# Caries Risk Assessment in Pediatric Dental Care: A Systematic Review

**Ameera Amer[1]\*, Naif Mayouf Alrasheedi[2], Eman Ali Alhabib[3], Renad Abdulrahman Alaishan[4], Rania Anwar Jeddawi[5], Lama Ayedh Alkahtani[6], Rafaa Mohamd Jably[7], Nasser Tayi Al-Mutairi[8], Hatem Shabab Almukhalfi[9] and Ghada Mohammed Madhan[6]**

[1]*Deparatment of Pediatric Dentistry, East Jeddah General Hospital, Jeddah, Saudi Arabia*

[2]*Oyoon Aljaw PHC, Ministry of Health, Buraydah, Saudi Arabia*

[3]*Primary Health Care, Ministry of Health, Hail, Saudi Arabia*

[4]*College of Dentistry, Batterjee Medical College, Jeddah, Saudi Arabia*

[5]*Al Kasr Al Ainy Medical School, Cairo University, Cairo, Egypt*

[6]*College of Dentistry, King Khalid University, Abha, Saudi Arabia*

[7]*College of Dentistry, Jazan University, Jazan, Saudi Arabia*

[8]*Department of Restorative Dentistry, Najran Armed Forces Hospital, Najran, Saudi Arabia*

[9]*Department of Restorative Dentistry , Army Medical Battalion , Khamis Mushait , Saudi Arabia*

**\*Corresponding Author:** Ameera Amer, Deparatment of Pediatric Dentistry, East Jeddah General Hospital, Jeddah, Saudi Arabia.

## Abstract

Caries risk assessment is essential for the prevention, diagnosis, and treatment of the disease to improve children's oral health. In this systematic review, we aim to summarize previously published studies about the effects of risk assessment of dental caries in pediatric patients and the different risk factors for developing them. For that, a systematic electronic database search was conducted for relevant studies published, from inception till 26th June 2020, in seven databases. Finally, we included eight papers for this systematic review. The sample size of the included studies ranged from 128 to 3,810 individuals. The mean male percentage was 55%, ranging from 38% to 100%. All of the included studies had a cross-sectional study design. In this study, we reviewed the different risk factors for dental caries in pediatric patients. Despite all studies agreed that most risk factors include oral hygiene, dietary habits, proper parenting, and dental medical history, the socio-economic status risk factor was a point of debate. Moreover, different CRATs have been reported with a variety of sensitivity and validity scores. Validating these tools will require studies with large sample sizes and comparing the effect of these tools on different populations.

***Keywords:*** *Caries; Risk; Assessment; Children; Pediatric*

## Introduction

Dental caries disease, which is formerly known as baby bottle tooth decay, or nursing bottle caries, now a day, the AAPD adopted the term ECC to better reflect its mulifactorial etiology.

(ECC) is defined as the presence of one or more decayed (with or without cavitated lesions), missing (due to caries), or filled tooth surfaces in any primary tooth in a child under the age of six [1]. The definition of sever early childhood caries (S-ECC) is any sign of smooth-surface caries in child younger than three years of age [1]. Specifically, 8% of children aged between three to five years of age account for 75% of ECC and the rate is increasing within this age [2-4]. The prevalence of the disease is the highest among other childhood

chronic diseases in the US. It is even seven times more prevalent than hay fever and five times than asthma. Moreover, it is more common in children within racial or ethnic minorities [5-7].

Caries risk assessment is essential for the prevention, diagnosis and treatment of the disease to improve children's oral health. Risk factors essential for the assessment are mostly obtained from interviewing children's parents. A plan for preventive care can be developed by risk assessment tools to help parents and dentists how to prevent the occurrence of ECC by a better understanding of the risk factors. This plan will help dentists in processing treatment and prevention decisions that are essential to protect children from the harmful effects of dental caries [8]. However, to obtain the best use of it, the risk assessment should be carried out early before the disease onset to achieve a favorable outcome. Applying risk assessment models to prevent ECC in this age is necessary for a sound permanent dentition process [9,10].

Risk models involve different factors including a susceptible host, diet, fluoride exposure, and the adaptation of microflorae with various social, behavioral, and cultural factors [11]. The commonest risk indicators include caries lesions, on-teeth plaque visibility, low salivary outflow, increased sugar intake, and other factors like the socio-economic level of the patient, the ability to seek medical care, and other demographic factors [11]. Many caries risk assessment methods (CRAMs) have been reported [12,13]. Furthermore, various caries risk assessment tools (CRATs) as American Association of Paediatric Dentistry Caries Assessment Tool (AAPD CAT), Caries Management By Risk Assessment (CAMBRA), and Cariogram have been developed based on these CRAMs [11,14,15]. However, many factors should be considered when applying these instruments as validity, reliability, and the degree of responsiveness [16]. Hopefully, these tools will help in better prediction of dental caries in children at high risk of developing complications.

## Aim of the Study

In this systematic review, we aim to summarize previously published studies about the effects of risk assessment of dental caries in pediatric patients and the different risk factors for developing them.

## Methods

### Search strategy and study selection

The study process was conducted following the accepted methodology recommendations of the PRISMA checklist for systematic review [17]. A systematic electronic database search was conducted for relevant studies published, from inception till 26th June 2020, in seven databases including Google Scholar, Scopus, Web of Science (ISI), PubMed, Cochrane Central Register of Controlled Trials (CENTRAL), Embase and CINAHL using keywords, medical subject (MeSH) terms. In databases not supporting MeSH terms, combinations of all possible terms were used. Moreover, We conducted a manual search of references from the included articles by searching the primary studies that had cited our included papers and scanning references of the relevant papers in PubMed and Google Scholar to avoid missing any relevant publications [18].

We included all original relevant studies, which are discussing Caries risk assessment in the pediatric population. Papers were excluded if there was one of the following exclusion criteria: pilot studies, duplicate records, data could not be reliably extracted or incomplete reports, abstract only articles, thesis, books, conference papers. Moreover, studies with adult populations were excluded. Title and abstract screening were done independently by four reviewers. Then, three independent reviewers performed a full-text screening to ensure the inclusion of relevant papers in our systematic review. Any disagreement was resolved by discussion and referring to the senior author when necessary.

## Data extraction

Two authors developed the data extraction sheet using the Microsoft Excel software. Data extraction was performed by three independent reviewers using the excel sheet. The fourth independent reviewer performed data checking to ensure the extracted data accuracy. All the disagreements and discrepancies were resolved by discussion and consultation with the senior author when necessary.

## Quality assessment

Three independent reviewers evaluated the risk of bias in included studies. The risk of bias in non-randomized studies - of interventions (ROBINS-I) was used to assess the quality of each included study [19]. Any discrepancy between the reviewers was solved by discussion.

## Results and Discussion

### Search results

We searched for included studies in 6309 records using the title and abstract screening method after the exclusion of 2698 duplicated records. The process resulted in the inclusion of 280 papers for a further full-text screening assessment. Manual search trials did not result in the inclusion of any new study. Finally, we included eight papers for this systematic review (Figure 1).
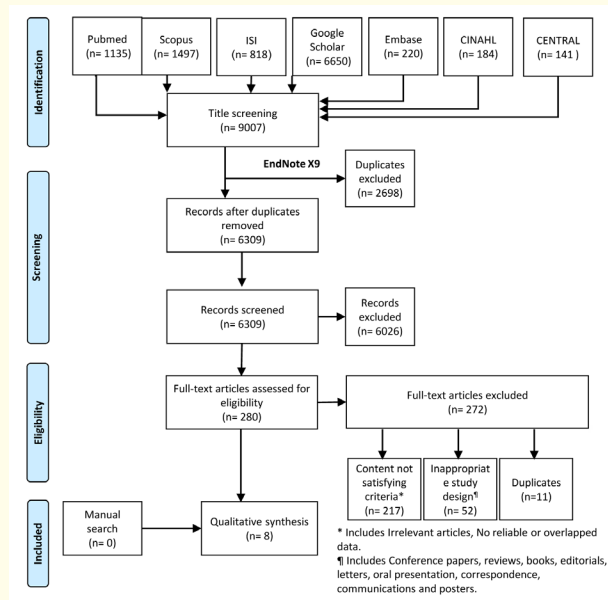


**Figure 1:** *Flowchart of the search and screening process.*

### Study characteristics and quality of the included studies

The sample size of the included studies ranged from 128 to 3,810 individuals. The mean male percentage was 55%, ranging from 38% to 100%. All of the included studies had a cross-sectional study design (Table 1). The results of risk bias assessment are summarized in figure 2.
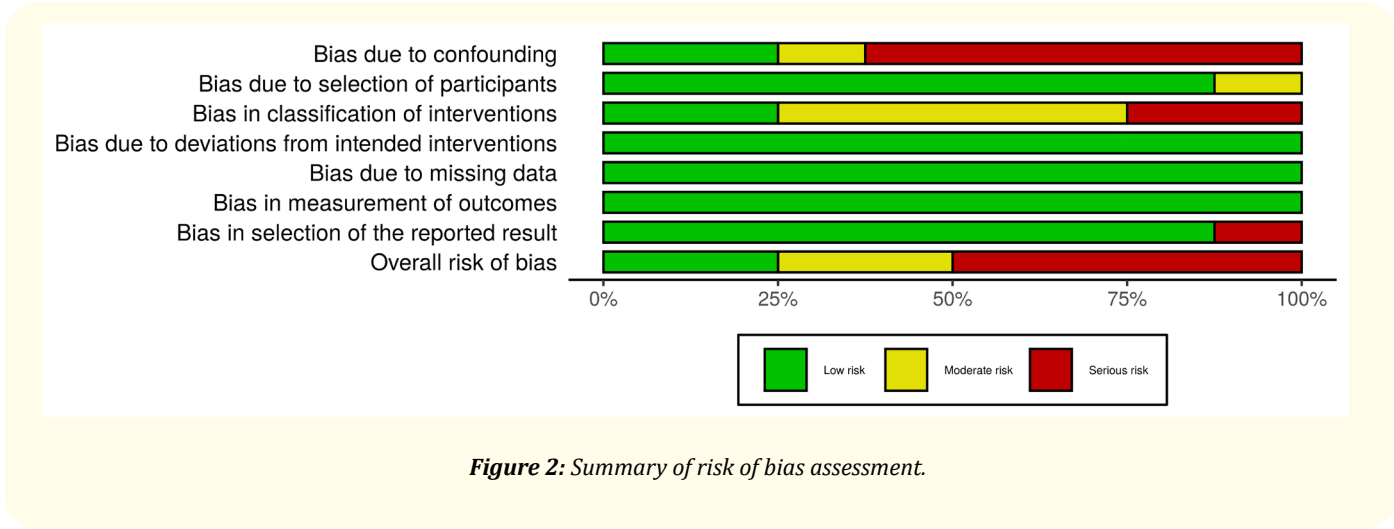
*Figure 2:* *Summary of risk of bias assessment.*

| Author, year | Country | Sample size | Male % | Age Mean (SD) | Aim | Main findings | Overall risk of bias |
|---|---|---|---|---|---|---|---|
| Seetha, 2019 [20] | India | 531 | 49.7 | 50.9 months (SD 12.6). | To allow risk scoring by childcare providers without clinical examination in order to guide dental referral in a community setting. | CRA-RT is a simple, valid, and reliable novel risk scoring system for ECC, to be used in a nondental, nonmedical setting. The proposed tool contains those behavioral risk or protective factors, the presence or absence of which could be assessed by interviewing the mother. The quick and easy risk scoring pattern with a cut-off score can guide the dental referral of preschool children by childcare providers in a community setting. | Serious |
| Goodwin, 2017 [21] | UK | 128 | 53 | 12.8 | To identify reliable and simple dietary risk factors for caries experience | the consumption of free sugars before bedtime may be an important risk factor for adolescent caries into dentine experience. | Low |
| Farsi, 2013 [22] | Saudi Arabia | 407 | 37.8 | 4 to 5 | to identify characteristic features of Saudi preschoolers at high risk for caries and to report the most significant caries risk predictors | Most of the Saudi children are at high risk for caries. Previous caries experience, enamel demineralization and socioeconomic status are the most significant caries risk predictors. These groups should be targeted for inclusion in caries prevention programmes. | Serious |
| Ghanim, 1998 [23] | Saudi Arabia | 446 | 44.6 | 4.13 (±0.83) | To evaluate the significance of variables such as oral hygiene, dietary habits, socio-economic status, and medical history of a child in assessing the level of caries risk and to generate a caries prediction model for preschool Saudi children. | Risk factors for dental caries have been identified and a caries prediction model has been developed for Saudi pre-school children. The prediction model, if verified, may provide with guidance in identifying high caries risk Saudi preschool children as targets for preventive programmes. | Moderate |

| Alhabdan, 2018 [24] | Saudi Arabia | 578 | 100 | 6 to 8 years | To estimate the prevalence of dental caries and identifying key associated factors in four major risk domains, | Dental caries were prevalent in school children, and individual factors were predominantly associated with the disease. | Serious |
|---|---|---|---|---|---|---|---|
| Chaffee, 2016 [25] | USA | 3,810 | 53.4 | 42.6 mo. (±16.5) | to assess the relative importance of pediatric CRA items in dental providers' decision-making regarding patient risk and in association with clinically evident caries | comprehensive CRA forms could also aid individualized care, linking risk assessment to disease management. | Serious |
| Gao, 2010 [26] | Republic of Singapore | 1,754 | 49.9 | 4.8 yrs (age range, 3.6-5.7 yrs). | To develop biopsychosocial models for caries risk assessment in various settings | These models are promising tools for cost-effective caries control and evidence-based treatment planning | Low |
| Sarmadi, 2008 [27] | Sweden | 432 | 50.46 | 6–19 years | to identify the factors forming the basis for dentist's caries risk assessment in dental care for children and adolescents | Dentists mainly base their caries risk assessments on past caries experience, a reliable risk indicator for assessing the risk of being affected by caries again. In children with no experience of caries, knowledge of other risk factors/indicators needs to be available to perform a caries risk assessment. In this study, documentation of such knowledge was strongly limited. | Moderate |

*Table 1: Characteristics of the included studies.*
*SD: Standard Deviation.*

### Caries risk assessment

In the past, surgical interventions were widely used for dental caries management. Recently, it has been well known that such procedures do not impact the development of the disease. Moreover, some damages resulting from these procedures are irreversible and lead to permanent cavitation. Therefore, there has been an urgent need to develop more safe and conservative measures for protection from the harmful effects of dental caries [28]. Many CRATs building-up attempts have been approached. Investigators have looked up different factors like demographics, cultures, microbiological profiles and dietary habits to establish a valid and sensitive prediction model for early detection and prevention of dental caries, but with limited significance [29]. Other approaches were developed to depend on one or two factors in estimating the risk of developing dental caries [30-36]. However, it was concluded that such approaches were not sufficient to be used for risk assessment [29]. On the other hand, other investigators relied on including various risk factors [37-39]. Recently, various CRATs have been reported by many studies [11,14,15,24,25,40]. However, the validity, and reliability of these tools are still questionable.

In this systematic review, our search process resulted in eight eligible studies that discussed different risk assessment procedures for dental caries in pediatric patients. Of these studies, four of them [20,23,26,40] included pre-school children only, two studies [24,25] included children between 6 - 8 years old. Only Goodwin., *et al.* [21] included patients aged 11 - 12 years old, while Sarmadi., *et al.* [27] was the only study that included all age ranges between 3 - 19 years. It is believed that the validity of the assessment models, that have proved efficient when applied to a certain population, cannot be applied as a valid instrument for another different population with different characteristics. Mejare., *et al.* [12] found that the results for using a risk assessment model for a certain population significantly differed when applied to another population. On the other hand, Beck., *et al.* [41] results showed validity for the model that he used with children when applied to a different population. Moreover, many studies focus on this age range for validating CRATs because of the nature of various factors that these patients witness as the feeding practices, the maternal and infantile oral health attitudes, and parenting behaviors [42].

There is no doubt that the assessment process is a long-term process and needs long follow-up periods for validating the results. We found that only Gao., *et al.* [26] and Chaffee., *et al.* [25] depended on the longitudinal observation of their patients. Gao., *et al.* [26] aimed at developing novel CRATs based on bio-physiological, medical, and personal habits. The novel tool was reported to have higher sensitivity when compared to the cariogram, a widely used CRAT for assessing CRA in children [14]. On the other hand, six studies [20,21,23,24,27,40] used interview-based reports for the validation of the risk factors that were previously reported to be of value in assessing the risks of dental caries in children. Seetha., *et al.* [20], however, conducted a cross-sectional study for building-up a new model that is based on interviewing patients' mothers, and other factors. The authors of this study reported that the tool was efficient in terms of dental caries intervention by early referral of children at high risk [20]. Al Ghanim., *et al.* [23] developed a tool with high predictive ability, sensitivity, and specificity. The tool showed statistical significance in debris index, frequency of consumption of soft drinks, consuming sweetened milk in bottles, frequency of sweets intake, and child's age at the first dental visit.

Regarding the assessment tools used by the included studies, Chaffee., *et al.* [25] relied on the CAMBRA tool and found that a high rate of children was at high risk of developing caries. Although authors reported a high sensitivity rate of 83.6% which is consistent with other studies [25,43], the validity of the tool is still questionable because of not having the recommended minimum score of combined sensitivity and specificity, according to Christian., *et al*. [44]. Goodwin., *et al.* [21] used the International Caries Detection and Assessment System (ICDAS) for the assessment of sugar consumption before bed. The results showed statistical significance in sugar consumption before bed, but no significance was recorded for between-meals, and total sugar consumption [21]. Besides, using the AAPD, Farsi., *et al.* [40] reported the frequency of sugar exposure per day was statistically significant between the absent and present caries children. The same author found no significance in water fluoridation and general health condition. Al Ghanim., *et al.* [23] also found a statistical significance in the frequency of sweet consumption. Almost all studies showed a correlation between children's oral health, dietary habits, and medical history. However, there were contradictions on the significance of the socio-economic status of the child and his family. When Farsi., *et al.* [40], Gao., *et al.* [26], and Chaffee., *et al.* [25] found the socio-economic status to be statistically significant, Al Ghanim., *et al*. [23], and Alhabdan., *et al.* [24], did not.

Limitations to our study include the different methodological approaches that were used by the included studies. Moreover, limitations to the sample size and population selection should be considered together with validating the risk assessment results in different sets of populations.

## Conclusion

In this study, we reviewed the different risk factors for dental caries in pediatric patients. Despite all studies agreed that most risk factors include oral hygiene, dietary habits, proper parenting, and dental medical history, the socio-economic status risk factor was a point of debate. Moreover, different CRATs have been reported with a variety of sensitivity and validity scores. Validating these tools will require studies with large sample sizes and comparing the effect of these tools on different populations.

**Funding**

None.

**Conflicts of Interest**

No conflicts related to this work.

**Bibliography**

1. Fontana Margherita., *et al*. "Defining Dental Caries for 2010 and Beyond". *Dental Clinics* 54.3 (2010): 423-440.

2. Macek MD., *et al*. "Survey of Oral Health Status of Maryland Schoolchildren, 2000--2001". *The Pediatric Dental Journal* 26.4 (2004): 329-336.

3. Dye BA., *et al*. "Trends in Oral Health Status: United States, 1988-1994 and 1999-2004". *Vital and Health Statistics* 11.248 (2007): 1-92.

4. Dye BA., *et al*. "Trends in Paediatric Dental Caries by Poverty Status in the United States, 1988-1994 and 1999-2004". *International Journal of Paediatric Dentistry* 20.2 (2010): 132-143.

5. Vargas CM., *et al*. "Sociodemographic Distribution of Pediatric Dental Caries: Nhanes Iii, 1988-1994". *The Journal of the American Dental Association* 129.9 (1998): 1229-1238.

6. Poland C and KJ Hale. "Providing Oral Health to the Little Ones". *Journal of the Indiana Dental Association* 82.4 (2003): 8-14.

7. Report Morbidity and Mortality Weekly. "Health Disparities Experienced by Racial/Ethnic Minority Populations". *CDC* (2004).

8. Fontana M and DT Zero. "Assessing Patients' Caries Risk". *Journal of the American Dental Association* 137.9 (2006): 1231-1239.

9. Ramos-Gomez FJ. "Clinical Considerations for an Infant Oral Health Care Program". *Compendium of Continuing Education in Dentistry* 26.5-1 (2005): 17-23.

10. "Guideline on Periodicity of Examination, Preventive Dental Services, Anticipatory Guidance/Counseling, and Oral Treatment for Infants, Children, and Adolescents". *The Pediatric Dental Journal* 35.5 (2013): E148-E156.

11. "Guideline on Caries-Risk Assessment and Management for Infants, Children, and Adolescents". *The Pediatric Dental Journal* 35.5 (2013): E157-E164.

12. Mejàre, I., *et al*. "Caries Risk Assessment. A Systematic Review". *Acta Odontologica Scandinavica* 72.2 (2014): 81-91.

13. Senneby A., *et al*. "Diagnostic Accuracy of Different Caries Risk Assessment Methods. A Systematic Review". *Journal of Dentistry* 43.12 (2015): 1385-1393.

14. Bratthall D and G Hänsel Petersson. "Cariogram--a Multifactorial Risk Assessment Model for a Multifactorial Disease". *Community Dentistry and Oral Epidemiology* 33.4 (2005): 256-264.

15. Featherstone JD., *et al*. "Caries Management by Risk Assessment: Consensus Statement, April 2002". *The Journal of the California Dental Association* 31.3 (2003): 257-269.

16. Mokkink Lidwine B., *et al*. "The Cosmin Checklist for Assessing the Methodological Quality of Studies on Measurement Properties of Health Status Measurement Instruments: An International Delphi Study". *Quality of Life Research: An International Journal of Quality of Life Aspects of Treatment, Care and Rehabilitation* 19.4 (2010): 539-549.

17. Liberati Alessandro., *et al*. "The Prisma Statement for Reporting Systematic Reviews and Meta-Analyses of Studies That Evaluate Health Care Interventions: Explanation and Elaboration". *PLOS Medicine* 6.7 (2009): e1000100.

18. Vassar Matt., *et al.* "Manual Search Approaches Used by Systematic Reviewers in Dermatology". *Journal of The Medical Library Association: JMLA* 104.4 (2016): 302.

19. Sterne JA., *et al*. "Robins-I: A Tool for Assessing Risk of Bias in Non-Randomised Studies of Interventions". *British Medical Journal* 355 (2016): i4919.

20. Muraleedhar Seetha Suchithra., *et al*. "Caries Risk Assessment and Referral Tool (Cra-Rt)-a Novel Risk Scoring System for Early Childhood Caries in Community Settings". *Community Dentistry and Oral Epidemiology* (2020).

21. Goodwin M., *et al*. "Sugar before Bed: A Simple Dietary Risk Factor for Caries Experience". *Community Dental Health Journal* 34.1 (2017): 8-13.

22. Farsi Najat., *et al*. "Caries Risk Assessment in Preschool Children in Saudi Arabia". *Oral Health and Preventive Dentistry* 11 (2013): 10.

23. Al Ghanim NA., *et al*. "Caries Prediction Model in Pre-School Children in Riyadh, Saudi Arabia". *International Journal of Paediatric Dentistry* 8.2 (1998): 115-122.

24. Alhabdan YA., *et al*. "Prevalence of Dental Caries and Associated Factors among Primary School Children: A Population-Based Cross-Sectional Study in Riyadh, Saudi Arabia". *Environmental Health and Preventive Medicine* 23.1 (2018): 60.

25. Chaffee BW., *et al*. "Caries Risk Assessment Item Importance: Risk Designation and Caries Status in Children under Age 6". *The JDR Clinical and Translational Research* 1.2 (2016): 131-142.

26. Gao XL., *et al*. "Building Caries Risk Assessment Models for Children". *Journal of Dental Research* 89.6 (2010): 637-643.

27. Sarmadi R., *et al*. "Strategies for Caries Risk Assessment in Children and Adolescents at Public Dental Clinics in a Swedish County". *International Journal of Paediatric Dentistry* 19.2 (2009): 135-140.

28. "Caries-Risk Assessment and Management for Infants, Children, and Adolescents". *The Pediatric Dental Journal* 39.6 (2017): 197-204.

29. Ellen RP. "Microbiological Assays for Dental Caries and Periodontal Disease Susceptibility". *Oral Sciences Reviews* 8 (1976): 3-23.

30. Crossner CG and AK Holm. "Saliva Tests in the Prognosis of Caries in Children". *Acta Odontologica Scandinavica* 35.3 (1977): 135-139.

31. Holm AK. "Dental Health in a Group of Swedish 8-Year-Olds Followed since the Age of 3". *Community Dentistry and Oral Epidemiology* 6.2 (1978): 71-77.

32. Rundegren J and T Ericson. "Actual Caries Development Compared with Expected Caries Activity". *Community Dentistry and Oral Epidemiology* 6.2 (1978): 97-102.

33. Klock B and B Krasse. "A Comparison between Different Methods for Prediction of Caries Activity". *Scandinavian Journal of Dental Research* 87.2 (1979): 129-139.

34. Seppä L and H Hausen. "Frequency of Initial Caries Lesions as Predictor of Future Caries Increment in Children". *Scandinavian Journal of Dental Research* 96.1 (1988): 9-13.

35. Tuomi T. "Pilot Study on Obesity in Caries Prediction". *Community Dentistry and Oral Epidemiology* 17.6 (1989): 289-291.

36. Seppä L., *et al*. "Past Caries Recordings Made in Public Dental Clinics as Predictors of Caries Prevalence in Early Adolescence". *Community Dentistry and Oral Epidemiology* 17.6 (1989): 277-281.

37. Pelkwijk A., *et al.* "Caries Experience in the Deciduous Dentition as Predictor for Caries in the Permanent Dentition". *Caries Research* 24.1 (1990): 65-71.

38. Abernathy JR., *et al.* "Development and Application of a Prediction Model for Dental Caries". *Community Dentistry and Oral Epidemiology* 15.1 (1987): 24-28.

39. Stamm JW., *et al.* "The University of North Carolina Caries Risk Assessment Study. I: Rationale and Content". *Journal of Public Health Dentistry* 48.4 (1988): 225-232.

40. Farsi N., *et al.* "Caries Risk Assessment in Preschool Children in Saudi Arabia". *Oral Health and Preventive Dentistry* 11.3 (2013): 271-280.

41. Beck JD., *et al.* "University of North Carolina Caries Risk Assessment Study: Comparisons of High Risk Prediction, Any Risk Prediction, and Any Risk Etiologic Models". *Community Dentistry and Oral Epidemiology* 20.6 (1992): 313-321.

42. Leong PM., *et al.* "A Systematic Review of Risk Factors During First Year of Life for Early Childhood Caries". *International Journal of Paediatric Dentistry* 23.4 (2013): 235-250.

43. Gao X., *et al.* "Validity of Caries Risk Assessment Programmes in Preschool Children". *Journal of Dentistry* 41.9 (2013): 787-795.

44. Christian B., *et al.* "A Systematic Review to Assess the Methodological Quality of Studies on Measurement Properties for Caries Risk Assessment Tools for Young Children". *International Journal of Paediatric Dentistry* (2018).

**Volume 19 Issue 9 September 2020**