Implementing the American Dental Association's Caries Risk Assessment Tool in a Developing Country - A Cross-Sectional Study.

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Abstract -
Introduction – Detection of onset of dental caries at an early age is necessary to prevent further tooth decay and consequent complications. Among several models available for identifying individuals with dental carries in near future, the American Dental Association (ADA) Caries risk assessment (CRA) questionnaire provides a simple yet effective approach without the need of special tools to identify dental caries risk. The purpose of this study was to categorize selected patients into the three different risk categories (high, moderate, and low risk) by using the ADA CRA forms for two groups: 0-6 years and above 6 years of age.
Method: A cross sectional study was carried out among selected patients from various
pediatric clinics in Mumbai, India, with 50 patients in 0-6 years and 58 patients
above 6 years. The ADA questionnaire was used for collection of demographic data along with information on fluoride exposure, sugar consumption, general health and clinical conditions of the patients.
Results- In the 0-6 age group, 52% (26) patients fell under high-risk category. Among the 26 high-risk patients, 84.61% (22) showed presence of high-risk clinical conditions. Remainder 40% and 8% of patients in the group were in moderate and low risk category respectively.
In the above 6 years age group, 37.93% (22) patients fell under high-risk category. 31.03% patients each were in moderate and low risk category.
Conclusion: Periodic monitoring for signs of caries progression and active measures
individualized to the patient's risk level should be carried out by parents and oral
health professionals to reduce cariogenic environment and monitor possible caries
progression.
Practical implication - The parents need to be educated regarding the negative impact
of frequent consumption of carbohydrates and the importance of fluoride exposure in
caries development.
Key words- Dental caries, CRA, Urban, Children, Cavitation, Fluoride, ADA

Introduction:

Dental caries has a multi-factorial etiology which includes four main factors: susceptible tooth surface, microflora, fermentable carbohydrates, and time[1]. Microbiological shifts within the oral biofilm affects the

balance of the tooth enamel remineralization or demineralization process; which is affected by salivary flow and composition, fluoride exposure, consumption of dietary sugars, and preventive behaviors (e.g., brushing teeth)[1]. It is one of the most prevalent chronic disease which can arise in early childhood as an aggressive tooth decay that affects the primary teeth of infants and toddlers[2].

Caries risk factors are described as biological reasons that either cause or increase current or future carious lesion[3]. Due to their pathologic characteristics, risk factors function as indicators of areas that can be corrected to improve existing imbalance[4] . The risk factors include inadequate use of fluoride, frequent or prolonged exposure of sugary foods or drinks between meals, poor oral hygiene , xerostomia, medical history (eating disorders or special health condition), recent caries exposure, and caries experience of mother and siblings. Caries Risk Assessment (CRA) forms are used to assess an individual's risk for dental caries based on the child's age. Based on the American Dental Association (ADA) CRA forms, patient can be categorized as low, moderate or high-risk status, and based on the patient's risk level, targeted treatments can be provided to help control the dental caries for the patient[4].

Various CRA models have been developed to identify individuals who are at a risk of developing caries in the future[5.] The assessment tool provided by the ADA offers a straightforward approach and gives a comprehensive understanding of the factors contributing to caries[6]. It determines the patient's specific risk of caries progression and assists clinicians in implementing the appropriate preventive measures for each patient. This tool is advantageous due to its convenience, as it does not require additional diagnostic tools like radiographs or salivary counts, making it effective for use in field settings. However, there is limited literature on its use for dental caries risk assessment. Hence, our aim of this study was to evaluate the risk status of selected patients using ADA CRA forms[10,11].

Methods:

A cross-sectional study design was used for assessing the caries risk using the ADA CRA forms among total of 108 patients which included 58 patients above the age of 6 years and 50 patients in 0-6 years age from various pediatric dental clinics in Mumbai, India. After receiving the consent from parents/guardian, the patients were clinically examined for cavitated lesions, missing teeth due to caries, amount of visible plaque, unusual tooth morphology that compromised oral hygiene, inter proximal restorations, exposed root surface, restorations with overhangs and/or open margins, presence of dental or orthodontic appliance and having xerostomia or salivary flow being visually adequate or inadequate. The caries risk assessment was done during their dental visits in pediatric clinic across Mumbai.

The contributing conditions such as use of fluoride, sugary diet consumption, caries experience of mother, caregiver and/or siblings, established record of the patient in a dental office and general health conditions questions such as special health care needs, undergoing chemotherapy/radiation therapy, presence of eating disorders, medications reducing salivary flow and drug/ alcohol abuse were asked to be filled by the parents/ guardians.

All patients examined were found to be healthy with no relevant medical history of special health care needs, undergoing chemotherapy/radiation or medications that reduce salivary flow.

Statistical analysis:

The collected data was tabulated in a spreadsheet using Microsoft Excel 2019 and then statistical analysis was carried out using GraphPad Prism for Windows, Version 9.5 (GraphPad Software, La Jolla California USA). Descriptive statistics were used to report the categorical variables in terms of frequencies and percentages and were tested using the Chi-square (χ^2) test with α=0.05. A P value of ≤0.05 was considered statistically significant.

Results:

The responses for the questions on Caries Risk Assessment using the ADA CRA forms among 0-6 years age group are provided in

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Table 1.
Table 1: Responses for the questions on Caries Risk Assessment of 0-6 years aged patients

Questions	Low Risk	Moderate risk	High risk	*P* value
CONTRIBUTING CONDITIONS				
Does your child have FLUORIDE Exposure such as through drinking water or in toothpastes such as colgate, Pepsodent, supplements or any other professional application?	Yes 30(60%)	No 20(40%)		0.2ns
Does your child consume sugary foods or drinks including juice,	Primarily at mealtimes	Frequent or prolonged exposure between meal exposures/day	Bottle or sippy cup with anything other than water at bedti	0.004 **

Questions	Low Risk	Moderate risk	High risk	*P* value
carbonated or non carbonated soft drinks, energy drinks or medicinal syrups?			me	
	24(48%)#	20(40%)#	6(12%)	
Family has low income? (eg. Has difficulty making ends meet) or eligible for any government aided programs?	No		Yes	<0.0001**
	45(90%)#		5(10%)	
Does mother, caregiver or siblings of the child have	No carious lesion in last 24 months	Carious lesion in last 7-23 months	Carious lesion in the last 6 months	<0.0001**
	39(78%)#	9(18%)	2(4%)	

Questions	Low Risk	Moderate risk	High risk	P value
caries/ cavities?				
Does the child have an established record in a dental office?	Yes	No		
	32(64%)	18(36%)		0.06ns
GENERAL HEALTH CONDITION				
Does your child have any special health care needs? (developmental, physical, medical or mental disabilities that prevent or limit performance of adequate	No		Yes	
	50(100%)#		0(0%)	<0.0001**

Questions	Low Risk	Moderate risk	High risk	*P* value
oral health care by themselves or caregivers)				
CLINICAL CONDITIONS				
Visually or Radiographically Evident Restorations/ Cavitated Carious Lesion	No new carious lesions or restorations in last 24 months		Carious lesions or restorations in last 24 months	0.47ns
	28(56%)		22(44%)	
Non-cavitated (incipient) Carious Lesions	No new lesions in last 24 months		New lesions in last 24 months	0.0018**
	36(72%)#		14(28%)	
Teeth missing due to caries	No		Yes	<0.0001**
	45(90%)#		5(10%)	
Visible Plaque	No	Yes		<0.0001**
	45(90%)#	5(10%)		
Dental / Orthodontic	No	Yes		<0.0001**
	49(98%)#	1(2%)		

Questions	Low Risk	Moderate risk	High risk	*P* value
Appliances Present (fixed or removable)				
Salivary flow	Visually adequate		Visually inadequate	<0.0001**
	45(90%)#		5(10%)	

ns: not significant (*P*>0.05), *: significant (*P*<0.05),**:highly significant (*P*<0.05)
#: responses were significantly different from rest of the responses.

The Caries risk assessment was carried out on a total of 108 patients divided into two age groups that are 50 patients belonging to 0-6 years and remainder 58 patients belonging to an age group above 6 years.
Risk Assessment in the children aged 0-6 years inferred that 60% of the children used fluoride-containing toothpaste, the proportion of which was not significantly different from those without it (*P* = 0.2).
 48% of the children primarily consume sugary foods etc at mealtimes while 40% frequently consume them between meals. Only 10% of the respondents reported belonging to a low-income group and 78% of the caregivers reported no carious lesions in the last 24 months. 64% of the children had an established record in a dental office. All the 50 children did not report of having a special health care need. The above-mentioned proportions were significantly higher than the other response except the distribution of children according to an established record in dental office (*P* < 0.01)
Clinical assessment revealed that around 44% of the children had carious lesions in the past 24 months, the proportion of which was not significantly different from those without it (*P*=0.47).
Incipient carious lesions were absent in 72% of the children and 90% of them did not have any missing teeth due to caries. Visible plaque was absent in 90% of the children and 98% of them did not have any dental or orthodontic appliances present. The salivary flow was visually adequate in 90% of the children. The above-mentioned proportions were significantly different than the other response(*P*<0.01).
The responses for the questions on Caries Risk Assessment using the ADA CRA forms in the >6 years age group are provided in **Table 2**.

Table 2: Responses for the questions on Caries Risk Assessment of >6 years aged patients

Questions	Low Risk	Moderate risk	High risk	*P* value
CONTRIBUTING CONDITIONS				
Does your child have FLUORIDE	Yes	No		<0.0001**
	46(79.30%)#	12(20.70%)		

Questions	Low Risk	Moderate risk	High risk	P value
Exposure such as through drinking water or in tooth pastes such as colgate, Pepsodent, supplements or any other professional application?				
Does your child consume sugary foods or drinks including juice, carbonated or non carbo	Primarily at mealtimes		Frequent or prolonged exposure between meal exposures/day	0.0002**
	43(74.14%)		15(25.86%)	

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Questions	Low Risk	Moderate risk	High risk	P value
nated soft drinks, energy drinks or medicinal syrups?				
Does mother, caregiver or siblings of the child have caries /cavities? (for patients 6-14)	No carious lesion in last 24 months	Carious lesion in last 7-23 months	Carious lesion in the last 6 months	<0.0001**
	34(58.62%) [#]	20(34.48%)[#]	4(6.90%)	
Does the child have an established record in a dental office, receiving regular dental care?	Yes	No		
	42(72.41%)[#]	16(27.59%)		0.0006**

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Ques tions	Low Risk	Mode rate risk	High risk	P value
GENERAL HEALTH CONDITION				
Does your child have any special health care needs ? (developmental, physical, medical or mental disabilities that prevent or limit performance of adequate oral health care by themselves or caregivers)	No	Yes (over age 14)	Yes (age 6-14)	<0.0001**
	58(100%)#	0(0%)		
Undergoing Chemo/ Radia	No		Yes	<0.0001**
	58(100%)#		(0%)	

Questions	Low Risk	Moderate risk	High risk	P value
tion Therapy?				
Eating disorders	No	Yes		<0.0001**
	58(100%)[#]	0(0%)		
Medications that reduce salivary flow	No	Yes		<0.0001**
	58(100%)[#]	0(0%)		
Drug/ Alcohol Abuse	No	Yes		<0.0001**
	58(100%)[#]	0(0%)		
CLINICAL CONDITIONS				
Cavitated or Non cavitated (incipient) Carious lesion or restorations (visually or radiographically evident)	No new carious lesions or restorations in last 36 months	1 or 2 carious lesions or restorations in last 36 months	3 or more carious lesions or restorations in last 36 months	0.02*
	27(46.55%)	21(36.21%)	10(17.24%)	
Teeth missing due to caries	No		Yes	<0.0001**
	50(86.21%)[#]	(0%)	8(13.79%)	

Ques tions	Low Risk	Mode rate risk	High risk	P value
in past 36 mont hs				
Visibl e Plaqu e	No	Yes		
	51(87. 93%)#	7 (12.07 %)		
Unus ual Tooth Morp holog y that comp romis es oral hygie ne	No	Yes		<0.00 01**
	58(100 %)#	0(0%)		
Interp roxim al Resto ration s- 1 or more	No	Yes		<0.00 01**
	45(77. 59%)#	13(22. 41%)		
Expo sed Root Surfa ces prese nt	No	Yes		<0.00 01**
	58(100 %)#	0(0%)		
Resto ration s with Over hangs and/o r Open Margi ns, Open	No	Yes		<0.00 01**
	58(100 %)#	0(0%)		

Questions	Low Risk	Moderate risk	High risk	P value
contacts with food Impaction				
Dental/ Orthodontic Appliances Present (fixed or removable)	No	Yes		<0.0001**
	54(93.10%)#	4(6.90%)	(0%)	
Severe Dry Mouth (Xerostomia)	No		Yes	<0.0001**
	58(100%)#		(0%)	

*: significant($P<0.05$),**:highly significant($P<0.05$)
#: responses were significantly different from rest of the responses

Risk Assessment in the children aged above 6 years inferred that 79.30% of the children used fluoride-containing toothpaste. 74.14% of the children primarily consumed sugary foods etc at mealtimes only. 58.62% of the caregivers reported no carious lesions in the last 24 months, while 34.48% reported a carious lesion in the past 7-23 months. 72.41% of the children had an established record in a dental office. All 58 children reported having a normal general health condition. The above-mentioned proportions were significantly higher than the other response($P<0.01$)
Clinical assessment revealed that around 17.24% of the children had 3 or more carious lesions in the past 36 months, the proportion of which was significantly lower than those without it ($P=0.02$).
86.21% of them did not have any visible carious lesions or restorations or any missing teeth due to caries. Visible plaque was absent in 87.93% of the children. All 58 children did not have any tooth morphology that compromised oral hygiene. 77.59% of them had one or more interproximal restorations, while none of them (100%) had any root exposures or any restorations with overhangs or open margins. 93.10% of them did not have any dental or orthodontic appliances present. Salivary flow was visually adequate in 100% of the children. The above-mentioned proportions were significantly higher than the other response($P<0.01$).

The total sum of all the patients in the study were categorized into overall low, moderate and high risk (**Table 3**). As per ADA characteristics, the criteria for categorizing the age group into overall low, moderate, and

high risk is presence of a single contributing or clinical condition in the high risk. Hence, despite the presence of primarily low and moderate contributing or clinical conditions in the analysis, the overall caries risk in the studied population was concluded to be high.

Table 3: Comparisons of the overall risk status between the age groups

Age Groups	Low*	Moderate*	High*	Total
0-6 years	4(18.18%)	20(52.63%)	26(54.17%)	50
>6 years	18(81.82%)	18(47.37%)	22(45.83%)	58
Total	22	38	48	108

*the % calculated are of the 0-6 and > 6 years age within low, moderate, and high-risk categories.

While categorizing between the two age groups, 52% (26) of patients fell under high-risk category in 0-6 age group while 37.93% (22) of patients fell under high-risk category in the > 6 years age group. While categorizing between the different risk categories, the majority of the study subjects belonged to the high-risk group (n=48), with 38 children belonging to the moderate age group and remainder 22 in the low-risk group. A corrected Chi-Square (χ^2) test of proportions revealed that the proportion of subjects belonging to the high-risk and moderate-risk groups was significantly higher (P=?) than the low-risk subjects.

A corrected Chi-Square (χ^2) test of independence was carried out to compare the frequency distribution of the study subjects between the risk categories according to the age groups, and a significant association was found(P=0.0006), implying that in the low-risk group, the proportion of subjects above 6 years was significantly higher than the subjects belonging to 0-6 years. The distribution of subjects according to age in the moderate and high-risk categories was nearly similar.

Discussion:
ADA's CRA forms were used to evaluate the potential of developing caries among children. The forms were prepared by the Councils on Dental Practice (CDP) and Scientific Affairs (CSA), in collaboration with cariology experts and the Council on Access, Prevention, and Inter professional Relations (CAPIR).
In the 0-6 years age group, among the 26 high risk category patients, 84.61% (22) showed presence of high-risk clinical conditions including presence of cavitated carious lesion, non-cavitated carious lesion or teeth missing due to caries. The distribution of contributing conditions among above patients displaying high-risk clinical conditions (84.61%) was 13.64% with low risk contributing condition, 59.09% with moderate contributing condition, and 27.27% with high risk contributing condition. In the same high-risk group, the remainder 15.39% (4) had high risk contributing conditions but did not show any presence of clinical condition.

Similarly, in the above 6 years age group, among the 22 high risk category patients, 59.09% (13) showed presence of high-risk clinical conditions including presence of 3
or more cavitated, non-cavitated carious lesion or teeth missing due to caries in past 36 months. The distribution of contributing conditions among above patients displaying high-risk clinical conditions (59.09%) was 7.69% with low risk contributing condition, 23.08%with moderate contributing condition, and 69.23%with high risk contributing condition. In the same age group, the remaining 40.91% (9) had high risk contributing conditions and had presence of 1 or 2 cavitated carious lesion or restoration in last 36 months. It is noted that high risk contributing factors increases the risk of developing carious lesions. The contributing conditions were found to be significant among sugar consumption, and the presence of caries in the mother or siblings.

Our study's results categorize a substantial proportion of children categorized as high risk similar to the dental caries risk assessment carried out among 6-10 years old school going children using the ADA CRA forms by Anusha R, in 2017[6]. While this study utilized the ADA CRA forms from 2016, our current study employs the revised 2018 ADA CRA forms which incorporated updated clinical recommendations and preventive measures reflecting advancements in evidence-based dental care. It also provided specific forms for two different age groups, enhancing the precision and relevance of our risk assessment, allowing for more accurate identification and management of caries risk in the studied population. Despite these differences, both studies emphasizes the need for consistent preventive strategies across various age groups. A systemic review conducted by Jessica F Large in 2023, found a positive relationship between the higher consumption of unhealthy beverages (especially sugar-sweetened beverages, SSB's) and unhealthy foods (particularly those high in free sugars) associated with a higher risk of developing dental caries[7]. 22 studies focused on the effects of consuming unhealthy foods and 17 studies examined the impact of consuming SSB's on dental caries. The studies predominantly looked at sweets, candy, or confectionery items, which are high in free sugars .

Even though majority of the study population had fluoride exposure, the overall caries risk assessment is high. One of the factors could be the water fluoridation level in parts of Mumbai where the study was completed. While no evidence exists for the fluoridation level of drinking water in Mumbai, a study conducted by Sabita Ram in 2017 concluded that the observed fluoride level in drinking water from all sources was less than that recommended by WHO in Navi Mumbai [8].

The ADA Caries Risk Assessment (CRA) forms were developed by an expert panel. However, to date, no clinical outcome studies validating these forms and procedures have been published[9]. The existing literature provides minimal evidence on the effectiveness of caries risk assessment using these tools. Future longitudinal studies are necessary to validate and refine these results, offering a more comprehensive understanding of caries risk assessment. Continued research with larger sample sizes and diverse demographics will be essential to enhance the accuracy and generalizability of our findings.

Conclusion:

While acknowledging the significance of risk factors in the development of caries,
this study also identifies limitations worth addressing. This study was conducted as a one-time assessment of caries risk. The findings are based on a single dataset and, while indicative, may not fully capture the variability over time or across different populations. To ensure the accuracy and reliability of the data collected, the questions were phrased in clear, non-technical language to improve comprehension. However, some degree of uncertainty remains regarding the parent's or the guardian's accurate response of certain questions. Given the high overall caries risk, it is crucial to develop individualized, tailored treatment plans.

References:

1. Selwitz RH, Ismail AI, Pitts NB. Dental caries. Lancet. 2007 Jan 6;369(9555):51-9. doi: 10.1016/S0140-6736(07)60031-2. PMID: 17208642.
2. E. Reich, A. Lussi, E. Newbrun,Caries-risk assessment*,International Dental Journal,Volume 49, Issue 1,1999, Pages 15-26, ISSN 0020-6539.
3. Maheswari SU, Raja J, Kumar A, Seelan RG. Caries management by risk assessment: A review on current strategies for caries prevention and management. J Pharm Bioallied Sci. 2015 Aug;7(Suppl 2):S320-4. doi: 10.4103/0975-7406.163436. PMID: 26538870; PMCID: PMC4606612.
4. Young DA, Featherstone JD. Implementing caries risk assessment and clinical interventions. Dent Clin North Am. 2010 Jul;54(3):495-505. doi: 10.1016/j.cden.2010.04.002. PMID: 20630192.
5. Cagetti MG, Bontà G, Cocco F, Lingstrom P, Strohmenger L, Campus G. Are standardized caries risk assessment models effective in assessing actual caries status and future caries increment? A systematic review. BMC Oral Health. 2018 Jul 16;18(1):123. doi: 10.1186/s12903-018-0585-4. PMID: 30012136; PMCID: PMC6048716.

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6.   Anusha R (2017) Dental Caries Risk Assessment Among 6-10 Year Old School Going Children - A Pilot Study. SF Dent Oral Res J 1:4.

7.   Jessica F Large, Claire Madigan, Rebecca Pradeilles, Oonagh Markey, Benjamin Boxer, Emily K Rousham, Impact of unhealthy food and beverage consumption on children's risk of dental caries: a systematic review, *Nutrition Reviews*, 2023;, nuad147, https://doi.org/10.1093/nutrit/nuad147

8.   Sabita M. Ram. Determination of Fluoride level in Drinking Water from Water Samples in Navi Mumbai, Maharashtra. *Journal of Indian Association of Public Health Dentistry.* 15(4):395-398, Oct-Dec 2017.

9.   Featherstone JDB, Crystal YO, Alston P, Chaffee BW, Doméjean S, Rechmann P, Zhan L, Ramos-Gomez F. A Comparison of Four Caries Risk Assessment Methods. Front Oral Health. 2021 Apr 28;2:656558. doi: 10.3389/froh.2021.656558. PMID: 35048004; PMCID: PMC8757708.

10. American Dental Association. Caries Risk Assessment Form (Age 0-6). Accessed May 27, 2021.

11. American Dental Association. Caries Risk Assessment Form (Age >6). Accessed May 27, 2021.