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1: J Calif Dent Assoc. 2003 Mar;31(3):205-9.

Xylitol and dental caries: an overview for clinicians.

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An overview of studies about xylitol and dental caries suggests potential clinical dental applications for xylitol. Xylitol is a naturally occurring, low-calorie sugar substitute with anticariogenic properties. Data from recent studies indicate that xylitol can reduce the occurrence of dental caries in young children, schoolchildren, and mothers, and in children via their mothers. Xylitol, a sugar alcohol, is derived mainly from birch and other hardwood trees. Short-term consumption of xylitol is associated with decreased *Streptococcus mutans* levels in saliva and plaque. Aside from decreasing dental caries, xylitol may also decrease the transmission of *S. mutans* from mothers to children. Commercial xylitol-containing products may be used to help control rampant decay in primary dentition. Studies of schoolchildren in Belize and Estonia, along with data from the University of Washington, indicate that xylitol gum, candy, ice pops, cookies, puddings, etc., in combination with other dental therapies, are associated with the arrest of carious lesions. A prospective trial in Finland has demonstrated that children of mothers treated with xylitol had lower levels of *S. mutans* than children of mothers treated with chlorhexidine or fluoride varnish. Food products containing xylitol are available commercially and through specialized manufacturers, and have the potential to be widely accessible to consumers.

Publication Types:

Review

Review, Tutorial

PMID: 12693818 [PubMed - indexed for MEDLINE]

2: J Dent Hyg. 2002 Fall;76(4):276-85.

Xylitol for caries prevention.

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Xylitol is a naturally occurring sweetener which is essentially not fermentable by the caries-inducive oral microflora. When tested as a sucrose replacer, or even as a small dietary addition, systematic xylitol use leads to impressive reductions in caries incidence. Xylitol is compatible and complementary with all current oral hygiene recommendations. The appealing sensory and functional properties of xylitol facilitate a wide array of applications that promote oral health.

Publication Types:

Review

Review, Tutorial

PMID: 12592919 [PubMed - indexed for MEDLINE]

3: ASDC J Dent Child. 2002 Jan-Apr;69(1):81-6, 13.

Effect of xylitol chewing gum on salivary Streptococcus mutans in preschool children.

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Dental caries remains a significant problem for poor children in the United States. One strategy for treating dental caries is to suppress streptococcus

mutans, the chief pathogen responsible for the disease. The purpose of this study was to evaluate the effect of xylitol gum in salivary *S. mutans* levels in preschool children. Sixty-one children were randomly assigned into the xylitol group and the control group. The xylitol group chewed gum sweetened only with xylitol (XyliFresh100%, Hershey Food Corporation, U.S.A.) three times a day for three weeks. *S. mutans* counts were tested using the Dentocult-SM Strip Mutans-test (Orion Diagnostica, Finland) at baseline and after three weeks. The shift from higher *S. mutans* scores to lower was greater in the xylitol group than in the control group ( $p < 0.05$ ). This study supports the suggestion that chewing xylitol gum may reduce salivary *S. mutans* levels. Xylitol chewing gum may provide a feasible caries prevention method for preschool children.

Publication Types:

Clinical Trial

Randomized Controlled Trial

PMID: 12119821 [PubMed - indexed for MEDLINE]

4: J Dent Educ. 2001 Oct;65(10):1106-9.

The effect of non-cariogenic sweeteners on the prevention of dental caries: a review of the evidence.

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The role of sugar substitutes such as xylitol and sorbitol in the prevention of dental caries has been investigated in several clinical studies. The purpose of this report is to review the current published evidence regarding the relationship between sugar substitutes and dental caries. A literature search was conducted using MEDLINE and EMBASE and included studies published from 1966 to 2001. Studies that included human subjects and were published in English were included in this review. A total of fourteen clinical studies were reviewed that

evaluated the effect of sorbitol or xylitol or the combination of both sugar substitutes on the incidence of dental caries. Most of the reports were of studies conducted with children outside of the United States. These studies demonstrated a consistent decrease in dental caries, ranging from 30 to 60 percent, among subjects using sugar substitutes as compared to subjects in a control group. These caries rate reductions were observed in subjects using xylitol or sorbitol as the sugar substitute in chewing gum or toothpaste. The highest caries reductions were observed in subjects using xylitol. These findings suggest that the replacement of sucrose with sorbitol and xylitol may significantly decrease the incidence of dental caries.

PMID: 11699985 [PubMed - indexed for MEDLINE]

5: Acta Odontol Scand. 2000 Dec;58(6):285-92.

Efficacy of a slow-release device containing fluoride, xylitol and sorbitol in preventing infant caries.

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A novel slow-release administration device, the "Fall-Asleep Pacifier" (FAP), was studied as a prophylactic measure against mutans streptococcal oral infection and dental caries in a risk group of 1-year-old children by comparing the test (T, n = 34) and control (C, n = 88) groups in a prospective cohort study. In the T group the children received their fluoride tablets (Fludent, containing NaF corresp. 0.25 mg F<sup>-</sup>, xylitol 159 mg and sorbitol 153 mg) in the evenings in FAP. In the C group the children received the same dose of Fludent crushed in food in the evenings. The proportion of children, whose plaque samples from the upper incisors were mutans streptococcus positive at the age of 24 months, was significantly ( $P < 0.05$ ) greater in group C (25%) than in group T (9%). The children in the T group developed significantly ( $P < 0.001$ ) less (none) new dentinal carious lesions in their primary dentitions than the children in the C group between 2 and 3 1/2 years of age. Fifty-four percent of

the children to whom the FAP was offered complied with regular use of it. The beneficial effect observed in the T group compared with the C group was apparently mostly due to the administration mode via FAP, which could prolong the intra-oral bioavailability of the prophylactic preparation.

Publication Types:

Clinical Trial

Controlled Clinical Trial

PMID: 11196405 [PubMed - indexed for MEDLINE]

6: Acta Odontol Scand. 2000 Dec;58(6):279-84.

Sealants and xylitol chewing gum are equal in caries prevention.

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Sealants and xylitol have been demonstrated to prevent dental decay, but their effect has never been compared in the same study. Regular use of xylitol chewing gum during 2 or 3 school years was compared with application of occlusal sealants in a randomized study. The reliability of the clinical observations was controlled by examining the presence of dental decay in the same teeth from bitewing radiographs in a blind study. After 5 years, no statistically significant differences between the sealant and xylitol groups were found. The results were in line with the results from separate studies with sealants or xylitol. There were no great differences between the costs of the measures. The selection between the compared preventive measures has to be made on the basis of practical aspects such as caries occurrence, availability of personnel and other resources, opportunity costs, cooperation with schools, and other local conditions.

Publication Types:

Clinical Trial

Randomized Controlled Trial

PMID: 11196404 [PubMed - indexed for MEDLINE]

7: J Dent Res. 2000 Nov;79(11):1885-9.

Comment in:

J Dent Res. 2001 Jul;80(7):1600-1.

Occurrence of dental decay in children after maternal consumption of xylitol chewing gum, a follow-up from 0 to 5 years of age.

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Studies have shown that prevention of mutans streptococci (MS) colonization in early childhood can lead to prevention of dental decay. In the microbiological part of the present study in Ylivieska, Finland, with 195 mothers with high salivary MS levels, regular maternal use of xylitol chewing gum resulted in a statistically significant reduction in MS colonization in their children's teeth at the age of 2 years compared with teeth in children whose mothers received fluoride or chlorhexidine varnish treatment. The children did not chew gum or receive varnish treatments. For the present study, the children were examined annually for caries occurrence by experienced clinicians who did not know whether the children were colonized with MS. Regardless of the maternal prevention group, the presence of MS colonization in children at the age of 2 years was significantly related to each child's age at the first caries attack in the primary dentition. In children at the age of 5 years, the dentinal caries (dmf) in the xylitol group was reduced by about 70% as compared with that in the fluoride or chlorhexidine group. We conclude that maternal use of xylitol chewing gum can prevent dental caries in their children by prohibiting the transmission of MS from mother to child.

Publication Types:

Clinical Trial  
Randomized Controlled Trial

PMID: 11145360 [PubMed - indexed for MEDLINE]

8: J Am Dent Assoc. 2000 Jul;131(7):909-16.

Maintaining mutans streptococci suppression with xylitol chewing gum.

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**BACKGROUND:** One strategy for treating dental caries is to suppress oral mutans streptococci, or MS, with chlorhexidine, or CHX, mouthrinse. Oral MS levels, however, tend to quickly return to baseline values without further intervention. In this clinical study, the authors evaluated the effect of xylitol chewing gum on MS regrowth. **METHODS:** The authors selected 151 subjects with elevated oral MS levels ( $\geq$  or = 10<sup>5</sup> colony-forming units per milliliter, or CFU/mL, of paraffin-stimulated saliva). Subjects rinsed with 0.12 percent CHX gluconate mouthrinse twice daily for 14 days. The authors then randomly assigned the subjects to one of three groups. Those in the test group (n = 51) chewed a commercial xylitol gum three times daily for a minimum of five minutes each time for three months. The placebo group subjects (n = 50) used a commercial sorbitol gum, and the control group subjects (n = 50) did not chew gum. The authors estimated MS load on the dentition using paraffin-stimulated saliva samples. The authors serially diluted the samples, plated them on selective media and incubated them anaerobically; they then enumerated the colonies under a stereomicroscope. **RESULTS:** MS levels were not significantly different between the three groups at baseline (mean log CFU/mL standard deviation: 5.4 0.7, 5.4 0.8, 5.2 0.7, respectively) nor after CHX therapy (2.7 0.8, 3.1 1.1, 3.0 1.1, respectively). After three months of gum chewing, the test group subjects had significantly lower salivary MS levels (3.6 1.2) than did the placebo (4.7 1.2) or control (4.4 1.3) group subjects.

CONCLUSIONS: Xylitol chewing gum appears to have the ability to prolong the effect of CHX therapy on oral MS. CLINICAL IMPLICATIONS: Maintaining long-term caries-pathogen suppression is feasible with currently available commercial products and can be expected to result in significant caries inhibition.

Publication Types:

Clinical Trial

Randomized Controlled Trial

PMID: 10916329 [PubMed - indexed for MEDLINE]

9: J Dent Res. 2000 Mar;79(3):882-7.

Comment in:

J Dent Res. 2001 Jul;80(7):1600-1.

Influence of maternal xylitol consumption on acquisition of mutans streptococci by infants.

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Xylitol is effective as a non-cariogenic sugar substitute. Habitual xylitol consumption appears to select for mutans streptococci (MS) with impaired adhesion properties, i.e., they shed easily to saliva from plaque. One hundred sixty-nine mother-child pairs participated in a two-year study exploring whether the mothers' xylitol consumption could be used to prevent mother-child transmission of mutans streptococci. All mothers showed high salivary levels of mutans streptococci during pregnancy. The mothers in the xylitol group (n = 106) were requested to chew xylitol-sweetened gum (65% w/w) at least 2 or 3 times a day, starting three months after delivery. In the two control groups, the mothers received either chlorhexidine (n = 30) or fluoride (n = 33) varnish treatments at 6, 12, and 18 months after delivery. The children did not chew gum or receive varnish treatments. MS were assessed from the mothers' saliva at

half-year intervals and from the children's plaque at the one- and two-year examinations. The MS were cultured on Mitis salivarius agars containing bacitracin. The salivary MS levels of the mothers remained high and not significantly different among the three study groups throughout the study. At two years of age, 9.7% of the children in the xylitol, 28.6% in the chlorhexidine, and 48.5% in the fluoride varnish group showed a detectable level of MS. In conclusion, therefore, habitual xylitol consumption by mothers was associated with a statistically significant reduction of the probability of mother-child transmission of MS assessed at two years of age. The effect was superior to that obtained with either chlorhexidine or fluoride varnish treatments performed as single applications at six-month intervals.

Publication Types:

Clinical Trial

Randomized Controlled Trial

PMID: 10765964 [PubMed - indexed for MEDLINE]

10: Pediatrics. 1998 Oct;102(4 Pt 1):879-84.

Comment in:

Pediatrics. 1998 Oct;102(4 Pt 1):971-2.

Pediatrics. 1998 Oct;102(4 Pt 1):974-5.

A novel use of xylitol sugar in preventing acute otitis media.

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**BACKGROUND:** Xylitol, a commonly used sweetener, is effective in preventing dental caries. As it inhibits the growth of pneumococci, we evaluated whether xylitol could be effective in preventing acute otitis media (AOM). **DESIGN:** Altogether, 857 healthy children recruited from day care centers were randomized to one of five treatment groups to receive control syrup (n = 165), xylitol

syrup (n = 159), control chewing gum (n = 178), xylitol gum (n = 179), or xylitol lozenge (n = 176). The daily dose of xylitol varied from 8.4 g (chewing gum) to 10 g (syrup). The design was a 3-month randomized, controlled trial, blinded within the chewing gum and syrup groups. The occurrence of AOM each time the child showed any symptoms of respiratory infection was the main outcome. RESULTS: Although at least one event of AOM was experienced by 68 (41%) of the 165 children who received control syrup, only 46 (29%) of the 159 children receiving xylitol syrup were affected, for a 30% decrease (95% confidence interval [CI]: 4.6%-55.4%). Likewise, the occurrence of otitis decreased by 40% compared with control subjects in the children who received xylitol chewing gum (CI: 10.0%-71.1%) and by 20% in the lozenge group (CI: -12.9%-51.4%). Thus, the occurrence of AOM during the follow-up period was significantly lower in those who received xylitol syrup or gum, and these children required antimicrobials less often than did controls. Xylitol was well tolerated. CONCLUSIONS: Xylitol sugar, when given in a syrup or chewing gum, was effective in preventing AOM and decreasing the need for antimicrobials.

Publication Types:

Clinical Trial

Randomized Controlled Trial

PMID: 9755259 [PubMed - indexed for MEDLINE]

11: J Dent Res. 1995 Dec;74(12):1904-13.

Xylitol chewing gums and caries rates: a 40-month cohort study.

Makinen KK, Bennett CA, Hujoel PP, Isokangas PJ, Isotupa KP, Pape HR Jr, Makinen PL.

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Dental caries is a pandemic infectious disease which can affect the quality of life and consumes considerable health care resources. The chewing of xylitol,

sorbitol, and even sugar gum has been suggested to reduce caries rates. No clinical study has simultaneously investigated the effectiveness of these gums when compared with a group receiving no chewing gum. A 40-month double-blind cohort study on the relationship between the use of chewing gum and dental caries was performed in 1989-1993 in Belize, Central America. One thousand two hundred and seventy-seven subjects (mean age, 10.2 years) were assigned to nine treatment groups: one control group (no supervised gum use), four xylitol groups (range of supervised xylitol consumption: 4.3 to 9.0 g/day), two xylitol-sorbitol groups (range of supervised consumption of total polyols: 8.0 to 9.7 g/day), one sorbitol group (supervised consumption: 9.0 g/day). The gum use during school hours was supervised. Four calibrated dentists performed the caries registrations by means of a modified WHO procedure. The primary endpoint was the development of an unequivocal caries lesion on a non-cavitated tooth surface. Compared with the no-gum group, sucrose gum usage resulted in a marginal increase in the caries rate (relative risk, 1.20; 95% confidence interval, 0.96 to 1.49;  $p = 0.1128$ ). Sorbitol gum significantly reduced caries rates (relative risk 0.74; 95% confidence interval, 0.6 to 0.92 ;  $p = 0.0074$ ). The four xylitol gums were most effective in reducing caries rates, the most effective agent being a 100% xylitol pellet gum (relative risk, 0.27; 95% confidence interval, 0.20 to 0.36;  $p = 0.0001$ ). This gum was superior to any other gum ( $p < 0.01$ ). The xylitol-sorbitol mixtures were less effective than xylitol, but they reduced caries rates significantly compared with the no-gum group. DMFS analyses were consistent with these conclusions. The results suggest that systematic usage of polyol-based chewing gums reduces caries rates in young subjects, with xylitol gums being more effective than sorbitol gums.

Publication Types:

Clinical Trial

Controlled Clinical Trial

PMID: 8600188 [PubMed - indexed for MEDLINE]

12: Int Dent J. 1995 Feb;45(1 Suppl 1):65-76.

Xylitol chewing gum and dental caries.

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There is an extensive peer-reviewed literature on xylitol chewing gum as it pertains to effects on tooth decay in human subjects, on human dental plaque reduction, on inhibition of dental plaque acid production, on inhibition of the growth and metabolism of the mutans group of streptococci which are the prime causative agents of tooth decay, on reduction of tooth decay in experimental animals, and on xylitol's reported contribution to the remineralisation of teeth. The literature not only supports the conclusion that xylitol is non-cariogenic but it is now strongly suggestive that xylitol is caries inhibitory, that is, anti-cariogenic in human subjects, and it supplies reasonable mechanistic explanation(s).

Publication Types:

Review

Review, Tutorial

PMID: 7607747 [PubMed - indexed for MEDLINE]

13: Caries Res. 1993;27(6):495-8.

Long-term effect of xylitol chewing gum in the prevention of dental caries: a follow-up 5 years after termination of a prevention program.

Isogangas P, Makinen KK, Tiekso J, Alanen P.

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About 65% of the original 258 children who participated in 1982-1984 in a caries prevention program involving the use of xylitol chewing gum were retrieved in 1989 for a follow-up study. Ninety-five subjects from the original xylitol (X)

group and 70 subjects from the original control (no-gum, C) group were available. In 1984, when the children completed the program at the age of 13-14 years, the caries scores were significantly lower in children who had used xylitol gums daily, compared with the C group. In 1989, 5 years after the discontinuation of the gum program, the difference between the X and C groups had continued to increase in favor of the X group. These effects were explained by assuming that the X gum program had facilitated the establishment of a low-virulent bacterial flora on the surfaces of the teeth, and especially on those teeth that erupted during the trial proper. This type of results are possibly helpful when evaluating cost-benefit ratios of caries prevention.

Publication Types:

Clinical Trial

Controlled Clinical Trial

PMID: 8281565 [PubMed - indexed for MEDLINE]

14: Acta Odontol Scand. 1985 Dec;43(6):381-7.

Collaborative WHO xylitol field studies in Hungary. VII. Two-year caries incidence in 976 institutionalized children.

Scheinin A, Pienihakkinen K, Tiekso J, Banoczy J, Szoke J, Esztari I, Zimmermann P, Hadas E.

The aim was to assess caries increment as influenced by partial substitution of sucrose by xylitol (X group) over a 2-year period in comparison with systemic fluoride (F group) and restorative treatment only (C group). The study differed from the 3-year field study of the same series primarily in that existing base-line differences were eliminated because the protocol required that all the new subjects entering the institutions in the 1st year were to be included for a 2-year trial. During this period the number of dropouts was 243 (19.9% of all subjects), the final material consisting of 976 children (6-12 years old). The 2-year DMFS increment was 3.8 in the X group, 4.8 in the F group, and 6.0 in the C group. The corresponding ratio (RS) between caries incidence and the tooth

surface population at risk was RSX, 4.5; RSF, 5.5; and RSC, 7.5. The xylitol regimen resulted in a lower increment of caries than measured in the F and C groups (p less than 0.001; covariance analysis, with base-line prevalence, number of permanent teeth, and visible plaque index as covariants).

PMID: 3879087 [PubMed - indexed for MEDLINE]

15: Acta Odontol Scand. 1975;33(5):269-78.

Turku sugar studies XVIII. Incidence of dental caries in relation to 1-year consumption of xylitol chewing gum.

Scheinin A, Makinen KK, Tammissalo E, Rekola M.

A longitudinal study was carried out in order to evaluate the caries incidence as affected by partial substitution of dietary sucrose (S) with xylitol (X), the effects of S- or X-containing chewing gums being compared during one year. The material comprised initially 102 young adults, predominantly dental and medical students, divided randomly into S- and X-groups. During the study 2 subjects were excluded, one due to lack of cooperation, the other not being allowed to enter the assigned S-group due to excessive caries prevalence. The subjects consumed 4.0 chewing gums per day in the S-group and 4.5 in the X-group. The frequency of sucrose intake was 4.2 times per day in the S-group, and 4.9 in the X-group. The caries incidence, assessed independently by clinical and radiographical means, expressed as the mean increment of decayed, missed and filled tooth surfaces, was 2.92 in the S-group, and -1.04 in the X-group. The corresponding values, when considering additionally the secondary caries reversals, were 3.76 in the S-group, and 0.33 in the X-group. The caries incidence was also expressed in combined quantitative and qualitative terms by considering in addition to the above parameters, also the changes in lesion size. The caries activity index thus calculated was 4.96 in the S-group, and 0.88 in the X-group. The results show a profound difference in the caries increment rate between the two experimental groups. The findings clearly indicate a therapeutic, caries inhibitory effect of xylitol.

Publication Types:

Clinical Trial

Randomized Controlled Trial

PMID: 1067728 [PubMed - indexed for MEDLINE]

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