found to be caries active, while the number of inactive caries lesions was significantly higher among enamel lesions (ICDAS II codes 1–3) (Table 5).

Multivariate Logistic Regression Analysis

A test of the full model against constant-only model was statistically significant, indicating that the predictors as a set reliably distinguished between the active and inactive carious surfaces (Chi-square = 429.98, $p < 0.001$; df = 10). Nagelkerke R^2 of 0.759 indicated a strong relationship between the independent variables and active caries lesions. Prediction success overall was 94.1% (83.6% for

Table 1: Comparison of age and gender with the presence of active/inactive caries surfaces

		Inactive surfaces (%)	*Active surfaces (%)*	*Total (%)*	*Chi-square*	*p value*
Child's age	3 years	2 (1.7)	19 (3.0)	21 (2.8)	0.858	0.651
	4 years	48 (41.4)	240 (38.5)	288 (38.9)		
	5 years	66 (56.9)	365 (58.5)	431 (58.2)		
Gender	Male	35 (30.2)	155 (24.8)	190 (25.7)	1.458	0.227
	Female	81 (69.8)	469 (75.2)	550 (74.3)		
Total		116 (100)	624 (100)	740 (100)		

Table 2: Comparison of oral hygiene practices with the presence of active/inactive caries surfaces

		Inactive surfaces (%)	*Active surfaces (%)*	*Total (%)*	*Chi-square*	*p value*
Brushing performed by	Adult or others	54 (46.6)	293 (47.0)	347 (46.9)	0.006	0.936
	Child	62 (53.4)	331 (53.0)	393 (53.1)		
Brushing supervised by adults	Yes	114 (98.3)	611 (97.9)	725 (98.0)	0.064	0.801
	No	2 (1.7)	13 (2.1)	15 (2.0)		
Frequency of brushing	2 or more times a day	38 (32.8)	317 (50.8)	355 (48.0)	12.758	<0.001*
	Less than 2 times a day	78 (67.2)	307 (49.2)	385 (52.0)		
Presence of fluoride in toothpaste	Yes	24 (20.7)	181 (29.0)	205 (27.7)	13.505	<0.001*
	No	18 (15.5)	160 (25.6)	178 (24.1)		
	Don't know	74 (63.8)	283 (45.4)	357 (48.2)		
Age at which brushing was initiated	<1 year	15 (12.9)	92 (14.7)	107 (14.5)	0.260	0.610
	>1 year	101 (87.1)	532 (85.3)	633 (85.5)		
Regular brushing at night	Yes	49 (42.2)	381 (61.1)	430 (58.1)	14.227	<0.001*
	No	67 (57.8)	243 (38.9)	310 (41.9)		
Device used for brushing	Toothbrush	116 (100.0)	617 (98.9)	733 (99.1)	1.314	0.252
	Finger or others	0 (0.0)	7 (1.1)	7 (0.9)		
Total		116 (100.0)	624 (100.0)	740 (100.0)		

*$p < 0.05$: significant

Table 3: Comparison of dietary practices with the presence of active/inactive caries surfaces

		Inactive surfaces (%)	*Active surfaces (%)*	*Total (%)*	*Chi-square*	*p value*
Method of feeding	Breast-fed	64 (55.2)	380 (60.9)	444 (60.0)	9.421	0.009*
	Bottle-fed	3 (2.6)	54 (8.7)	57 (7.7)		
	Both	49 (42.2)	190 (30.4)	239 (32.3)		
Feeding duration	Less than 1 year	15 (13.0)	65 (10.5)	80 (10.9)	0.655	0.418
	More than 1 year	100 (87.0)	555 (89.5)	655 (89.1)		
Feeding drink with which child feel asleep in infancy	Formula milk in bottle	12 (10.3)	60 (9.6)	72 (9.7)	12.356	0.006*
	Milk without sugar in bottle	13 (11.2)	110 (17.6)	123 (40.0)		
	Milk with sugar/ sweetened fruit juice in bottle	27 (23.3)	74 (11.9)	111 (49.2)		
	Breast milk	64 (55.2)	380 (60.9)	444 (60.0)		
Sweet score	Excellent or good	12 (10.3)	28 (4.5)	40 (5.4)	6.564	0.010*
	Watch out zone	104 (89.7)	596 (95.5)	700 (94.6)		
Total		116 (100.0)	624 (100.0)	740(100.0)		

*$p < 0.05$: significant

Table 4: Comparison of dental attendance pattern with the presence of active/inactive caries surfaces

		Inactive surfaces (%)	*Active surfaces (%)*	*Total (%)*	*Chi-square*	*p value*
Visited dentist	Yes	40 (34.5)	290 (46.5)	330 (44.6)	5.693	0.017*
	No	76 (65.5)	334 (53.5)	410 (55.4)		
Fluoride application by dentist	Yes	13 (11.2)	111 (17.8)	124 (16.8)	3.038	0.081
	No	103 (88.8)	513 (82.2)	616 (83.2)		
Total		116 (100.0)	624 (100.0)	740 (100.0)		

*$p < 0.05$: significant

Table 5: Comparison of clinical parameters with the presence of active/inactive caries surfaces

		Inactive surfaces (%)	*Active surfaces (%)*	*Total (%)*	*Chi-square*	*p value*
Presence of plaque on tooth surface	Plaque absent	90 (77.6)	286 (45.8)	376 (50.8)	39.459	<0.001*
	Plaque present	26 (22.4)	338 (54.2)	364 (49.2)		
Depth of lesion-ICDAS score	Enamel lesion	114 (98.3)	63 (10.1)	177 (23.9)	4.180	<0.001*
	Dentin lesion	2 (1.7)	561 (89.9)	563 (76.1)		
Total		116 (100.0)	624 (100.0)	740 (100.0)		

*$p < 0.05$: significant

inactive caries lesions and 96% for active caries lesions). The results of the regression analysis showed that previous dental visits and sweet score in the watch out zone were significantly associated with active caries surfaces. Among the clinical parameters, the presence of visible plaque on the tooth surface and dentinal cavitated lesions (ICDAS II codes 4–6) resulted in higher odds of having active caries surfaces (Table 6).

Discussion

International Caries Detection and Assessment System was developed as a visual criterion to standardize caries detection procedures.[12,13] ICDAS criteria have been used for caries diagnosis in clinical practice, research work, and epidemiological surveys. A scoring criterion was added to the ICDAS II system for assessment of lesion activity. The system is referred to as ICDAS-LAA system.[13] This system is shown to have good reliability and validity.[5] Hence, this system was used to study the factors associated with lesion activity.

The results of this study showed that the presence of visible plaque on the tooth surface and cavitated dentinal lesions are associated with active caries surfaces. The cavitated caries lesions are not amenable to proper oral hygiene maintenance by the patient, thereby harboring plaque on their surface. The progression of caries lesions occurs due to the presence of bacterial plaque in these plaque harboring sites.[18] They provide a suitable niche for microorganisms to thrive and contribute to lesion activity. Persistence of microorganisms results in successive pH drops at the tooth plaque interface, resulting in lesion progression.[7,19] It is notable that oral hygiene habits such as twice or more frequency of brushing and regular nighttime brushing were high among children with active caries lesions, as revealed by the univariate analysis in this study. Regular brushing results in the disturbance of the established plaque and hence should lead to decreased caries activity.[20] However, in this study, as most of the active caries surfaces were cavitated, they served as plaque stagnation areas rendering the toothbrushing ineffective in decreasing plaque. The severity of lesion is an important consideration for the management

Table 6: Multivariate analysis depicting odds ratio between active and inactive carious lesions

Variable		*Wald value*	*Odds ratio*	*Confidence interval*	*p value*
Frequency of brushing	2 or more times daily (ref.)				
	Less than twice daily	0.37	1.39	4.01–0.48	0.543
Fluoride in toothpaste	Yes (ref.)				
	No	0.18	1.29	3.29–0.47	0.668
	Don't know	1.44	1.38	3.59–0.53	0.509
Method of feeding	Breast-fed (ref.)				
	Bottle-fed	0.31	0.73	2.18–0.25	0.577
	Both	1.48	3.22	21.17–0.49	0.223
Bottle-feed drink with which child falls asleep	Formula milk/milk without sugar/breast-fed (ref.)				
	Milk with sugar/juice	0.07	1.22	5.14–0.29	0.788
Frequency of dental visit	Never visited dentist (ref.)				
	Visited dentist	4.03	0.39	0.98–0.16	0.045*
Sweet score	Excellent or good (ref.)				
	"Watch out" zone	5.76	4.95	18.27–1.34	<0.001*
Plaque present on surface	Absent (ref.)				
	Present	20.6	6.84	15.71–2.98	<0.001*
Depth of lesion (as per ICDAS score)	Enamel lesion (scores 1–3) (ref.)				
	Dentin lesion (scores 4–6)	98.91	9.64	15.06–1.06	<0.001*
Nighttime brushing	Yes (ref.)				
	No	0.03	1.1	3.20–0.38	0.862

*$p < 0.05$: significant

of active carious lesion.[15] Active dentinal lesions (ICDAS codes 4–6) require operative management such as restorative treatment, while active enamel lesions (ICDAS codes 1–3) can be managed by a preventive/nonoperative approach such as oral prophylaxis, pit and fissure sealant, and fluoride varnish application.[15,21] This underlines the need for regular dental visits by the patient for restorative treatment.

In a previous *in vivo* study, where the association of various parameters related to children and their teeth with the activity of occlusal caries lesions was evaluated, children who had visited dentist previously had less number of active caries lesion.[5] In this study, a higher proportion of children with active caries lesions had visited the dentist earlier. A possible reason for this could be easy recognition of cavitated lesion by the parent, which is often associated with symptoms leading to the initial dental visit. The restorative therapy to be provided by the dentist for the management of these lesions could lead to further dental visits.[22] Visiting dentist only when a complaint arises is a common behavior seen among children with ECC.[6] In this study population, most of the inactive lesions were early enamel lesions and were not recognized by parents, resulting in no dental visits by these children.

Another factor contributing to active caries lesions is the sweet score of the diet being in the "watch out zone," as per the results of this study. Frequent sugar exposure, especially to sticky foods, leads to accumulation of mutans streptococci and lactobacilli on the tooth surface, thereby aiding in progression of the lesion.[19] The proportion of active caries surfaces in the study population was found to be as high as 82.6%. The proportion of active caries lesions has also been found to be high in earlier epidemiological surveys.[8,15] Most of the cavitated dentinal lesions were active, as cavitated lesions do not facilitate biofilm removal. However, enamel lesions are mostly non-cavitated and facilitate plaque removal.[8]

The results of the study highlight that certain improper oral health practices can contribute to the activity of the caries lesions. The risk factors associated with the activity of caries lesions among children with ECC, as observed in this study, may be targeted by the clinician during the management of children with ECC. Hence, parental education to increase the awareness about oral health practices, particularly plaque control measures, decreasing sugar exposures in the diet, and regular visits to the dentist for completion of the restorative therapy, should be done by the dentist during the initial visit of the patient with ECC. It should be stressed on by the dentist that these factors not only cause dental caries but also contribute to their progression.

Considering the pattern of coding of ICDAS II, which relies on clinician's visual and tactile examination skills, there exists a possibility for subjectivity in identifying the state of the lesion.[13] Hence, the examiners were thoroughly trained and calibrated, prior to the onset of the study. The cross-sectional frame of the study, which does not give a temporal cause and effect relationship, limits the results of this study. An inherent recall bias associated with the responses of the parent to the questionnaire is also a limitation.[23] Further studies with analytical design may confirm the results of this study.

Conclusion

Within the limitations of this study, it can be concluded that caries lesions in the teeth with visible plaque on their surfaces and cavitated lesions extending to dentin are likely to be active caries lesions. Higher frequency of sugar consumption in the diet is also associated with active caries lesions.

Author Contributions

Dr Shailja Datta, Dr Suprabha BS, and Dr Ramya Shenoy formulated the concept and design of this study and carried out the acquisition, analysis, and interpretation of the data. Dr Shailaja Datta and Dr Suprabha BS drafted this article. Dr Arathi Rao and Dr Ramya Shenoy revised it critically for intellectual content. Dr Suprabha BS gave the final approval of the version to be published.

This manuscript has been read and approved by all the authors, the requirements for authorship as stated in instructions to authors have been met, and each author believes that the manuscript represents honest work.

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