

# THE EFFECT OF CHEWING SUGAR-FREE GUM AFTER MEALS ON CLINICAL CARIES INCIDENCE

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**Editor's note:** This article marks the debut of "Advances in Dental Products," a new department in JADA. It provides a peer-reviewed forum for the increasing number of submissions of commercially funded research. It will appear in The Journal as material becomes available and is approved through the peer-review process.

**I**n recent years, a great deal of interest has centered on the use of chewing gum after meals as a means of stimulating salivary flow to prevent the formation of dental caries. The increase in flow enhances the buffering capacity of saliva, which effectively neutralizes the drop in plaque pH that occurs after eating.<sup>1</sup> Since the mid-1980s, researchers have been examining the effect of salivary stimulation on plaque pH, with the assumption that a reduction in plaque pH after food ingestion should lead to a reduction in caries rates. Numerous studies have shown a significant reduction in the acidogenicity of plaque when food consumption was followed by chewing sugar-free gum.<sup>2-8</sup> In addition, studies have shown that chewing gum after meals enhances remineralization<sup>1,9,10</sup> and prevents demineralization.<sup>11</sup>

## ABSTRACT

**To determine the effect of chewing sugar-free gum on caries incidence, the authors conducted a randomized clinical study. A total of 1,402 children in Puerto Rico, in grades 5 through 7 at baseline, completed the study. They were randomized by classroom into a control group or chewing gum group; those in the gum group were instructed to chew sugar-free gum for 20 minutes after each of three meals a day. Clinical and radiographic evaluations were performed at baseline and after two and three years. The results show that all subjects and high-risk subjects, respectively, in the gum group developed 7.9 percent and 11.0 percent fewer decayed, missing or filled surfaces than subjects in the control group. Based on these findings, the authors concluded that chewing sorbitol-based sugar-free gum after eating significantly reduces the incidence of dental caries.**

Two literature reviews concur that a potential caries reduction occurs when a sugar-free gum is chewed after a meal or snack.<sup>12,13</sup> However, Edgar and Geddes<sup>13</sup> noted varying results in regard to the efficacy of these products in reducing dental caries when compared with a no-treatment control group. Thus, we initiated a randomized, examiner-blinded clinical trial to investigate whether the use of sugar-free (sorbitol-mannitol-aspartame) chewing gum after meals reduces clinical caries incidence.

## SUBJECTS, MATERIALS AND METHODS

**Subjects.** The protocol for this trial was approved by the institutional review boards at both Indiana University, Indianapolis, and the University of Puerto Rico, San Juan. We recruited 2,601 male and female schoolchildren enrolled in grades 5 through 7 in three communities in Puerto Rico. These communities were selected from screening data that indicated a relatively high caries prevalence and low levels of professional dental care and intervention. The drinking water in these communities contained negligible amounts of fluoride (0.1 parts per million).

TABLE 1

SUMMARY OF CHANGES IN DENTAL CARIES AFTER TWO YEARS.						
GROUP	n	OBSERVED CHANGE IN DMFS, MEAN (SD)* NUMBER	COVARIANCE-ADJUSTED CHANGE IN DMFS			
			Mean No.	RMSE†	Difference (Percentage)‡	P-Value
<b>All Subjects</b>						
Control	944	6.05 (5.15)	6.08			
Gum	874	5.71 (4.72)	5.69	4.54	-6.4	.013
<b>High-Risk Subjects</b>						
Control	808	6.60 (5.20)	6.68			
Gum	759	6.18 (4.78)	6.12	4.64	-8.4	.004

\* DMFS: Decayed, missing or filled surfaces; SD: standard deviation.  
 † Square root of the mean square error term for the analysis of covariance model.  
 ‡ Negative values indicate fewer new DMFS in the gum group than in the control group.

We obtained written informed consent from the children and their parents or guardians. Children wearing orthodontic appliances or those with a medical condition that could pose a risk to them or to other subjects (for example, hepatitis, phenylketonuria deficiency, tuberculosis or any condition requiring antibiotic medication before dental procedures) were not included in the study panel.

**Evaluations.** One of us (B.B.B.), not otherwise involved in day-to-day contacts with schools and subjects, evaluated the permanent dentitions of all subjects for caries, clinically and radiographically, at baseline and after two and three years. All clinical examinations were conducted with artificial light, mouth mirrors, compressed air and dental explorers. We used the criteria established by Radike<sup>14</sup> to diagnose carious lesions. In the clinical evaluation, both visual and tactile criteria had to be met for a diagnosis of caries to be made.

White spots were not diagnosed as carious unless they could be felt as well as seen. This is in contrast to at least one other chewing gum trial in which diagnoses were made at a precavitation level.<sup>15</sup>

The number of bitewing radiographs taken after the clinical examination varied from zero to four for each subject, depending on the visual accessibility of the permanent interproximal tooth surfaces. When interpreting the radiographs, the examiner (B.B.B.) evaluated only the interproximal surfaces. All clinical and radiographic diagnoses were made without reference to previous examination records or knowledge of treatment group.

**Treatment.** After the baseline evaluations, we randomly assigned classrooms to one of two groups after stratifying them by school system and arraying them by grade and decayed, missing or filled surfaces, or DMFS, status. At the outset of the trial, there were

123 classrooms in 18 schools. As the trial progressed, school officials tried to promote children into classrooms consistent with their group assignment.

Subjects were assigned to either the no-gum group or the sugar-free chewing gum group (Extra/Orbit brand, William Wrigley Jr. Co.), with sorbitol (40 to 60 percent), mannitol (4 to 15 percent) and aspartame (< 0.6 percent) sweeteners. We instructed subjects to chew the gum three times a day, after meals, for 20 minutes each time. Gum use was supervised by the teachers in the morning and at noon during school, but was unsupervised after evening meals and on days when school was not in session.

During the three-year study period, about one-third of the prescribed number of chewing sessions were supervised. Records of subject compliance were maintained by the teachers. We estimated compliance by keeping rosters of classroom participation and by instructing the children to return the outer wrappers from used sticks of gum. All children were instructed to continue their usual oral hygiene practices, including receiving professional dental care.

**Data analysis.** The primary outcome variable for this study was DMFS. Because randomization was performed at the classroom level, the analysis adjusted for this clustering.<sup>16</sup> The statistical analysis used a linear model, with age, sex, baseline caries scores (that is, DMFS) and baseline surfaces at risk as covariates, plus random-effects terms for school, treatment by school and classroom within treatment by school. We included these terms to account for the classroom's having been used as

the unit of randomization.

The principal comparisons between the chewing and nonchewing regimens used one-tailed statistical tests of hypotheses.<sup>17</sup>

Experience suggests that subjects with a history of caries can be expected to have higher caries levels in the future than subjects who are caries-free at the baseline examination. We analyzed the data for both "all available subjects" and for "high-risk" subjects, who had evidence of caries in the permanent dentition at the baseline examination (that is, a DMFS score greater than zero). Only 340 (13.1 percent) of the subjects were caries-free at the baseline examination.

We analyzed the two-year data for subjects actively participating after two years. Three-year data were analyzed two ways. First, we used results for subjects who were actively participating in the trial at the end of the study. We also used data for all subjects who could be located at the end of the study and who consented to an examination even if they had dropped out of the trial. This approach, often called intention-to-treat, provides a more valid estimate of treatment efficacy, as it relates to actual practice in the community.<sup>18</sup> Analysis by intention-to-treat is the general rule in medical trials and is recommended whenever reasons for dropout may be related to the treatment.<sup>16,18,19</sup>

**RESULTS**

The mean age of subjects at baseline was 11.65 years (n = 1,283) and 11.72 years (n = 1,318) for the control and treatment groups, respectively. The mean number of DMFS at

**TABLE 2**

SUMMARY OF CHANGES IN DENTAL CARIES AFTER THREE YEARS.						
GROUP	n	OBSERVED CHANGE IN DMFS, MEAN (SD)*	COVARIANCE-ADJUSTED CHANGE IN DMFS			
			Mean No.	RMSE†	Difference (Percentage)‡	P-Value
<b>Subjects Who Completed Study</b>						
<b>All Subjects</b>						
Control	746	8.63 (6.54)	8.72			
Gum	657	8.10 (6.07)	8.03	5.87	-7.9	.046
<b>High-Risk Subjects</b>						
Control	632	9.46 (6.53)	9.54			
Gum	572	8.67 (6.10)	8.49	5.97	-11.0	.007
<b>Intention-to-Treat Subjects</b>						
<b>All Subjects</b>						
Control	766	8.58 (6.51)	8.60			
Gum	699	8.00 (5.98)	7.79	5.84	-9.4	.018
<b>High-risk Subjects</b>						
Control	649	9.39 (6.51)	9.34			
Gum	607	8.59 (6.02)	8.26	5.94	-11.6	.003

\* DMFS: Decayed, missing or filled surfaces; SD: standard deviation.  
 † Square root of the mean square error term for the analysis of covariance model.  
 ‡ Negative values indicate fewer new DMFS in the gum group than in the control group.

baseline was 7.22 and 7.11 for all subjects in the control and treatment groups, respectively, while the number of DMFS for the high-risk subjects in the control and treatment groups was 8.39 and 8.11, respectively. At the outset of the study as well as after two and three years, the control and treatment groups were similar with regard to age, sex and DMFS. Attrition affected both groups equally.

Table 1 summarizes the changes in subjects after two years. For all subjects and high-risk subjects, respectively, the subjects in the sugar-free gum group had 6.4 percent

(P = .013) and 8.4 percent (P = .004) fewer new DMFS than subjects in the control group.

Table 2 summarizes the results after three years for subjects who were actively participating at the end of the study and for subjects who may not have completed the study but who were available for final evaluation. Only 62 subjects who dropped out during the trial could be located for, examined for and included in this analysis. Findings for all subjects and for high-risk subjects who completed the study show that the children who chewed

sugar-free gum after meals had 7.9 to 11.0 percent fewer new DMFS than the children in the control group ( $P = .046$  and  $P = .007$ , respectively). When those subjects who dropped out were added to the samples, the data show that children initially randomized to the gum group had 9.4 to 11.6 percent fewer new DMFS than children randomized to the control group.

We also analyzed reversals in diagnoses (that is, decayed or filled surfaces at baseline becoming sound at subsequent evaluations). For all active subjects, we found no differences between the control and gum groups with regard to the number of reversed diagnoses. After three years, the reversal rates (mean  $\pm$  standard deviation) were  $0.32 \pm 0.63$  and  $0.29 \pm 0.70$  for the control and gum groups, respectively.

## DISCUSSION

This is the first randomized, controlled clinical trial to directly test the use of sugar-free chewing gum after meals for anticaries effects. Our findings indicate that sugar-free chewing gum significantly reduces caries incidence, as measured by changes in DMFS. Based on previous laboratory and in situ studies, the anticaries effect observed in this study is likely due to salivary output stimulation, with accompanying effects on remineralization and plaque pH after food ingestion. Thus, it is reasonable to conclude that sugar-free gums in general would have the same effect if used in the same manner (that is, chewed for 20 minutes after meals three times a day), assuming that the same level of

salivary stimulation and compliance are achieved.

## CONCLUSION

We found that the use of sugar-free gum after meals resulted in about 0.7 fewer new DMFS in all subjects and about one fewer new DMFS in high-risk subjects over the three-year study period. Over time, such results can reap considerable savings in dental treatment resources when extrapolated to the general population. ■

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Additional information regarding this study is available on request from the authors.

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