

## Changes in caries risk profile following the use of xylitol chewing gums – An interventional study

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### Abstract

**Aim:** The study aims to evaluate the changes in caries risk profile after the use of Xylitol chewing gums.

**Materials and Method:** Xylitol chewing gums were distributed to ten healthy individuals between the age group of 18 to 25 years to be used thrice daily for a period of 14 days. A structured questionnaire was designed to procure demographic details, medical and diet history and fluoride exposure from each subject. Unstimulated salivary samples were collected to assess the salivary flow rate, buffering capacity and *S.mutans* levels. Decay, Missing, Filling Surface index and Silness and Loe index were used to record caries experience and plaque amounts. From the obtained data two cariograms were constructed for each individual before and after the intervention. The change in the percentage of the different sectors of the cariogram were tabulated and interpreted.

**Result:** A substantial increase in the percentage of green sector was seen in all the subjects after 14 days use of Xylitol. A decrease in the percentage of red sector followed by light blue sector was also observed in all the subjects at the end of 14 days.

**Conclusion:** Caries risk profiles of individuals improve greatly following the use of Xylitol chewing gums. Xylitol is an effective caries preventive agent that can improve the chance to avoid new cavities for an individual.

**Keywords:** Dental Caries, Cariogram, Prevention, Risk assessment.

### Introduction

An ounce of prevention is better than a pound of cure. The significance of prevention of any disease over cure or arrest is obvious. The avoidance of the disease and maintenance of health is a well recognized act of preservation. The concept of primary prevention is ever evolving. Employing preventive strategies becomes meaningful when it is based on the risk level of the individual. The approach being proactive, demands the need for prediction of disease in an individual. This led to the construction of prediction models using the information available on risks associated with the disease.<sup>(1)</sup> Risk is the probability that some harmful event will occur. Risk factors and risk behaviours can be considered as key elements of disease predilection. Risk factors are social, economic or biological status, behaviours or environments with or cause increased susceptibility to a specific disease, ill health or injury (WHO health promotion glossary 1998). Risk behaviours are specific forms of behaviour which are proven to be associated with increased susceptibility to a specific disease or ill-health (WHO health promotion glossary 1998). Risk assessment is the systematic evaluation of the potential risks involved.

Dental caries is an endemic disease which can be cured and prevented. Caries management by risk assessment (CAMBRA) is a philosophy that aims to identify and modify the risk factors and behaviours to prevent dental caries. This takes into consideration that every patient has an individualistic set of attributes, each of which can either be disease favouring or protective. Thus the strategy is preventive rather than therapeutic. The focus is on the disease process rather than the

outcome and importantly it is patient centric. Caries risk assessment (CRA) is the fundamental component of CAMBRA. Dental caries being a multifactorial disease, the risk assessment involves large set of information to be collected, compiled and analysed. This necessitates the employment of a multifactorial risk assessment tool.<sup>(2)</sup>

Cariogram is one such computer based risk assessment program. The relevant data relating to the patient is obtained and fed into the software. This is converted to scores by a built-in algorithm following the standard protocol. The information is evaluated and summarized as a pie-chart. This is a graphical illustration depicting the interaction of various factors. The cariogram algorithm involves weightage being given to each of the factors. Weightage expresses the different degrees to which every factor can influence disease outcome. This is based on review of ample literature. There are no scientific studies that have comprehensively analysed all the factors together simultaneously. Thus the development of a cariogram is based on the theoretic impact of the risk factors.<sup>(3)</sup>

Xylitol is a five carbon sugar alcohol. Studies have reported xylitol to be efficient in prevention of dental caries. Literature reveals that consumption of xylitol reduces growth and metabolism of both the acidogenic and aciduric oral flora thus improving the salivary defence mechanism. The occurrence figures of dental caries are known to have significantly reduced with daily consumption of xylitol chewing gums in many clinical studies.<sup>(4)</sup> Thus the aim of this study is to assess the changes in caries risk profiles after the use of Xylitol chewing gums

## Materials and Method

A 14 days prospective field trial with before and after comparisons was conducted after obtaining approval from the ethical committee of the institutional review board. Ten healthy individuals of the age group 18-25 years were enrolled in the study. Subjects using sugar-substitute gums, under antibiotic cover or/and on antibiotic therapy in the past two weeks and allergic to xylitol gums were excluded from the study. Written informed consent was obtained from the subjects after elaborating the purpose of the study. Xylitol chewing gums (Orbit White, Wrigley India Pvt. Ltd., Bangalore, Karnataka, India) were distributed to all the subjects. The subjects were asked to follow a uniform oral hygiene routine throughout the period of study. They were instructed to use the chewing gums for a period of 14 days thrice everyday (within 20 minutes after every meal— breakfast, lunch and dinner) for a duration of 5 minutes. All the subjects were recruited from the same hostel with a common mess and thus uniform diet was ensured. The individuals were instructed to refrain from antimicrobial medications and adhere to similar oral hygiene procedures. They were instructed to use the same tooth paste and were asked to brush twice daily using the modified Bass brushing method. Apart from that they were discouraged to use any additional oral hygiene aid during the study period. The subjects were constantly monitored throughout the study period.

A structured questionnaire was used to obtain information regarding the medical history, drug history, diet content, frequency and exposure to fluorides. This was followed by clinical examination using mouth mirror and explorer No.23 and 17 to record the DMFS index (WHO 1987 criteria) for evaluating the past caries experience. Sillness and Loe Plaque index was recorded to ascertain the oral hygiene status. The participants were asked to fill up a 5ml sterile plastic container with unstimulated saliva. The time taken to collect this amount was noted and the salivary flow rate was assessed. The collected saliva was then subjected to laboratory analysis for assessing the buffering capacity and *S.mutans* levels. For microbial analysis, 1ml of the sample was taken, serially diluted and vortex mixed. 0.1ml of this sample was inoculated onto MitisSalivarius agar base (HIMEDIA, Mumbai, Maharashtra, India) and was incubated at 37°C for 48 hours with 3% CO<sub>2</sub>. Based on the colony morphology and gram staining, the identification of *Mutans streptococcus* was done. The colony forming units were then counted manually. Buffering capacity was assessed using digital pH meter (Digital pH meter, MIFA systems private limited, Ahmadabad, Gujarat, India). Calibration of the pH sensitive electrodes was done for pH 4.0 and 7.0 using standard pH pellets. 250 micro litres of lactic acid (pH 3, 1.5mM) was titrated into the salivary sample and mixed.

The pH value of the titrated sample was noted from the digital reading display. At the end of 2 weeks, salivary samples were collected again following the same protocol for analysing the flow rate, buffer capacity and *S.mutans* levels. Plaque scores were also recorded again at the end of 14 days.

This data was tabulated in Microsoft excel 2007. Two cariograms (Bratthall *et al* cariogram, Internet version 2.01.) were constructed for each individual with data obtained before and after usage of xylitol chewing gums. The green components of the cariograms were compared pre and post intervention.

## Results

Table 1 shows change in the green sector of all subjects before and after the intervention. Results of the trial reveal an increase in the percentage of green sector after 14 days in all subjects. The mean increase in percentage of the green sector is from 59.3% to 67%. This shows that xylitol is an effective anti-cariogenic agent. The difference in the green sector percentage among the subjects ranges from 3% to 20% with a central value of 7.7%.

Table 2 shows the change in percentage of the remaining four sectors on comparing the pre-and post intervention cariogram models. A difference range of 1% to 7% is seen under the red sector. This sector shows the maximum range of difference when compared to the other sectors indicating that xylitol reduces the quantity of plaque and *mutans streptococcus* count. Red sector is followed by light blue sector with a difference range of 0% to 7% signifying the improvement on salivary flow rate and buffering capacity by xylitol. The yellow sector and the dark blue sector reveal insignificant changes from the baseline values.

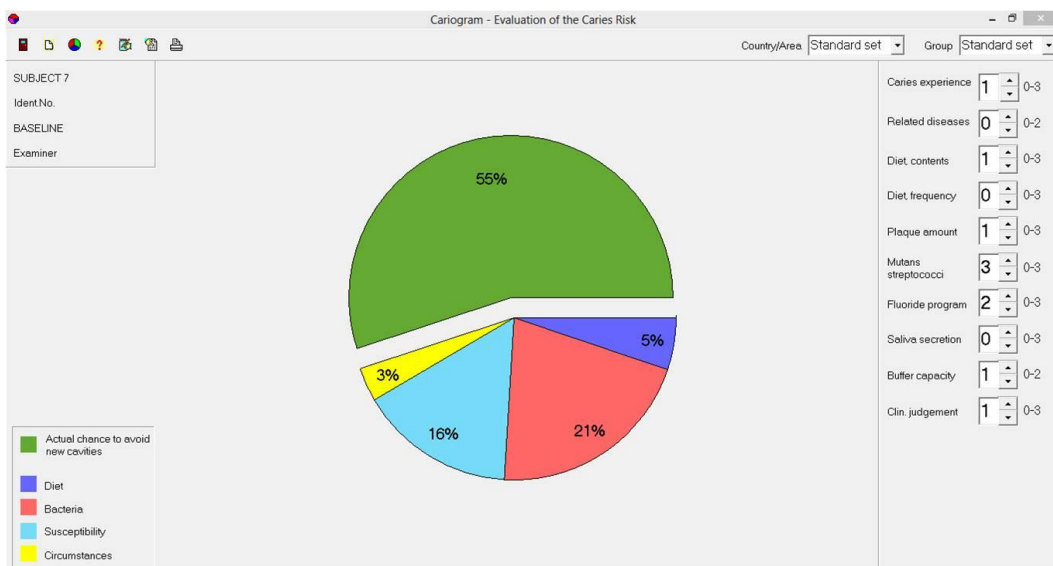
Fig. 1 shows the cariogram models constructed for one of the study subjects at baseline and figure 2 shows the cariogram constructed after 14 days.

**Table 1: Percentage of green sector in cariogram for all subjects before and after intervention**

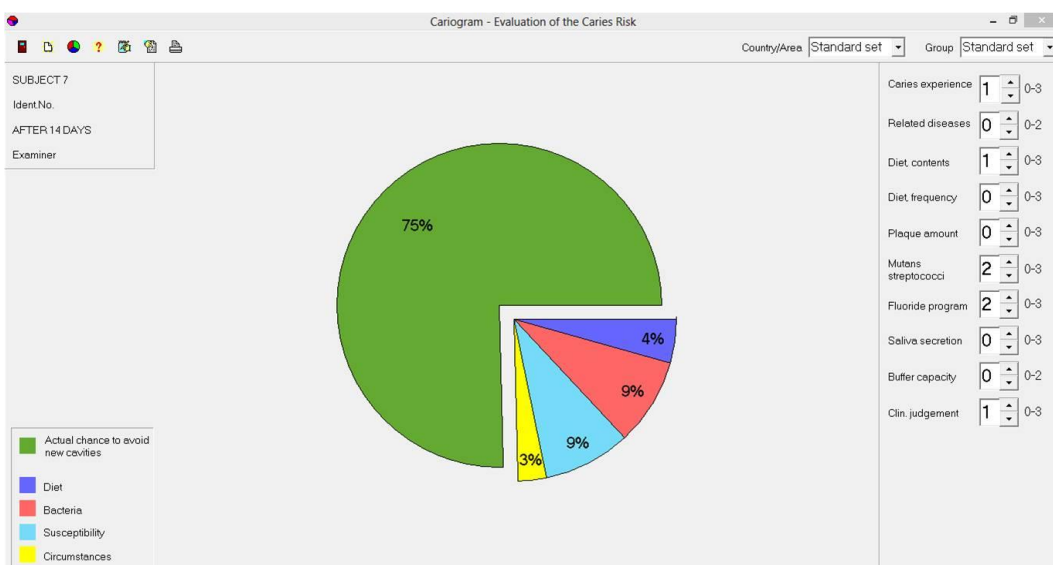
Subject	% of green sector		Difference in %
	At baseline	After 14 days	
1	50	54	4
2	54	57	3
3	45	50	5
4	76	79	3
5	56	65	9
6	74	85	11
7	55	75	20
8	74	86	12
9	75	79	4
10	34	40	6

**Table 2: Percentage of the remaining four sectors of the cariogram for all the subjects before and after intervention**

Subject	% of light blue sector		Difference in %	% of red sector		Difference in %	% of dark blue sector		Difference in %	% of yellow sector		Difference in %
	At baseline	After 14 days		At baseline	After 14 days		At baseline	After 14 days		At baseline	After 14 days	
1	21	21	0	21	16	5	5	5	0	3	3	0
2	8	9	-1	15	9	6	15	17	-2	7	9	-2
3	15	10	5	15	15	0	15	15	0	10	10	0
4	18	7	1	10	7	3	5	5	0	1	2	-1
5	12	2	10	16	12	4	8	8	0	8	2	6
6	11	5	6	11	7	4	3	2	1	1	1	0
7	16	9	7	21	9	12	5	4	1	3	3	0
8	11	6	5	11	4	7	3	2	1	1	2	-1
9	10	7	3	8	7	1	5	5	0	2	2	1
10	19	16	3	19	16	3	24	26	-2	2	3	1



**Fig. 1: Cariogram of one subject pre-intervention**



**Fig. 2: Cariogram of the same subject post-intervention**

## Discussion

Care is an absolute. Prevention is the ideal – Christopher Howsen.

As health care professionals, we have been trained classically to focus more on treatment and less on prevention. The onset of disease is accompanied by mental agony, physical distress, pre-treatment ailment, loss of productivity and a range of deleterious complications. These cannot be compensated by the remedial procedures. The gross advantages offered by primary prevention must be exploited completely. There is a need for a radical shift in the approach to diseases. Preventive medicine should become an integral part of clinical practice.<sup>(1)</sup>

Dental caries is a multifaceted and dynamic disease. The salient feature of the disease is that each patient has a unique set of contributory factors which makes the pathological process individualistic. A universal mode of prevention for dental caries cannot be implemented, thus it must be customized and tailored according to the patient in question.<sup>(5)</sup> This calls for comprehensive risk profile compilation where large amount of data should be analysed. Such an assessment enables identification of risk which should be tackled and modified. This allows the intervention to be targeted.<sup>(6-8)</sup> Cariogram is one such risk assessment tool that integrates disease indicators, risk factors and protective factors to predict the probability of developing caries. Cariogram is a graphical representation of caries risk. It explains the inter relationship between various contributory factors, depicts probability of avoiding caries and advocates focussed intervention. It can be used easily in clinical practice for patient education and motivation.<sup>(3)</sup> In this study the cariogram outcomes are used to not only assess the risk of the individual but also to evaluate the effectiveness of the preventive intervention.

In the recent past, more interest has been focused on the use of sugar free gum after every meal as a preventive strategy.<sup>(9)</sup> Chewing gum with non-cariogenic sweeteners after consuming carbohydrates lead to rise in pH as a sequence of stimulated salivary flow with increased bicarbonate levels. This causes neutralization of pH by increased buffering capacity and enhanced clearance of fermentable carbohydrates. As a long term effect, it leads to reduction in the incidence of caries.<sup>(10-13)</sup> Xylitol is one such sugar free sweetener which has been researched widely for its caries protective action. Ever since its approval by the Food and Drug Administration, it has been widely used in various forms namely candies, gummy bear snacks, dentifrice, syrups, chewing gums, mouth rinse, etc.<sup>(14-18)</sup> The significant advantage with chewing gum include better acceptability, prolonged period of contact with the tooth surface and permanence below the critical pH for a limited period.<sup>(19-22)</sup> Hence this study employs chewing gum as the mode of delivery for Xylitol. After every meal, there is a fall in pH for 5 to 20 minutes interval. To counteract the fall in pH, chewing gums must be

provided during this critical period. Hence the subjects were instructed to follow the same.<sup>(23,24)</sup>

At the end of 14-day trial period, there is substantial increase in the green sector. This means that the 'chance of avoiding caries' has been increased. Clinical studies suggest Xylitol to be an effective caries protective agent.<sup>(4)</sup> The results of this study also prove the same. This increase in green sector is due to the decrease in the other sectors. In the current study, the red sector has been predominantly modified followed by the light blue sector. The depreciation in the red sector at the end of 14 days signifies the impact of xylitol on dental plaque and *Mutans streptococcus*. Dental plaque does not ferment Xylitol.<sup>(25-27)</sup> There is ample evidence that oral flora does not adapt to metabolize xylitol. Hence bacterial growth is discouraged.<sup>(28-31)</sup> Secondly there is a selective effect on *Mutans streptococcus* resulting in the development of resistance. These resistant strains possibly exhibit less virulence in the oral habitat.<sup>(29,33-34)</sup> Plaque on exposure to xylitol results in increased concentrations of ammonia and basic ammonia acids which neutralize the plaque acids.<sup>(34-36)</sup> Apart from these, in-vitro studies have demonstrated the uptake of xylitol by certain strains of oral streptococci, converting it into xylitol-5-phosphate leading to the formation of intra-cellular vacuoles and degradation of cell membranes in *S.Mutans* and *S.Sobrinus*. Via this mechanism xylitol is acting in a bacteriostatic way.<sup>(37-41)</sup> Finally, few strains participate in "the futile metabolic cycle" where the cell takes up xylitol and phosphorylates to xylitol-5-phosphate which is then acted upon by sugar-phosphate phosphatases, resulting in expulsion of the end product. Though the relevance of the process is yet to be established, it is more likely to be beneficial than harmful.<sup>(41-50)</sup> There is ample evidence in literature which suggest the decrease of plaque growth by xylitol compared with sugars and other polyols. These studies include the Turku sugar studies and trials of partial substitution and supplementation. There is also good evidence that the ability of plaque to produce acids by metabolism of sugars is reduced by Xylitol.<sup>(51,52)</sup> Further research is needed to assess the clinical relevance of these mechanisms.

Light blue sector is made up by the combination of salivary secretion, salivary buffer capacity and fluoride program. Since there was no fluoride intervention, the change observed in the light blue sector is attributed to salivary secretion and salivary buffer capacity. The influence of xylitol can be implicated in these changes. Numerous studies suggest that the anti-caries effect of chewing gum relies on the act of chewing rather than the sweetener present in the gum. Literature suggests that chewing gums stimulated the salivary flow, improved the buffering capacity and neutralized the plaque pH.<sup>(53,54)</sup> Stimulated saliva in comparison with unstimulated saliva contains a greater concentration of ions which predominantly constitute the lattice structure of hydroxyapatite. Thus, stimulated saliva more

effectively repairs the enamel crystal damaged by initial lesions.<sup>(54)</sup>

Past caries experience and related general diseases constitute the yellow sector. According to the results there is no change in the sector as caries take more than 14 days to develop. Moreover, no drastic deterioration in general health can be seen during a limited period of 14 days.<sup>(3)</sup> The dark blue sector is made up by diet content and diet frequency. This sector shows insignificant alterations as the patients were not advised to change their diet pattern.<sup>(3)</sup> If within 14 days an apparent improvement is seen in the green sector as a result of using Xylitol, then long term use of this compound will surely result in better oral health. Hence long term trial with a larger sample size, which is particularly a drawback of this study, is required to certify and justify the caries preventive nature of Xylitol.

### Conclusion

Within the limitations of the present study it can be concluded that a visible and desirable increase in the green sector of the cariogram is seen following the use of Xylitol chewing gums. Thus it becomes evident that Xylitol is a good preventive intervention; however the effectiveness of the agent against a dynamic disease like dental caries can be validated only by long term trials. Usage of these gums can be advocated to larger populations to impede the burden of dental caries. Prevention is the centre stone in the riviere of comprehensive dental care. Hence preventive approaches based on the risk assessment needs of a patient will be the precise way to practice holistic dentistry.

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