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Effect of Sugar-Free Chewing Gum on Salivary pH and Caries Prevention in School-Aged Children

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ABSTRACT:

Background: Dental caries is a prevalent oral health issue among school-aged children, primarily driven by acidic oral environments that promote enamel demineralization. Saliva plays a vital role in neutralizing acids and maintaining oral health. Sugar-free chewing gum, particularly those containing xylitol, has been suggested to stimulate saliva production and increase salivary pH, thereby contributing to caries prevention.

Aim: This study aimed to assess the effect of sugar-free chewing gum on salivary pH levels and its role in the prevention of dental caries among school-aged children.

Methods: This prospective interventional study was conducted at Shifa International Hospital, Islamabad, from May 2024 to April 2025. A total of 110 school-aged children between the ages of 6 and 12 years were enrolled. Baseline salivary pH levels were recorded using a standardized digital pH meter. The participants were instructed to chew xylitol-containing sugar-free gum for 10 minutes, three times daily, over a 4-week period. Salivary pH was re-evaluated at weekly intervals. Caries incidence was monitored clinically and radiographically at the start and end of the intervention.

Results: There was a significant increase in salivary pH from a mean baseline value of 6.2 ± 0.3 to 7.0 ± 0.2 by the end of the fourth week ($p < 0.001$). Additionally, the number of new carious lesions observed during the study period was significantly lower in participants using sugar-free gum compared to historical controls. A strong inverse correlation ($r = -0.68$, $p < 0.01$) was observed between elevated salivary pH and new caries formation, suggesting a protective effect.

Conclusion: The use of sugar-free chewing gum effectively increased salivary pH and contributed to the prevention of dental caries in school-aged children. This simple, cost-effective intervention could be a valuable adjunct to routine oral hygiene practices in pediatric populations.

Keywords: Sugar-free chewing gum, salivary pH, dental caries, caries prevention, xylitol, school-aged children, oral health.

INTRODUCTION:

Dental caries had remained one of the most prevalent chronic diseases affecting children worldwide, particularly those in the school-going age group. The etiology of dental caries was multifactorial, involving host factors such as enamel susceptibility, dietary patterns, oral hygiene practices, microbial colonization, and salivary composition [1]. Among these, the role of saliva in maintaining oral homeostasis had been well established. Saliva served as a natural buffering system that helped neutralize acids produced by bacterial metabolism of dietary sugars, thereby protecting tooth enamel from demineralization. The pH

level of saliva played a critical role in this protective mechanism; when the pH fell below the critical threshold of 5.5, enamel demineralization ensued, paving the way for the development of carious lesions.

In recent years, the use of sugar-free chewing gum as a caries-preventive strategy had gained considerable interest due to its ability to stimulate salivary flow and enhance buffering capacity [2]. Unlike conventional chewing gums that contained fermentable sugars, sugar-free gums were sweetened with non-cariogenic agents such as xylitol, sorbitol, or mannitol. Among these, xylitol had been the most extensively studied and had demonstrated both salivary stimulation and antibacterial effects. It had been shown to reduce the levels of Streptococcus mutans, the principal microorganism responsible for caries, thus potentially lowering the incidence of dental decay [3].

School-aged children were particularly vulnerable to caries due to poor oral hygiene, frequent snacking, and limited access to dental care in some communities. The incorporation of simple, low-cost, and non-invasive interventions like sugar-free chewing gum into daily routines had offered a promising avenue for caries prevention in this population [4]. Previous studies had shown that chewing sugar-free gum after meals could elevate salivary pH and reduce plaque accumulation, which in turn could reduce caries risk. However, the magnitude and consistency of these effects, especially in younger populations, had remained a subject of ongoing research.

Furthermore, the psychological and behavioral aspects of chewing gum among children had also been explored. Chewing gum was generally well accepted by children and could be easily distributed in school settings, making it a practical adjunct to traditional oral hygiene practices [5]. Unlike fluoridated toothpaste or mouthwashes, sugar-free gum did not require supervision or complex instructions, thus increasing the likelihood of regular use.

Given these considerations, it had become important to assess the specific impact of sugar-free chewing gum on salivary pH levels and caries prevention in school-aged children [6]. By evaluating this relationship, health professionals and educators could better understand the preventive potential of such a widely accessible and acceptable product. The present study was therefore designed to investigate the effects of sugar-free chewing gum on salivary pH and its subsequent role in reducing the risk of dental caries among children aged 6 to 12 years. The study aimed to fill the knowledge gap by providing empirical evidence from a local context, contributing to the growing body of literature supporting non-pharmacological caries-prevention strategies in pediatric dentistry [7].

MATERIALS AND METHODS:

This study was conducted at the Department of Dentistry, Shifa International Hospital, Islamabad, from May 2024 to April 2025. A total of 110 school-aged children, ranging from 6 to 12 years old, were enrolled after obtaining written informed consent from parents or guardians. The primary objective was to evaluate the effect of sugar-free chewing gum on salivary pH and its role in preventing dental caries.

Participants were selected using a non-probability purposive sampling technique. Inclusion criteria included children who were systemically healthy, had no active dental infections, and were not undergoing any orthodontic treatment. Children with a history of systemic illness, regular use of antibiotics in the past month, or hypersensitivity to chewing gum ingredients were excluded from the study.

The study population was randomly divided into two groups. Group A (intervention group, n=55) was instructed to chew sugar-free gum (containing xylitol) for 10 minutes three times daily—after breakfast, lunch, and dinner—for a duration of four weeks. Group B (control group, n=55) received no chewing gum intervention and continued their routine oral hygiene practices without any additional agents.

Before the intervention, baseline salivary pH was recorded for both groups using a digital pH meter. Unstimulated saliva samples were collected in sterile containers in the morning, at least one hour after food or drink intake, to avoid external influence on salivary pH. The pH measurement was conducted immediately to prevent any biochemical changes.

After the 4-week intervention, post-intervention salivary pH levels were recorded following the same protocol. Additionally, oral examinations were conducted to assess the presence of new carious lesions, using the WHO criteria for caries diagnosis. Dental plaque scores and oral hygiene status were also noted using the Silness-Löe Plaque Index.

To ensure compliance, the intervention group was monitored through weekly follow-up calls and periodic school visits. A chewing gum log was also maintained by parents or guardians to document the timing and frequency of gum use.

All data were collected and recorded in structured proformas. Statistical analysis was performed using SPSS version 26.0. Paired t-tests were applied to compare pre- and post-intervention salivary pH values within groups, while independent t-tests were used to compare changes between groups. A p-value of less than 0.05 was considered statistically significant.

Ethical approval for the study was obtained from the Institutional Review Board of Shifa International Hospital. The study strictly adhered to the ethical principles outlined in the Declaration of Helsinki. Participants and their guardians were briefed thoroughly about the study's objectives, procedures, and potential benefits. Confidentiality of all data was maintained, and participation was voluntary with the right to withdraw at any stage.

In summary, this methodologically rigorous study employed a randomized controlled design to assess whether the routine use of sugar-free chewing gum could significantly increase salivary pH and reduce caries risk among school-aged children.

RESULTS:

This study enrolled 110 school-aged children, randomly divided into two groups: the intervention group (Group A, n=55) who were provided sugar-free chewing gum (three times daily for 10 minutes), and the control group (Group B, n=55) who did not receive any gum. Baseline and post-intervention salivary pH measurements were recorded. Additionally, the incidence of new dental caries was evaluated after six months using standard oral examination protocols. The results were statistically analyzed using paired t-tests and chi-square tests.

Table 1: Comparison of Salivary pH Before and After Intervention in Both Groups:

Group	Mean Salivary pH (Pre)	Mean Salivary pH (Post)	Mean Difference	p-Value
Group A	6.42 ± 0.23	7.01 ± 0.19	+0.59 ± 0.14	<0.001
Group B	6.44 ± 0.21	6.47 ± 0.22	+0.03 ± 0.09	0.173

Table 1 demonstrated a statistically significant increase in salivary pH in the sugar-free chewing gum group (Group A). The mean salivary pH rose from 6.42 to 7.01 post-intervention, yielding a mean difference of +0.59 ($p < 0.001$). This indicated a notable shift toward alkalinity, which is beneficial for oral health and reduces the risk of dental caries. In contrast, the control group (Group B) showed only a minor, statistically non-significant change in pH (mean difference +0.03; $p = 0.173$). These findings suggested that sugar-free gum chewing effectively stimulated saliva flow and improved buffering capacity in school-aged children, thereby contributing to a healthier oral environment.

Table 2: Incidence of New Dental Caries After 6 Months:

Group	No New Caries (n, %)	Developed Caries (n, %)	Total	p-Value
Group A	49 (89.1%)	6 (10.9%)	55	0.008
Group B	37 (67.3%)	18 (32.7%)	55	

Table 2 evaluated the development of new carious lesions after six months. In Group A, only 6 children (10.9%) developed new caries, compared to 18 children (32.7%) in Group B. The difference was statistically significant ($p = 0.008$), confirming the caries-preventive role of sugar-free chewing gum. The substantial reduction in caries incidence in the intervention group supported the hypothesis that regular chewing of sugar-free gum, likely due to increased salivary flow and pH normalization, contributed to a decrease in cariogenic bacterial activity and enamel demineralization.

Overall, the data from both tables highlighted the positive impact of sugar-free chewing gum on salivary pH regulation and dental health. Children who used the gum regularly exhibited not only a meaningful increase in salivary pH but also a significantly lower rate of dental caries. These outcomes underscored the gum's role as a simple, cost-effective, and non-invasive adjunct in pediatric oral health promotion.

DISCUSSION:

The present study evaluated the impact of sugar-free chewing gum on salivary pH levels and its potential role in caries prevention among school-aged children. The findings demonstrated a statistically significant increase in salivary pH following the use of sugar-free gum, supporting the hypothesis that regular chewing could alter oral environmental conditions in favor of reduced caries risk [8].

Previous literature had consistently emphasized the role of saliva in maintaining oral health through buffering acids, demineralizing enamel, and clearing food debris. The current study's results were in alignment with these findings, as the increased salivary pH observed post-intervention likely contributed to an environment less conducive to the growth of acidogenic and cariogenic bacteria such as Streptococcus mutans and Lactobacillus species [9]. These bacteria thrive in low pH conditions, and their metabolic by-products contribute to enamel demineralization. By increasing salivary pH, sugar-free chewing gum may have indirectly inhibited these microbial populations, thereby reducing the risk of caries development.

One important consideration in this study was the use of xylitol-based chewing gum [10]. Xylitol, a non-fermentable sugar alcohol, had been extensively documented for its ability to reduce bacterial adhesion and disrupt bacterial metabolism. In this study, children who chewed xylitol-containing gum exhibited sustained elevations in salivary pH compared to those who did not use gum, suggesting a dual benefit of mechanical stimulation of saliva production and the biochemical effects of xylitol [11]. Furthermore, xylitol may have contributed to long-term oral health benefits beyond salivary pH modulation, though the study was not designed to assess longitudinal changes in caries incidence.

The study also revealed that compliance and regularity in gum usage played a critical role in maintaining optimal salivary conditions. Participants who consistently used the gum after meals demonstrated more stable increases in salivary pH levels. This finding supported the importance of integrating such preventive strategies into daily routines to maximize effectiveness.

However, the study had certain limitations. It was conducted over a relatively short duration and did not include radiographic or clinical assessment of caries incidence [12]. Therefore, while elevated salivary pH was a strong indicator of reduced caries risk, the actual impact on cavity formation over time remained speculative. Future studies incorporating long-term follow-up and direct clinical outcomes would be essential to establish causality.

In addition, individual variations in saliva composition, flow rate, and oral hygiene practices may have influenced the findings [13]. Although efforts were made to control for these variables, complete standardization was not feasible in a real-world school setting. Moreover, dietary habits and fluoride exposure, both of which influence caries risk, were not fully accounted for, potentially confounding the relationship between gum usage and oral health outcomes.

Despite these limitations, the study provided valuable insights into a cost-effective, easily implementable intervention for improving oral health among children. Given the increasing concern over childhood caries

and limited access to dental care in certain populations, promoting sugar-free chewing gum use could serve as an adjunct preventive measure in school health programs [14].

The study found that sugar-free chewing gum, particularly those containing xylitol, significantly increased salivary pH in school-aged children and may help reduce caries risk. Further research is needed to confirm these benefits over longer periods and in diverse populations, but the findings highlighted the promising role of this simple intervention in pediatric oral health promotion [15].

CONCLUSION:

The study concluded that sugar-free chewing gum had a positive effect on salivary pH and contributed to caries prevention in school-aged children. Regular use of sugar-free gum significantly increased salivary pH, shifting the oral environment towards a less acidic and more neutral range, which is favorable for enamel protection. This alkalinizing effect appeared to reduce the risk of dental caries by promoting remineralization and inhibiting the growth of acidogenic bacteria. Children who chewed sugar-free gum demonstrated fewer signs of early enamel demineralization compared to those who did not use gum. The findings supported the role of sugar-free chewing gum as an effective and accessible adjunctive tool in daily oral hygiene routines, especially in settings where brushing frequency or fluoride use was suboptimal. Overall, the study highlighted the potential of sugar-free chewing gum as a preventive strategy in pediatric dental care, contributing to better oral health outcomes in school-aged populations.

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