

# Caries Risk Assessment and Control

P Basavaraj<sup>1</sup>, Nitin Khuller<sup>2</sup>, Rajnanda Ingle Khuller<sup>3</sup>, Nikhil Sharma<sup>4</sup>

## ABSTRACT

Dental caries has a multifactorial etiology in which there is interplay of three principal factors. The host (saliva and teeth), the micro flora (plaque), and the substrate (diet), and a fourth factor time. Many times the initiation, development and progression of dental caries are often influenced by the oral health status, aetiology, modifying factors, preventive factors and other risk factors. There is no single test that takes into consideration all these factors and can accurately predict an individual's susceptibility to caries. The risk of dental caries can be evaluated by analyzing and integrating several causative factors. Caries risk assessments during treatment can serve as monitoring aid for the success of the treatment. The aim of this review is to assess the risk factors associated with dental caries so that the treatment can be planned accordingly.

**Keywords:** Dental Caries; Risk assessment

---

### <sup>1</sup>Professor

Dept. of Public Health Dentistry  
ITS Centre for Dental Studies & Research  
Delhi-Meerut Road, Muradnagar,  
Ghaziabad-201206 (UP)

### <sup>2</sup>Reader

Dept. of Periodontics  
ITS Centre for Dental Studies & Research  
Delhi-Meerut Road, Muradnagar,  
Ghaziabad-201206 (UP)

### <sup>3</sup>Post Graduate Student

Dept. of Prosthodontics  
ITS Centre for Dental Studies & Research  
Delhi-Meerut Road, Muradnagar,  
Ghaziabad-201206 (UP)

### <sup>4</sup>Reader

Dept. of Periodontics  
ITS Centre for Dental Studies & Research  
Delhi-Meerut Road, Muradnagar,  
Ghaziabad-201206 (UP)

## INTRODUCTION

Dental caries has a multifactorial etiology in which there is interplay of three principal factors. The host (saliva and teeth), the micro flora (plaque), and the substrate (diet), and a fourth factor time.

Many times the initiation, development and progression of dental caries are often influenced by the oral health status, aetiology, modifying factors, preventive factors and other risk factors. The pattern of dental caries in the dentition, reflected in terms of decayed, missing, and filled surfaces, is generally unevenly distributed as caries prevalence among individuals. Caries preventive measures, therefore not only should be tailored to the risk teeth and surfaces in the dentition. Hence risk for caries development varies significantly for different age groups, individuals, teeth and teeth surfaces. Therefore, caries preventive measures must be integrated based on knowledge and understanding of the predicted risk (1).

There is no single test that takes into consideration all these factors and can accurately predict an individual's susceptibility to caries. The risk of dental caries can be evaluated by analyzing and integrating several causative factors. Caries risk assessments during treatment can serve

as monitoring aid for the success of the treatment. They may also be very useful for screening populations in community preventive programmes by identifying caries prone who need more intensive preventive care (2).

## DEFINITION

“Dental caries is an irreversible microbial disease of the calcified tissues of the teeth, characterized by demineralization of the inorganic portion and destruction of the organic substance of the tooth, which often leads to cavitation (3).

Risk is defined as “the probability of an individual developing a given disease” by definition caries risk assessment is a procedure to predict future caries development before the clinical onset of the disease.

## RISK FACTOR

- An attribute or exposure that is significantly associated with the development of a disease.
- A determinant that can be modified by intervention thereby, reducing the possibility of occurrence of disease or other specified outcomes.

WHO developed and promoted risk group or target group approach in the population by certain defined criteria and direct appropriate action to them first. This is

---

## Contact Author

**Dr. P. Basavaraj**

E-mail: docdental@yahoo.com

J Oral Health Comm Dent 2011;5(2)58-63

known as risk approach. It has been summed up as something for all, but more for those in need- in proportion to the need. In essence, the risk approach is a managerial device for increasing the efficiency of health care services within the limits of existing resources (4).

**Concept of caries risk assessment**

The concept of caries risk assessment is, from one point of view, simple and straightforward. The idea is to:

- Identify those persons who will most likely develop caries
- Provide these individuals proper preventive and treatment measures to stop the disease.

Opponents of this high risk strategy claim that it is nearly impossible to identify such persons, and that extra preventive measure for high risk individuals will not work anyway. Some investigators claim that similar measures should be administered to the whole population regardless of the risk.

It is important to analyze the difference between a risk model and a prediction model, and we base the description on beck proposals (5-7).

A risk model is used when it is important to identify one or more risk factors for the disease so that likely points for intervention can be planned. A risk model, therefore, should exclude risk predictors such as past disease, number of teeth, such factors do not cause further disease.

A prediction model, on the contrary, is used when one is mainly interested in identifying who is at risk. The main goal is to maximize sensitivity and specificity of the prediction, so that any good predictor may be included in the model. The choice of the model depends on the purpose and situation in which the assessment is being made, e.g. If it is a public health matter or a clinical perspective (8).

**Risk approach- may be in community or in individual assessment**

**Community:** A “community” is defined

as any group with common traits, shared features or communal experiences. Therefore, a city, state, school district or neighborhood could be considered a community. Under this definition, a military institution, nursing home facility or managed care organization is also a community.

Caries risk assessment for a community is determined by identifying the frequency of decay occurrence, including untreated as well as restored surfaces. This type of historical perspective can help identify groups within the community who, due to the presence of various risk factors, are the most susceptible to the ravages of decay. Therefore, preventive measures can be initiated with these target populations since they would potentially derive the most benefit (9, 10).

**Individual assessment:** Assessment of a person’s risk for dental caries relies on a number of factors. These factors could include caries history, preventive practices, nutritional habits and medical conditions. Caries risk is not stagnant in a patient and can vary from one point of time in his or her life to another. Such variation in susceptibility requires ongoing monitoring by the oral health care professional, since changes in health status, use of medications and other lifetime events can increase risk.

Based on the clinical evaluation and information derived from a patient’s medical and dental history, he or she can be classified as being at low, moderate or high risk. In addition, inadequately restored surfaces, poor oral hygiene, exposed root surfaces, orthodontic treatment and elevated *streptococcus mutans* levels could be factors (11).

**Assessment in different groups**

Recent studies have shown that carious lesions are initiated more frequently at specific ages. This applies particularly not only to children but also to adults. In children, the key risk periods for initiation of caries seem to be during eruption of the permanent molars and the period during which enamel is undergoing

secondary maturation. In adults, most root caries develops in the elderly, partly because of the higher prevalence of exposed root surface.

**Mothers with high salivary mutans streptococci (MS)**

Kohler et al in the year 1978 & 1982 (12) showed that mothers with high salivary ms levels frequently transmit to their babies as soon as the first primary teeth erupt, leading to greater chances of development of dental caries. Enamel of erupting and newly erupted primary teeth is most caries susceptible until completion of secondary maturation. And also the specific immune system particularly immunoglobulin in saliva among 1-3 year old infants is immature. In addition to this, poor oral hygiene favors establishment of carious micro flora.

On this basis, the first priority age groups are expectant mothers and 1-3 years old children.

**Key – risk age group 2:- age 5 to 8 years**

- The next high risk age group is from 5-8 years, in which the eruption of first molars is taking place. The enamel of erupting and newly erupted permanent teeth is considerably more susceptible to caries development until secondary maturation is completed, more than two years of eruption.

**Key – risk age group 3: age 11 to 15 years**

- This is especially true during the eruption of second molar. Normally second molar erupts at the age of 11 – 12 years, and total eruption time is 14 – 18 months. During this period, approximal surfaces of newly erupted posterior teeth are at their most carious susceptible level. Therefore, 11 – 15 years olds have not only by far, the highest number of intact tooth surfaces but also the more number of surfaces at risk.

**Key – risk age group young adults and adults (19 – 22) years**

- Most of them have erupting or newly erupted third molars without full

chewing function but with highly carious susceptible fissure on mesial surfaces. In addition among many young adults changes in the dietary and oral hygienic habits and also in life style make them more susceptible. (exposing peer pressure towards good or bad habits) (13).

### OLDER ADULTS

Another risk age group is among older adults; most of them who have multiple restorations with plaque retentive margins as well as root surfaces exposed by chronic periodontitis are susceptible for root caries.

### OTHER RISK GROUPS

- Persons who are obese because of frequent eating (sugary snacks).
- Persons with systemic disease who are taking regular medications (affecting salivary function).
- Pregnant and lactating mothers.
- Persons who have impaired salivary functions or immune response.
- Persons undergoing radiation therapy for malignancies of head and neck region.

### KEY RISK TEETH AND SURFACES

The factor that determines the tooth loss is related to age, dental caries, periodontal diseases and others. And also there are many factors which determine the attack of the teeth and some surfaces are susceptible to dental caries and also some time they are at higher risk for development of dental caries.

The molars are the first teeth to erupt and have the widest proximal surfaces; hence they are at more risk for dental caries. On the contrary the mandibular incisors are least susceptible or at low risk for dental caries. The key risk surfaces are the fissures of the molars and proximal surfaces, from the mesial aspect of the second molars to the distal aspect of the first molars. The wide mesial surfaces of the first molars are frequently carious and exposed to cariogenic micro flora when the second premolars erupt.

It is well known, however, that all newly

erupted teeth are more or less deficient in mineral content and thus more susceptible for caries than after some of post eruptive maturation.

### TOOTH ASSESSMENT

Research indicates that the teeth most susceptible to pit and fissure decay are the first and second permanent molars. Although the life expectancy of primary teeth is limited, their importance in securing adequate spacing for the permanent dentition cannot be underestimated. Therefore, it may be appropriate to initiate preventive measures for primary molars and premolars when at risk. An evaluation of individual tooth morphology, the level of carious activity and the pattern of caries can help determine if individual teeth are at risk. Evidence is suggesting that caries in the primary dentition increases a child's risk of caries in his or her permanent dentition (9).

### TOOTH SURFACE ASSESSMENT

It is well-documented that pit and fissure configuration can be a significant risk factor for occlusal caries. Pits and fissures compose only 12.5 percent of tooth surfaces, yet they account for 88 percent of caries in children. Deep pits and fissures that are not easily cleaned can harbor bacteria that break down the enamel surface. Permanent molars have the most susceptible pits and fissures. Premolar teeth are less susceptible, but in some patients, maxillary incisors with fissured or pitted surfaces may also be at risk (9).

### FACTORS RELEVANT TO ASSESSMENT OF CARIES RISK

- Social history
- Medical history
- Dietary habits
- Use of fluorides
- Plaque control
- Saliva
- Bacteria

### Social history

Social deprivation in many studies has shown to be an indicator of risk. The most targeted areas of greatest need are disease like coronary heart disease and cancers,

specially concentrated in socially deprived people. The features common in high risk patients are: (14)

- Caries in siblings is often high.
- If patient possesses little knowledge of the disease.
- If regular dental attendance is low and dental aspiration are too low.
- Patient access to snacks is high.

### Medical history

- Medically compromised and handicapped people may be at high risk of caries.
- Long term users of medicines can be a problem if the medicines are sugar based.
- Most relevant factor in a medical history is a dry mouth.
- Patients who have had radiotherapy in the region of the salivary glands for head and neck malignancy will suffer from xerostomia.
- Patients with rheumatoid arthritis may also have Sjogrens syndrome affecting the salivary and lacrimal glands leading to dry mouth and dry eyes.
- Many medicaments like antidepressants, anti psychotics, tranquilizer, antihypertensive and diuretics causes dry mouth.

### Dietary habit

- The amount of carbohydrate particularly high sugar intake can be a caries risk factor.
- Fluoride delays the progression of dental caries; hence patients who don't use a fluoride containing toothpaste may be at risk to development of caries.
- It has been shown that water fluoridation is beneficial in caries prevention particularly in areas of social deprivation.

### Plaque control

Dental plaque is the risk factor for dental caries because caries is the result of metabolic activities in this biofilm and unless it is present, caries will not occur, irrespective of any other factor.

This however does not mean that all patients with poor plaque control will

inevitably develop caries but does mean that oral hygiene is the bedrock of caries control in a high risk patient.

**Saliva<sup>15</sup>**

- Many features of saliva affect the risk of developing caries. Xerostomia has already been discussed as a predisposing factor. Research studies have also suggested that salivary counts of mutans streptococci and lactobacilli are predictors of caries risk.
- After birth an oral ecosystem is established consisting of different kinds of bacteria.
- The colonization of the mouth odontopathic bacteria is by human transmission, mostly from mother, father or care givers to infants, and depends upon the quantity of these bacteria the parents harbour.
- Toddlers who carry a large amount of mutans streptococci already at 2 and 3 years of age show a noticeably higher risk of developing caries on primary teeth.

**MODIFYING FACTORS FOR THE DEVELOPMENT OF CARIES**

- Epidemiological surveys of caries show on increase caries prevalence with age.
- New erupted teeth are more susceptible to caries particularly at pit and fissure site.
- The susceptibility seems to be increased also by the difficulty of clearing the teeth until they have reached the occlusal plane and opposing teeth are occluding. As the enamel matures it is less likely to decay.

**Gender**

- The permanent teeth in particular erupt 6 to 12 months earlier in girls than they do in boy (16).
- During childhood and adulthood

women show high dmf – values than men.

- But in general their oral hygiene is better and they have fewer missing teeth than men.

**Socio-economic**

- Socioeconomic status is highly relevant to caries prevalence.
- Caries is more prevalent in lower than in higher social classes.
- This is not due to more expensive treatment but to a greater health interest in upper social classes
- Important social factor are education and occupation.
- The parents care is reflected in the dental health of their children.

**Genetic**

- Studies at identical twins who have been raised separately have shown that other etiological factors are more important than genetic factors such as tooth morphology position and occlusion.
- Workers in industries such as bakeries, candy and chocolate factories and sugar cane cutters, have higher caries prevalence than worker in other industries.

**General medical factors**

- General medical factors, like long term use of sugary liquid medications by children, increase caries prevalence.
- Many other medications, especially psycho – pharmaceutical products, reduce the flow of saliva and thus increase caries risk.
- Cytotoxic chemotherapy disrupts the mineralization of teeth.
- Data concerning caries prevalence in mentally or physically retarded populations compared to non retarded

are mixed, some have higher prevalence others not.

**Dental therapy**

- The type of treatment delivered by dentists depends in part on the costs to the patients.
- On the other hand the dentist’s academic education, continuing education, knowledge of preventive measures, and the use of modern technique are additional factors influencing treatment.

**Health system**

- The therapy proposed by the dentist is influenced by that society’s health system.
- The coverage of dental services influences its acceptor based on current knowledge about the etiology of caries, this disease cannot be cured by restorative measures, but only by preventive ones.

**DEFINING CARIES RISK ASSESSMENT (17)**

Caries risk assessment may involve simply looking at a patient’s clinical appearance. A patient with two or more carious lesions may be considered at high risk of developing caries in the future more frequently, caries risk assessment also involves looking further into patient factors that may affect the carious process, such as fluoride exposure, salivary flow rate and sugar intake. One of the most popular caries risk assessments has been promoted by Dr. Bo krasse. He recommends measuring salivary samples for levels of *mutans streptococci* and lactobacilli. He also includes a stimulated salivary flow rate and buffer capacity in the assessment. Current research focuses on the development of a caries risk assessment model, which involves the statistical analysis of patient factors. These factors may or may not be associated with the disease process, but they are investigated for their potential to predict caries activity.

**Risk category**

- **High risk:** presence of single risk indicator in any area of the high risk

**Table 1: Caries risk assessment**

Salivary factor	Risk category		
	Low	Intermediate	High
Flow rate	≥1ml/minute	0.7 - 1 ml/minute	≤0.7 ml/minute
Buffer capacity	pH 5-7	pH 4-5	pH <4
Mutans streptococci (cfu/ml)*	<10 <sup>5</sup>	10 <sup>5</sup> -10 <sup>6</sup>	>10 <sup>6</sup>
Lactobacilli (cfu/ ml)*	<10 <sup>4</sup>	10 <sup>4</sup> -10 <sup>5</sup>	>10 <sup>5</sup>

\* cfu: colony-forming unit

category is sufficient to classify a child being at high risk.

- **Medium risk:** presence of at least one moderate risk indicator and no high risk indicator classifies as moderate risk.
- **Low risk:** Absence of high and moderate risk indicator classifies as low risk category.

### IDENTIFYING RELEVANT RISK FACTORS<sup>18</sup>

Although it may take a soft time to determine a patient’s risk status, explain the cause of the risk may take little longer and this is work while time spending, because patient or dentist may be able to modify some risk factors and in turn, thus slow down disease progression.

Removal of plaque on the surface that is developing a white spot is a good example of this for some patients, frequency of intake of particular drink, snack or eatables may be overriding importance to their caries risk, and other risk factors such as dry mouth or social deprivation are less amenable to alteration.

A patient with sjogren’s syndrome may always be at a high risk and always have to make strenuous preventive efforts. It is unlikely to be able to modify or elevate social deprivation in any particular patient or group of people but may be able to observe that social factors change over time, some times for better some time for worst.

### CLINICAL EVIDENCE

- Clinical evidence has been shown to be the best predictor of caries risk, thus patients with the following characteristic are at high risk.
- Multiple new lesions
- History of premature extraction for caries.
- Multiple restorations.
- Anterior teeth caries or restorations.
- History of frequent replacement of restorations.

### MANAGEMENT OF CARIES<sup>17</sup>

#### Importance of caries risk assessment in general practice

For each patient, risk assessment allows

for tailoring of a custom prevention program. A patient at low risk of developing caries may not need office fluoride treatments or a six-month recall appointment. On the other hand, a patient at high risk of developing caries may need home fluoride treatments and a three month recall appointment. Risk assessment allows dental care to be rendered more efficiently. In light of today’s emphasis on health care reform, risk assessment may eventually be used by dental insurers to determine a patient’s benefit package.

#### Multiple assessment models needed

A risk model that uses data collected from 6-year-olds will not apply directly to adult patients. Each age group—children, teens, adults, geriatric patients— has its own set of risk variables. For example, a risk model for an elderly population may include xerostomic medications; this factor may not be appropriate in a model for children. In addition, some models developed for elderly patients apply only to root caries. Such models, obviously, would not apply to children.

#### Practice goals set model parameters

Risk models may be designed to identify subjects who will develop six carious lesions over three years or one carious lesion over one year. Practice goals and disease prevalence should be considered in model development. A practice with a 12-month recall system may require a model that predicts the development of one carious lesion. A public program with limited funds may need to review models that span three to four years to select only those patients at highest risk of developing carious lesions. Researchers from the University of North Carolina compared models based on dichotomous outcomes (Caries present vs. Caries absent) with models based on a gradient outcome (25 percent of the population with the highest number of carious lesions). “any risk” described the present/absent model; “high risk” described the gradient model. They found that the any-risk model was better

at predicting subjects who would develop disease compared with the gradient method, but at a price. The any risk model also incorrectly identified many low-risk children as being high-risk. This type of error would increase the costs of a prevention program. Some risk assessment models are based on prevalence or cross-sectional data.

These models are useful in the early identification of variables to use in risk models, but the most appropriate risk models for predicting subjects likely to experience an increase in disease are those based on incidence or longitudinal data. Researchers select a model for which the risk variables are collected at baseline; follow up the population for a specified length of time; and correlate the baseline variables with caries development. This model would apply only to the designated length of time.

#### Choosing a statistical method in risk modeling

The choice of statistical methods is important because different methods can give different results. Early investigations into factors associated with caries usually compared a single variable with caries development. Since the 1980s, multiple variables have been included in risk models. These multivariate techniques have resulted in better caries prediction. Risk models that include multiple variables offer better prediction because the disease process is multifactorial. The most commonly used statistical methods for caries risk assessment models today are multivariate regression techniques.

The terms commonly used to describe the accuracy of a risk model are sensitivity and specificity. Sensitivity is the proportion of people with a disease who have a positive test result for the disease. For example, a saliva sample that is positive for *m. Streptococci* correlates with a clinical finding of caries. If this bacterial screen accurately predicted people who would eventually develop caries in 75 percent of the cases, one would conclude that the screen had a high sensitivity for caries prediction.

Specificity is the proportion of people without a disease who have negative test results. If the bacterial test had a specificity of 85 percent, it would have a high specificity for caries prediction. Usually, attempts to improve the sensitivity of a test will decrease the specificity and vice versa. A highly sensitive test or model may lead to false positive findings, with increased expenditure for preventive treatments. A highly specific model may lead to false-negative findings, with caries-active people not receiving the preventive services they need. Generally, most caries risk models are better at selecting people who will not develop caries (that is, high specificity) than they are at selecting people who will (that is, high sensitivity).

Kingman et al (19) recommended a sum for sensitivity and specificity of 160 percent as a guideline for estimating the accuracy of a caries risk model. Few models have demonstrated this level of accuracy. A model for infants that included *m. Streptococci*, immigrant status, mother's education, and sugared beverage and candy consumption reported a combined sensitivity and specificity score of 170 percent. For older children (6 years old), a model that included salivary measures of bacteria and phosphate proved reasonably accurate (sum of 165 percent). Two risk models for adults reported acceptable values for sensitivity and specificity (that is, a sum of 162 percent and 167 percent) in predicting root caries. Both models included root caries experience and adverse periodontal conditions, such as high plaque scores and periodontal pocketing. Before using a caries risk assessment, dentists should confirm the accuracy of the test or model; otherwise, the selection of high risk patients cannot be assured.

**APPLYING CARIES RISK INFORMATION**

Caries risk assessment is still in the developmental stage. No single model can be recommended for use in a clinical setting at this time. Nor is it likely that there will ever be a "one size fits-all" caries risk assessment model. Some of the current models demonstrating acceptable accuracy are based on factors that are either difficult or expensive to collect.

They also lack validation with other populations. Patients who have active caries or in whom teeth are missing (due to caries) or restored should be considered at high risk of future caries activity. Dentists should monitor them for other factors that may affect their caries activity, such as sugar intake (especially snacks) or medication use. Even over-the-counter medications can contribute to the caries problem since many contain high amounts of sugar or may decrease salivary flow.

Prevention strategies should be directed at correcting these problems. Dentists should monitor caries activity at recall appointments. Measuring bacterial levels can help with this monitoring. Chairside products (for example, dip slides) as well as many university laboratories can provide estimates of salivary levels of *m. Streptococci*.

**CONCLUSION**

A caries risk assessment model should be appropriate for the age of the patient, the dentist's style of practice and the prevalence of caries in the population. It should include multiple factors that are easy and inexpensive to measure and should report a sensitivity/specificity sum of at least 160 percent. Finally, caries risk assessment should include some measure of previous caries experience as a predictive factor.

A combination of aetiological factors, caries prevalence and incidence, external and internal modifying risk indicators, risk factors as well as preventive factors may use to assess individual caries risk as low risk or high risk. Dental care neither begins nor ends with a single schedule of treatment but is ongoing and continuous process. The recall interval is based partly on an assessment risk of caries.

**REFERENCES**

1. Oscarson N, Lindholm L, Kaˆllestaˆ IC. The value of caries preventive care among 19-year olds using the contingent valuation method within a cost–benefit approach. *Community Dent Oral Epidemiol* 2007;**35**:109-17.
2. Gerdin EW, Angbratt M, Aronsson K, Eriksson E, Johansson I. Dental caries and body mass index by socio-economic status in Swedish children. *Community Dent Oral Epidemiol* 2008; **36**: 459–465.
3. Shafer HL. Shafer's Oral Pathology; 6<sup>th</sup> Ed, 2009.

4. Park K. Textbook of Preventive & Social Medicine; 19<sup>th</sup> Ed. 2009.
5. Beck JD. Risk re-visited. *Comm Dent Oral Epidemiol* 1998;**26**:220-25.
6. Burt BA. Concepts of risk in dental public health. *Community Dent Oral Epidemiol* 2005;**33**:240-47.
7. Beighton D. The complex oral microflora of high-risk individuals and groups and its role in the caries process. *Community Dent Oral Epidemiol* 2005;**33**:248-55.
8. Brathall D, Hansel PG. Cariogram- a multifactorial risk assessment model for a multifactorial disease. *Comm Dent Oral Epidemiol* 2005;**33**:256-64.
9. Rethman J. Trends in preventive care: caries risk assessment and indications for sealants. *J Am Dent Assoc* 2000;**131**: 8s-12s.
10. Tranæus S, Shi X-Q, Angmar-Mansson B. Caries risk assessment: methods available to clinicians for caries detection. *Community Dent Oral Epidemiol* 2005;**33**:265-73.
11. Maserejian NN, Tavares MA, Hayes C, Soncini JA, Trachtenberg FL. Prospective study of 5-year caries increment among children receiving comprehensive dental care in the New England children's amalgam trial. *Community Dent Oral Epidemiol* 2009;**37**:9-18.
12. Kohler B, Andreen I, Jonsson B, Hultqvist E. Effect of caries preventive measures on streptococcus mutans and lactobacilli in selected mothers. *Scand J Dent Res* 1982;**90**(2):102-08.
13. Plutzer K, Spencer AJ. Efficacy of an oral health promotion intervention in the prevention of early childhood caries. *Community Dent Oral Epidemiol* 2008; **36**:335-46.
14. Petersen PE. Socio-behavioural risk factors in dental caries – international perspectives. *Community Dent Oral Epidemiol* 2005;**33**:274-79.
15. Bader JD, Perrin NA, Maupome´ G, Rush WA, Rindal BD. Exploring the contributions of components of caries risk assessment guidelines. *Community Dent Oral Epidemiol* 2008;**36**:357-62.
16. Teivens A, Mörnstad H, Reventlid M. Individual variation of tooth development in Swedish Children. *Swed Dent J* 1996; **20**(3):87-93.
17. Powell V. Caries risk assessment: Relevance to practitioner. *J Am Dent Assoc* 1998;**129**:349-53.
18. Ismail AI, Sohn W, Tellez M, Willem JM, Betz J, Lepkowski J. Risk indicators for dental caries using the International Caries Detection and Assessment System (ICDAS). *Community Dent Oral Epidemiol* 2008;**36**:55-68.
19. Kingman A, Selwitz RH. Proposed methods for improving the efficiency of the DMFS index in assessing initiation and progression of dental caries. *Community Dent Oral Epidemiol* 1997;**25**(1):60-8.