



Comparison of Dental Caries Risk Assessment Using Three Caries Risk Assessment Tools: A Cross- Sectional Study

Dr. Devendra Patil, Dr. Pranauti Sonaje, Dr. Parin Bhanushali, Dr. Manohar Poojari, Dr. Shilpa Shetty, Dr. Farhin Katge

Reader, Department of Pediatric and Preventive Dentistry, Terna Dental College, Navi Mumbai¹

Post Graduate student Department of Pediatric and Preventive Dentistry Terna Dental College, Navi Mumbai²

Lecturer, Department of Pediatric and Preventive Dentistry, Terna Dental College, Navi Mumbai³

Professor, Department of Pediatric and Preventive Dentistry, Terna Dental College, Navi Mumbai⁴

Reader, Department of Pediatric and Preventive Dentistry, Terna Dental College, Navi Mumbai⁵

Professor, Department of Pediatric and Preventive Dentistry, Terna Dental College, Navi Mumbai⁶

(Received: 28 January 2026 Revised: 16 March 2026 Accepted: 09 April 2026)

KEYWORDS

Dental caries;
Risk
assessment;
Disease
indicators; Risk
tools.

ABSTRACT:

Introduction Background: Primary prevention and treatment of carious lesions is an important step to arrest caries progress. This can be achieved by using caries risk assessment tools. The aim of this study was to compare CAMBRA, ADA and CRAFT caries risk assessment tools in children and check the usability of these tools in assigning caries risk.

Methods: In this cross-sectional study children aged 6-14 years were included to evaluate the risk of dental caries. The selected children were clinically examined by a single observer for dental caries status. Data was collected and subjected to CAMBRA, ADA forms and the mobile application CRAFT. The caries risk for each child was evaluated using scores obtained from the caries risk assessment tools. Data was subjected to statistical analysis. A p-value of less than 0.05 was set as statistically significant.

Results: Results showed statistically significant difference between ADA and CRAFT assessment tools ($p=0.01$), whereas comparison between CAMBRA- ADA and CAMBRA-CRAFT was statistically insignificant ($p=0.936$, $p=0.770$ respectively).

Conclusion: Caries risk assessment can serve as an important diagnostic tool to identify the risk factors and provide a risk-based preventive care that can bridge the oral health inequalities in society.

Clinical relevance: Dental caries is a multifactorial disease and a dynamic process that can be prevented. This prevention can be achieved using caries risk assessment and using preventive treatment modalities. This study provides evidence for the applicability of the CRAFT caries risk assessment tool for treatment. It also highlights the important measures that should be considered when selecting a caries risk assessment tool to use in clinical practice.

INTRODUCTION:

Dental caries is a multifactorial disease involving different types of microorganisms, dysbiosis of the dental plaque biofilm caused by dietary habits which include frequent consumption of fermentable carbohydrates, malfunction of the salivary system, insufficient preventive measures and more. Therefore, there is no single "magic bullet" that cures dental caries.¹

In the current dental caries care paradigm, where the focus is on preventative measures rather than prompt intervention for tooth decay, determining a patient's caries risk status is an important step. This assessment should be done on a regular basis to track changes in your oral health over time.¹

Hausen has defined caries risk as the probability that an individual will develop a certain number of carious lesions (cavitated or non-cavitated) or reach a given level of disease



progression, over a specific period of time, provided his or her exposure status remains the same during this period.² When making decisions about the course of treatment and preventive measures for children who have dental caries or who are considered to be at risk, the dentist is guided by the particular data gathered from a systematic assessment of caries risk.³

According to Bratthall and Petersson (2005), caries risk assessment (CRA) models can be 'risk models' or 'prediction models'. The prediction models based on factors such as the past caries experience could tell "who are at risk" whereas the risk models can identify "the existing risk" factors for future caries in individuals.⁴

Various caries risk assessment tools like Cariogram, Caries Management by Risk Assessment Tool (CAMBRA), American Academy of Pediatric Dentistry (AAPD), American Dental Association (ADA), Traffic Light Matrix (TLM), Caries risk assessment for treatment (CRAFT) are available which can be used to determine the caries risk of an individual. Some of the risk assessment tools are available in chart form where examiner categorises the child into caries risk category based on clinical and radiographical examinations, oral hygiene practice and dietary habits. Some caries risk assessment tools are application based or software based.

A consensus conference of experts conducted in April 2002 in Sacramento, California, established the Caries Management by Risk Assessment Tool (CAMBRA), which was released in 2003. This tool is based on the caries balance concept, which is the degree to which dental caries advances, stops or reverses depends on the risk factors and protective factors. CAMBRA risk assessment forms are for two age groups, 0-5 years and 6 years to adults.^{5,6}

Another CRA tool is given by American Dental Association (ADA) for ages 0-6 years and >6 years of age. Each of the forms contain clinical observations, preventive factors and risk factors. Depending on where the patients' ticked boxes lie on the questionnaire, the dentist will classify their caries risk as low, moderate or high.¹

Caries risk assessment for treatment (CRAFT) is a simple mobile application which can be used chairside was proposed in 2016. It is non-invasive, four-point approach proposed for the management of caries based on risk assessment. Diet, decay, fluoride exposure and other factors are among its four parameters. A red star denotes "risk" and a green star indicates "safety." After filling the questionnaire, the application calculates the caries risk. Based on the risk as ascertained from the CRAFT, age-appropriate recommendations can be chosen.⁷

The purpose of this study was to compare the accuracy of CAMBRA, ADA and CRAFT caries risk assessment tools of children.

MATERIALS AND METHODS:

Study design:

This cross-sectional study was conducted in the Department of Pediatric and Preventive Dentistry according to the STROBE (Strengthening the Reporting of Observational Studies in Epidemiology) guidelines.

Ethical approval and consent:

Ethical clearance was obtained from the Institutional Ethical Review Board (TDC/EC/27/2023).

Parents of the participants were informed regarding all aspects of the study and informed consent was obtained.

Study participants:

The study population consisted of the residents of Navi Mumbai who attended the dental outpatient of dental institute. As per the available literature, no studies are available comparing CRAFT with other caries risk assessment tools. Hence, a pilot study was conducted. The sample size of 50 was calculated based on the results of pilot study.

INCLUSION CRITERIA:

- Co-operative children of age group 6-14 years

EXCLUSION CRITERIA:

- Parents not willing to give consent
- Children with systemic disorders who could not cooperate

After receiving informed consent from the parents and based on the inclusion and exclusion criteria, children between the ages of 6 and 14 were chosen.

The selected children were clinically examined by a single observer for dental caries status utilizing the WHO Oral Health Survey criteria (1997)⁸ for dental caries. Examination was carried out using sterilized diagnostic instruments under illumination. To check the salivary flow, 3 - 4 ml of unstimulated saliva was collected into a sterile beaker and time was noted using stopwatch. Then the salivary flow rate in ml/min was calculated.

For each child, examiner filled the CAMBRA and ADA caries risk assessment forms after examination and obtaining required information from the parents. For CRAFT caries risk assessment tool, parents were asked to fill the necessary information in the application-based questionnaire. Based on the clinical examination and entered information in the respective caries risk assessment tool, caries risk for each child was calculated. The salivary flow



rate in accordance with Dawes,⁹ 0.3 – 0.4 ml/min was considered normal and below this range was considered low.

Statistical analysis:

An Excel spreadsheet was created by compiling and organising the data. IBM SPSS software version 17.0 was used to analyse it. For descriptive statistics, mean and standard deviation were employed, while for statistical analysis, unpaired Student t-test and Chi-square test were used. A p-value of less than 0.05 was deemed statistically significant.

Results:

Using CAMBRA, it was observed that 2% children showed moderate risk, 94% showed high risk and 4% showed extreme risk. Using ADA, 4% children showed moderate risk and 96% showed high risk. Using CRAFT, 10% children showed low risk, 40% showed moderate risk and 50% showed high risk (**Table 1, Graph 1**).

Results showed statistically significant difference between ADA and CRAFT assessment tools ($p=0.01$), whereas comparison between CAMBRA- ADA and CAMBRA-CRAFT was statistically insignificant ($p=0.936$, $p=0.770$ respectively) (**Table 2**).

Discussion:

Dental caries and its consequences can lead to severe negative impact on quality of life and the treatment modalities can be expensive. Current research indicates that treating and preventing dental caries still present significant obstacles. The current trend in dental caries management is caries risk assessment (CRA), to analyse and reduce risk factors for caries occurrence and create individualised treatment and management regimens for caries based on CRA.¹⁰ Hence, assessment of caries risk in early stage will be beneficial for prevention of caries in young population.

The age group of 6-14 years is included in this study as children in this age group are easily accessible. In addition, these children are either in mixed dentition period or are transitioning from mixed to permanent dentition. For this age group, risk-based caries care is essential to prevent caries in the permanent teeth and reducing the incidence of caries. In developing countries like India, prevalence of caries is increasing as the children are consuming free sugars and other fermentable carbohydrates.^{11,12} Also, the prevalence of molar incisor hypomineralization (MIH) is increased to 10%. Very few children receive six monthly fluoride application.¹³

A high incidence of caries may be caused by frequent between-meal snacking, untreated caries, hyposalivation, immune suppression and absence of topical fluoride usage. When

certain etiological variables are present, there is an elevated caries risk and caries activity.⁷

The amount of microbial load and the activity of dental caries can be estimated from existing untreated dental caries. Past caries experience is generally the best predictor of future caries risk.⁷ Also, ADA and CRAFT both include vertical transmission of caries from mother to child.¹⁴

Various CRA tools such as CAMBRA, CAT and Cariogram are widely used tools in the developed countries.⁷ The majority of these tools have been refined for use in developed countries, and their application in the Indian context has not received enough attention. While socioeconomic status, ethnic origin and migration are all mentioned in Western literature as significant predictors of dental caries, the same has not yet been proven for the Indian population. The Indian environment presents notable differences in eating patterns, oral hygiene practices and dental care.¹⁵ Thakur et al.⁷ validated CRAFT against Alban's test and concluded that it can be used as a caries risk assessment tool for Indian population.

Featherstone et al.¹ compared four CRA tools: CAMBRA, Cariogram, ADA and American Academy of Pediatric Dentistry (AAPD). Results showed that Cariogram and CAMBRA gave equivalent results. Authors concluded that both the caries risk assessment tools can be used alternatively.¹ Hence, in this study CAMBRA caries risk assessment tool is taken as a standard group and compared with ADA and CRAFT.

Cheng et al.¹⁶ found in a randomised controlled trial that the CAMBRA intervention transmitted more of its anti-caries effect through the combined action on several mediators than through any single variable, likely due to the multifactorial nature of caries. Another study by Sudhir et al.¹⁷ that assessed CAMBRA's predictive ability for caries risk in institutionalised children aged 12 to 13 years found that the tool was very effective in predicting caries risk. These results were in accordance with the results of present study.

In the study done by Nessa Mary John et al.,¹⁸ authors compared CAT, CAMBRA and Cariogram for children with or without Early Childhood Caries (ECC). The results demonstrated that while Cariogram correctly assessed caries risk, CAT and CAMBRA overestimated it. Similarly in the present study CAMBRA overestimated the caries risk when compared to ADA and CRAFT. In another study by Agouropoulos et al.,¹⁹ CAMBRA displayed better performance in distinguishing subjects between risk categories compared with Cariogram and AAPD assessment tools.

Even though ADA assessment tool is widely used around the world, there have been no published clinical outcomes studies that validate these forms. In study done by Featherstone et al.



on hypothetical patients, ADA underestimated the risk whereas in our study it showed similar results as that of CAMBRA.¹

CRAFT is a newer caries risk assessment tool as it is not compared with other caries risk assessment tools. In study done by Iyer et al.,²⁰ association between dental caries status, risk assessment using CRAFT and oral health related quality of life was assessed (OHRQoL). The authors noticed moderate correlation between caries status and its impact on OHRQoL. In the present study, CRAFT underestimated caries risk as compared to CAMBRA and ADA. It showed statistically significant difference with ADA group ($p=0.01$).

Limitations:

To validate the caries risk assessment tools used in this study, regular follow-up should be done for all the patients. It is recommended to determine the sensitivity and specificity of the assessment tools on all age groups to ensure its usage on a larger scale.

Conclusion:

Caries risk assessment can serve as an important diagnostic tool to identify the risk factors and hence aid in reducing the high burden of caries. As CRAFT is a simple, chairside caries risk assessment tool and specially designed for Indian population, it can be used as an alternative to other caries risk assessment tools.

References:

1. Featherstone JDB, Crystal YO, Alston P, et al. Evidence-Based Caries Management for All Ages-Practical Guidelines. *Front Oral Health* 2021 Apr 27;2:657518. doi: 10.3389/froh.2021.657518.
2. Suneja ES, Suneja B, Tandon B, Philip NI. An overview of caries risk assessment: Rationale, risk indicators, risk assessment methods, and risk-based caries management protocols. *Indian J Dent Sci* 2017 Jul 1;9(3):210-4.
3. Ramos-Gomez FJ, Crystal YO, Ng MW, Crall JJ, Featherstone JD. Pediatric dental care: prevention and management protocols based on caries risk assessment. *J Calif Dent Assoc* 2010 Oct;38(10):746-61. Erratum in: *J Calif Dent Assoc*. 2010 Nov;38(11):790. PMID: 21162350; PMCID: PMC3470809.
4. Thakkar R, Ashwin MJ. CRAFT-A Proposed Framework for Caries Risk Assessment in Indian Children. *EC Paediatrics*. 2022;11:33-45.
5. Featherstone JDB, Crystal YO, Ramos-Gomez F. CAMBRA® Caries Management by Risk Assessment A Comprehensive Caries Management Guide for Dental Professionals. July 2019.
6. 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.
7. Thakur JH, Subhadra HN, Jawdekar A. Evaluation of CRAFT as a Tool for Caries Risk Assessment in 3- to 6-year-old Children and its Validation against Alban's Test: A Pilot Study. *Int J Clin Pediatr Dent* 2019 Nov-Dec;12(6):538-42. doi: 10.5005/jp-journals-10005-1698. PMID: 32440071; PMCID: PMC7229380.
8. World Health Organization. Oral health surveys: basic methods. World Health Organization; 2013.
9. Dawes C. Physiological factors affecting salivary flow rate, oral sugar clearance, and the sensation of dry mouth in man. *J Dent Res* 1987;66:648-53.
10. Cheng L, Zhang L, Yue L, et al. Expert consensus on dental caries management. *Int J Oral Sci* 2022 Mar 31;14(1):17. doi: 10.1038/s41368-022-00167-3. PMID: 35361749; PMCID: PMC8971510.
11. Touger-Decker R, Loveren CV. Sugars and dental caries. *Am J Clin Nutr* 2003;78:881-92. doi: 10.1093/ajcn/78.4.881S.
12. Moynihan P, Petersen PE. Diet, nutrition and the prevention of dental diseases. *Public Health Nutr* 2004;7(1A):201-26. doi: 10.1079/PHN2003589.
13. Shetty AJ, Dixit UB, Kirubakaran R. Prevalence of molar incisor hypomineralization in India: A systematic review and meta-analysis. *J Indian Soc Pedod Prev Dent* 2022;40(4):p 356-67. doi: 10.4103/jisppd.jisppd_462_22
14. Manchanda S, Sardana D, Liu P, Lee GH, Lo E, Yiu CK. Horizontal transmission of streptococcus mutans in children and its association with dental caries: a systematic review and meta-analysis. *Pediatr Dent* 2021 Jan 15;43(1):1E-2E.
15. Pandey P, Nandkeoliar T, Tikku AP, Singh D, Singh MK. Prevalence of Dental Caries in the Indian Population: A Systematic Review and Meta-analysis. *J Int Soc Prev Community Dent* 2021 Jun 10;11(3):256-265. doi: 10.4103/jispcd.JISPCD_42_21. PMID: 34268187; PMCID: PMC8257015.

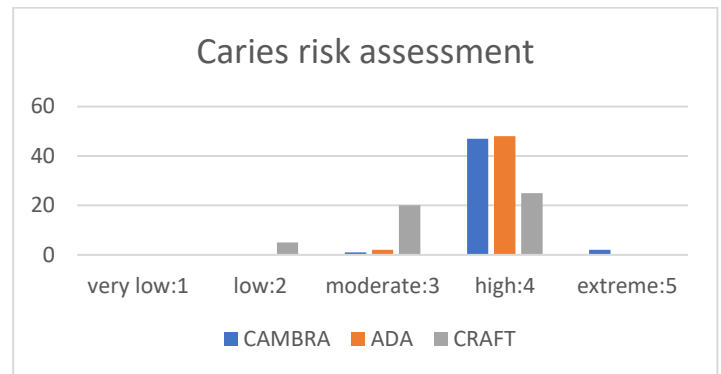


16. Cheng J, Chaffee BW, Cheng NF, Gansky SA, Featherstone JD. Understanding treatment effect mechanisms of the CAMBRA randomized trial in reducing caries increment. *J Dent Res* 2015 Jan;94(1):44-51. doi: 10.1177/0022034514555365. Epub 2014 Oct 29. PMID: 25355774; PMCID: PMC4270809.
17. Sudhir KM, Kanupuru KK, Fareed N, Mahesh P, Vandana K, Chaitra NT. CAMBRA as a Tool for Caries Risk Prediction Among 12- to 13-year-old Institutionalised Children - A Longitudinal Follow-up Study. *Oral Health Prev Dent* 2016;14(4):355-62. doi: 10.3290/j.ohpd.a35621. PMID: 26870852.
18. Nessa Mary John, Anandakrishna L. Comparative Evaluation of 3 Caries Risk Assessment Tools for Children with Early Childhood Caries. *Acta Sci Dent Sci* 2020;4:9:150-4.
19. Agouropoulos A, Birpou E, Twetman S, Kavvadia K. Validation of Three Caries Risk Assessment Tools for Preschool Children From Areas with High Caries Prevalence. *Pediatr Dent* 2019 Sep 15;41(5):391-399. PMID: 31648671.
20. Iyer CR, Jawdekar AM. ECC Status, CRAFT Categorization and OHRQoL Assessment in 3–6-year-old Children: A Cross-sectional Study. *Int J Clin Pediatr Dent* 2023; 16 (2):199-204.

| Risk Assesment | CAMB RA | | AD A | | CRAF T | |
|----------------|---------|---|------|---|--------|---|
| | | | | | | |
| Very low/No | - | - | - | - | 0 | 0 |
| Low | 0 | 0 | 0 | 0 | 5 | 1 |
| | | % | | % | | % |
| Moderate | 1 | 2 | 2 | 4 | 2 | 4 |
| | | % | | % | 0 | 0 |
| | | | | | | % |
| High | 4 | 9 | 4 | 9 | 2 | 5 |
| | 7 | 4 | 8 | 6 | 5 | 0 |
| | | % | | % | | % |

| | | | | | | |
|--------------------|---|---|---|---|---|---|
| Very high/ extreme | 2 | 4 | - | - | - | - |
| | | % | | | | |

Table 1: Table showing caries risk assessment comparing CAMBRA, ADA and CRAFT



Graph 1: Caries risk assessment comparing CAMBRA, ADA and CRAFT

| p value | CAMBRA | ADA | CRAFT |
|---------------|--------|-------------|-------------|
| CAMBRA | - | 0.936 | 0.770 |
| ADA | 0.936 | - | 0.01 |
| CRAFT | 0.770 | 0.01 | - |

Table 2: Table showing statistical analysis comparing CAMBRA, ADA and CRAFT