ORIGINAL ARTICLE

Awareness of Dental Students and Faculty Members Regarding Xylitol Products for the Prevention of Dental Caries at a Private Dental College of Karachi

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Abstract

Background: Xylitol's unique properties make it a valuable tool in dental care. Its capacity to prevent the growing bacteria, especially Streptococci mutans, is crucial in preventing tooth cavities. By disrupting the metabolism of these microorganisms, xylitol aids in plaque reduction and acids that can lead to tooth decay. This makes xylitol a sugar substitute that offers proactive benefits for oral health care. Recent local literature on the awareness of dental practitioners regarding the preventive effect of xylitol on dental caries remains scant.

Objective: To assess dental students' and faculty members' awareness of xylitol products for the prevention of dental caries.

Methods: A cross-sectional study was conducted at Baqai Dental College, Baqai Medical University, from February 2023 to May 2024. The study sample comprised 196 dental students in clinical years, house officers, and faculty members, among whom a piloted self-structured questionnaire was distributed. The data were analyzed using SPSS version 20.

Results: The response rate of the study was 80%. The median age of the respondents was 23.00 (IQR=24.00-23.00) years and 114 (58.2%) were students. The results showed that only 69 (35.2%) of the participants knew the recommended daily dose of xylitol for dental health benefits. About the most likely reason for low prescription of xylitol products, 100 (51.0%) of them cited lack of awareness followed by expense (n=55, 28.1%). Moreover, Only 26 (13.3%) participants had adequate awareness regarding the use of xylitol products for the prevention of dental caries. On multivariable analysis, participants' source of information regarding xylitol products was found to be significantly associated with their awareness level (aOR=0.12, 95% CI: 0.02-0.50, p=0.004).

Conclusion: Only 13.3% of the study population had adequate awareness regarding the use of xylitol products for the prevention of dental caries. Moreover, participants' source of information regarding xylitol products was found to be significantly associated with their awareness level.

Keywords: *Awareness, xylitol, dental caries, students, dental, faculty.*

INTRODUCTION

Xylitol is a carbohydrate derived from xylose, which is a natural sweetener [1]. It has been known for over a century [2, 3]. First discovered in the late 19th century, it is usually found in small amounts in various fruits and vegetables such as strawberries and cauliflowers [4]. It is commonly extracted from hardwood/ beechwood trees, corn cobs, and plant materials for commercial use [5]. Obtainable from our everyday commercial products such as chewing gums, toothpaste, gels, *etc.* [6].

Dental caries, commonly known as tooth decay or cavities, is a multifactorial disease that involves the demineralization of dental hard tissues *i.e.* enamel, dentin, and cementum [7, 8]. It is primarily caused by the interaction of various factors, including bacteria, diet, host factors such as saliva and tooth structure, and time [9]. It remains a significant public health concern worldwide, with an estimated 2 billion people suffering from caries of permanent teeth and 514 million children suffering from caries of primary teeth globally [10]. A recent systematic review and meta-analysis from Pakistan reported the prevalence of dental caries at the national level and in Sindh to be 56.62% (95% CI: 49.54 to 63.57) and 58.94% (95% CI: 43.796 to 73.274) respectively [11].

Xylitol is a sugar alcohol that is commonly used as a sweetener. It can be found naturally or artificially and is prepared mainly from plant materials. This polyol has a significant antiplaque effect on teeth surface and can reduce gingival inflammation. It can also bind with calcium ions leading to consequent remineralization of teeth enamel [12]. It has beneficial effects on preventing dental caries by disrupting the energy production process of cavity-causing bacteria like Streptococcus mutans, which are major contributors to tooth decay [3, 5, 13]. By interfering with their ability to metabolize sugars, xylitol helps reduce the production of acids that can erode tooth enamel. Additionally, it can reduce bacterial adherence to tooth surfaces, making it more difficult for plaque to form. Its sweet taste also stimulates saliva flow, which helps to wash away food particles and neutralize acids in the mouth. Furthermore, it has

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a neutral pH value, which can help maintain a healthier oral environment by preventing the acidity that promotes tooth decay [14]. Hence, adhering to recommended dosages is crucial to ensure both the efficacy and safety of xylitol when used as a sugar substitute or in oral care products. Maintaining moderation in consumption helps harness its benefits while avoiding any potential adverse effects [10].

Available literature suggests that xylitol chewing gum, consumed in divided periods throughout the day, has a preventive effect on dental caries. A study conducted by Pınar *et al.* proposes that xylitol can have a beneficial influence on dental hygiene by reducing the growth and levels of Streptococcus mutans bacteria in the mouth [15]. Previous studies by Wu *et al.* and He *et al.* suggest a reduction in dental plaque accumulation by reducing the abundance of bacteria in individuals consuming xylitol chewing gums [13, 16]. Sticking to the recommended daily dose of xylitol, usually between 6 to 10 grams, is crucial for obtaining its dental health benefits while minimizing the risk of adverse reactions like irritable bowel syndrome, diarrhea, and nephrolithiasis [12, 17].

Dentists' ability to effectively reduce tooth decay and improve patient's caries risk status depends heavily on their awareness, perception, and practical clinical experience. Understanding the dynamics of dental caries, knowledge of factors that can play a preventive role, being skillful at clinical diagnosis, and recognizing factors contributing to the onset of the disease are all fundamental. Awareness about the beneficial role of xylitol in preventing dental caries could thus prove invaluable in this regard. This knowledge can allow for a comprehensive and proactive approach to oral health care, which can also be transferred to patients using counseling to effectively manage their existing diseases and prevent future issues [18]. Such lack of counseling by dental professionals remains a challenge to managing oral diseases in their early stages [19, 20].

To the best of the authors' knowledge, recent local literature on the awareness of dental practitioners regarding the beneficial effects of xylitol chewing gums on oral health is limited at best. In the given context, this study was conducted to assess the awareness of dental students and faculty members of a private dental college in Karachi regarding xylitol products for the prevention of dental caries.

MATERIALS AND METHODS

A cross-sectional study was conducted at Baqai Dental College, Baqai Medical University from February 2023 to May 2024. BDS students of clinical years, house officers, lecturers, and senior lecturers were included whereas those refusing to give verbal informed consent were excluded from the study.

Keeping the frequency of study outcome at 50% for a most liberal estimate, with a 95% confidence level and 7% precision, the required sample size was 196 respondents by using an online openEpi calculator [21]. Non-probability purposive sampling technique was used to include participants in the study.

Data were collected from students, house officers, and faculty members by the principal investigator using a study questionnaire. The questionnaire was pre-tested on 10% of sample size to check for reliability. The value of Cronbach's alpha came out to be 0.713 indicating an acceptable level of internal consistency. Moreover, face validity was assessed by asking participants if the study questions appeared to have assessed their awareness regarding the preventive role of xylitol products in dental caries.

The study questionnaire consisted of a 19-item questionnaire. The questionnaire consisted of two main sections; the first section consisted of four questions related to the social demographic characteristics of the respondent and the second section consisted of twelve questions related to awareness regarding xylitol products in preventing dental caries and three other questions assessing some further awareness aspects regarding xylitol products.

Once the questionnaire was filled and returned it was crosschecked to whether it was filled and each question was attended. At the end of data collection, the correct responses of the participants were given a score of 1 while the incorrect responses were given a score of 0. Participants who correctly answered 80% of the awareness questions *i.e.* 10 out of 12 questions were considered as having adequate awareness regarding xylitol products in preventing dental caries.

Data were entered on SPSS version 20. Frequency and percentage were calculated for categorical variables while median and interquartile range were generated for continuous variables after checking normality assumption with Shapiro-Wilk test. For inferential analysis, binary logistic regression was applied to compute univariate odds ratio with a 95% confidence interval for determining the association of participants' characteristics with their awareness level. Variables with $p<0.25$ and other important variables irrespective of $p<0.25$ in univariate analysis were used to build a multivariable regression model to compute adjusted odd ratios with a 95% confidence interval. A two-tailed p-value of ≤0.05 was considered statistically significant.

To the best of the authors' knowledge, the study procedures are in line with the institutional ethical standards for human experiments and the Helsinki Declaration, including obtaining verbal informed consent from all the participants. Ethical approval of the study was also duly taken from Baqai Institute of Health Sciences (FHM 28-2023).

RESULTS

The response rate of the study was 80%. The median age of the participants was 23.00 (24.00-23.00) years, 103 (52.6%) of them were female, 114 (58.2%) were students and 42 (21.4%) were house officers.

Regarding awareness of xylitol products, only 69 (35.2%) of the participants knew the recommended daily dose of xylitol for dental health benefits. Moreover, concerning side effects of xylitol, only 42 (21.4%) respondents were aware of constipation, only 68 (34.7%) respondents were aware of bloating, only 98 (50.0%) respondents were aware of diarrhea, only 60 (30.6%) respondents were aware of nausea whereas only 41 (20.9%) respondents were aware that weight gain is a possible side effect of xylitol (**Table 1**).

Table 1: Awareness regarding xylitol.

Awareness Regarding Xylitol (n = 196)	Count (%)
Are you aware of numerous natural sweeteners?	
Yes	182 (92.9)
No	14 (7.1)
Can xylitol have preventive role in oral diseases?	
Yes	188 (95.9)
No	8 (4.1)
Can xerostomia be prevented by xylitol?	
Yes	181 (92.3)
No	15 (7.7)
Can dental caries be prevented by xylitol?	
Yes	177 (90.3)
No	19 (9.7)
Are you aware of recommended daily dose of xylitol for dental health benefits?	
Yes	69 (35.2)
No	127 (64.8)
Is constipation a potential side effect of xylitol?	
Yes	42 (21.4)
No	154 (78.6)
Is bloating a potential side effect of xylitol?	
Yes	68 (34.7)
No	128 (65.3)
Is diarrhea a potential side effect of xylitol?	
Yes	98 (50.0)
No	98 (50.0)
Is nausea a potential side effect of xylitol?	
Yes	60 (30.6)
No	136 (69.4)
Is weight gain a potential side effect of xylitol?	
Yes	41 (20.9)
No	155 (79.1)
Should xylitol products be recommended to prevent dental caries?	
Yes	167 (85.2)
No	29 (14.8)
Future research on xylitol in preventing dental caries is important and needed?	
Yes	184 (93.9)
No	12 (6.1)

Table 2: Source of information, commercial availability and prescription trend of xylitol products.

Further Awareness Aspects	Count (%)
What is your most important source of information about xylitol?	
Syllabus/academic text	27 (13.8)
Other medical literature	86 (43.9)
Personal knowledge	62 (31.6)
Social/print media	13 (6.6)
Word of mouth	8 (4.1)
In which of the following forms xylitol is most commonly available?	
Chewing gums	98 (50.0)
Toothpastes	77 (39.3)
Mouthwashes	12 (6.1)
Chewable tablets/ Lozenges	9 (4.6)
Which one of the following is the most likely reason for low prescription of xylitol product?	
It is expensive	55 (28.1)
It is inaccessible	32 (16.3)
Lack of awareness	100 (51.0)
Inappropriate taste and texture	9 (4.6)

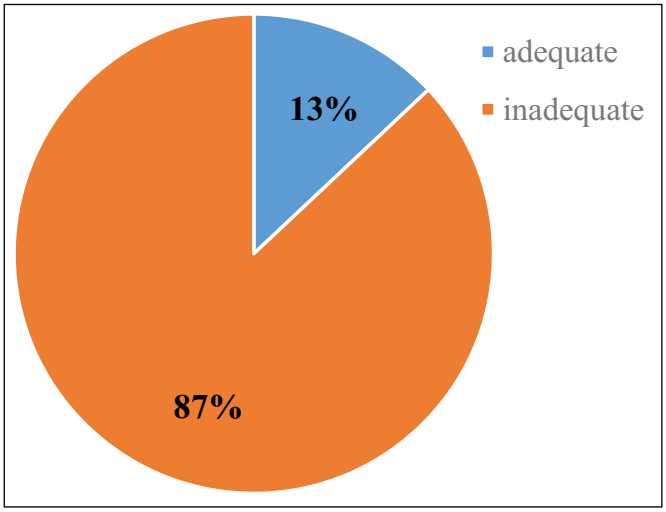

Fig. (1): Awareness level of respondents.

Assessment of awareness regarding product familiarity, insight, market trends, and accessibility showed that 86 (43.9%) participants reported medical literature to be their most important source of information about xylitol followed by personal knowledge (n=62, 31.6%). When respondents were inquired about the forms in which xylitol is commercially available, 98 (50.0%) replied chewing gums whereas 77 (39.3%) replied toothpaste. However, when respondents were questioned about the most likely reason for low prescription of xylitol products, 100 (51.0%) of them cited lack of awareness followed by expense (n=55, 28.1%) (**Table 2**).

Moreover, the results showed that only 26 (13.3%) participants had adequate awareness regarding the use of xylitol products for the prevention of dental caries (**Fig. 1**).

Table 3: Multivariable analysis of association between participants' characteristics and source of information regarding xylitol products with their awareness level.

Participants Characteristics	aOR	95% CI		p-value
		Lower	Upper	
Age (Years)	1.01	0.79	1.3	0.906
Gender				
Male	1.59	0.66	3.84	0.296
Female	Ref			
Designation				
Student	8.57	0.34	216.17	0.192
House Officer	6.02	0.25	141.84	0.265
Faculty Member	Ref			
Most important source of information about xylitol				
Syllabus/academic text	Ref			
Other medical literature	0.42	0.15	1.16	0.097
Personal knowledge	0.12	0.02	0.50	0.004
Social/print media	0.19	0.02	1.78	0.149
Word of mouth	0.33	0.03	3.22	0.347

CI: Confidence interval, aOR: Adjusted odds ratio, Ref: Reference category

Multivariable analysis further revealed that participants' source of information regarding xylitol products was significantly associated with their awareness level where respondents who relied upon their personal knowledge had significantly lower odds of having adequate awareness regarding xylitol products than those whose referred to their syllabus or academic texts (aOR=0.12, 95% CI: 0.02-0.50, p=0.004) (**Table 3**).

DISCUSSION

The dental community advocates for the use of xylitol as an adjunctive therapeutic agent in dental care. It is often recommended for use alongside proper oral hygiene practices to prevent dental caries [22]. This highlights the importance of integrating xylitol into oral health routines as part of a holistic approach to maintaining dental well-being [23].

The study results showed that 92.9% of the respondents were aware of numerous natural sweeteners. Likewise, Katayama *et al.* in 2020 reported that 94.0% of respondents were aware of xylitol [24]. Gowdar *et al.* 2021 found 60.2% of study participants were aware of various sugar substitutes [25]. Awareness about the importance and advantages of natural sweeteners has indeed grown in recent years, especially in the context of health concerns related to dietary habits and lifestyle choices. Natural sweeteners, such as xylitol, offer several benefits over traditional table sugar *i.e.* sucrose, making those increasingly popular choices among health-conscious individuals.

The study results showed that 95.9% of the respondents were aware of the preventive role of xylitol in oral diseases. Likewise, Nassar *et al.* in 2020 reported that 92.0% of respondents correctly identified xylitol as the only cavity-preventing sugar substitute [18]. Similarly, Stavnesli *et al.* 2018 reported that 95.0% of participants possessed knowledge about the dental applications of xylitol [23]. The debate surrounding xylitol's role in preventing dental caries has indeed been ongoing for quite some time. While sugar is strongly suspected as the main culprit behind tooth decay, the effectiveness of replacing sugar with xylitol for caries prevention is still a topic of discussion. Research spanning the last three decades has contributed to our understanding of xylitol's potential benefits, but it is essential to note that the evidence does not yet conclusively suggest that xylitol alone is the key to preventing dental caries. It can certainly be a helpful addition to preventive strategies, but it should not be relied upon as the sole solution.

The current study result revealed that 93.9% of participants agreed that there is a need for future research on xylitol in preventing dental caries. To prevent dental caries by utilization of xylitol products, there is a need for additional studies to explore and refine strategies for its effective utilization. By probing into various aspects such as dosage, frequency, duration of use, and potential synergies with other preventive measures, scientists aim to optimize the effectiveness of dental care products containing xylitol in combating tooth decay. Overall, the call for further research reflects an awareness of the need to advance knowledge in the field of dental caries prevention and ultimately improve the oral health outcomes of patients.

The current study result showed that 43.9% of participants revealed that medical literature was their most important source of information about xylitol followed by personal knowledge (31.6%) and syllabus (13.8%). Likewise, Stavnesli *et al.* 2018 reported that 44.4% of participants identified medical literature as their primary source of information regarding oral health, followed by popular press 25% [23]. The latest medical literature plays a crucial role as a source of information regarding xylitol and its potential impact on oral health. Literature not only benefits patient care by allowing dental professionals to implement evidence-based practices but also strengthens their knowledge and skills. From enhancing communication with patients to fostering professional growth through collaboration and networking, staying informed contributes to better outcomes for both healthcare providers and the individuals they serve.

Alarmingly, only 13.3% of the study participants were found to have adequate awareness regarding xylitol products for the prevention of dental caries. Khathoon SS in 2016 reported only 25% of students have such awareness [20]. This shows that unfortunately, the awareness regarding preventive use of xylitol products has not increased with time. This must be a serious concern for all relevant stakeholders as this awareness

has the potential to contribute significantly towards decreasing the burden of dental caries in our population. Updating dental syllabi, continued dental education and training, seminars and conferences, and scientific publications highlighting the importance of using xylitol as a preventive agent against cavities can play an important role in disseminating this awareness to dental practitioners.

Encouraging the adoption of xylitol products as part of daily oral hygiene routines could be an effective and convenient way to complement traditional preventive measures like brushing and flossing. Its ease of use and portability make it accessible to a wide range of individuals, including those who may have difficulty with traditional oral hygiene practices.

Interestingly, participants' source of information regarding xylitol products was found to be significantly associated with their awareness level. Traditionally, students or practitioners in any field consult syllabi and academic texts to enhance their understanding of a particular topic. This finding shows that this practice, in our local setting, is effective in keeping them up to date with the knowledge of preventive usage of xylitol products.

It is acknowledged that being a single-center study with a moderate sample size, the generalization of study findings is limited.

CONCLUSION

Only 13.3% of the study population had adequate awareness regarding the use of xylitol products for the prevention of dental caries. Moreover, participants' source of information regarding xylitol products was found to be significantly associated with their awareness level.

This study emphasizes the necessity of educating dental professionals about xylitol and its role as a preventive agent in the context of oral health. Focusing on updating dental syllabi and referring to relevant academic texts for a detailed description of the preventive role of xylitol in the context of oral health seems to be the best way forward. Additionally, continued dental education and training, seminars and conferences, and scientific publications highlighting the importance of using xylitol as a preventive agent against cavities can play an important role in disseminating this awareness to dental practitioners.

LIST OF ABBREVIATIONS

SPSS: Statistical Package for the Social Sciences

WHO: World Health Organization

SD: Standard Deviation

ETHICS APPROVAL

The study procedures are in line with the institutional ethical standards for human experiments and the Helsinki Declaration, including obtaining verbal informed consent from all the participants. Ethical approval of the study was also duly taken from Baqai Institute of Health Sciences (FHM 28-2023).

CONSENT FOR PUBLICATION

Before data collection, verbal informed consent was taken from each participant of the study.

AVAILABILITY OF DATA

Data cannot be shared publically because it is the intellectual property of Baqai Institute of Health Sciences. Data are available from Baqai Institute of Health Sciences (contact *via* manager.mph@baqai.edu.pk)

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CONFLICT OF INTEREST

The authors declare no conflict of interest.

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Declared none.

AUTHORS' CONTRIBUTION

ZS: Study concept, designing, data collection and manuscript drafting

NJ: Study designing, critical review and revision of the initial draft

SMZHN: Study designing, result analysis and interpretation, critical review and revision of the final draft

All the authors have read and approved the manuscript.

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