RESEARCH ARTICLE

Sugar consumption and caries occurrence among Pakistani school children

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Abstract

Objectives: To estimate the frequency and pattern of sugar intake among Pakistani school going children and its association with early carious lesion and caries history.

Methods: The cross-sectional study was conducted from January to May 2016 in seven schools of Bhakkar district in the Punjab province of Pakistan, and comprised of school children aged 11-12 years. Diet diaries were used to assess the frequency of sugar intake while caries was assessed using the Modified International Caries Detection and Assessment System. Bivariate analysis was used to assess the association of sugar consumption and early carious lesion with selected sociodemographic variables, and regression analysis was performed to evaluate the factor that matters most in caries occurrence.

Results: Of the 226 subjects, 115(51%) had early carious lesion. Mean frequency of sugar intake was 5.2±3.2 times per day. Children who consumed sugar between main meals (p=0.01) and within two hours before bedtime (p=0.04) had significantly higher history of having caries. Cariogenic intake before bedtime was significantly associated with overall caries risk (p=0.02).

Conclusion: The frequency of sugar intake among the subjects was slightly higher than the recommended level.

Keywords: Sugar intake, Dental caries, Early caries lesion, ICDAS, DMFT. (JPMA 68: 1483; 2018)

Introduction

Dietary free sugar (DFS) is undoubtedly the most important diet-related factor in the aetiology of dental caries.[1] Both the amount and frequency of sugar intake are related to the development of dental caries.[2,3] Limiting the intake of DFS, which refers to all monosaccharide's and disaccharides added to food and sugars naturally present in honey, syrup, fruit juices and concentrates,[1] significantly reduces the risk of dental caries.

To evaluate the effects of DFS on the formation of carious lesion, it is necessary to take into account important dietetic elements, such as the type of carbohydrate consumed as well as the frequency and timing of intake.[4] The intake of DFS between main meals and before bedtime have been shown to be significantly related to caries experience.[1,5] A diet history on DFS intake patterns, with the inclusion of the aforementioned information, should be obtained in the dental clinic to determine the diet-related caries risk habits of persons and to employ appropriate anti-cariogenic strategies.

In low income countries (LICs), there is a likelihood of higher DFS consumption and this, coupled with the less available preventive measures, results in a more detrimental effect to carious development.[6] Unfortunately, there is relatively little information available about the amount of DFS consumed and patterns of consumption in developing countries. Studies undertaken in selected cities of Pakistan have reported that DFS consumption among children is very high and that dental caries is more frequent in subjects consuming DFS.[7,8] Such studies are few in number and were conducted in different cities. They relied on relatively small non-representative samples, possibly due to financial and time constraints. Besides, they have only looked at frank cavitation and not early carious lesion (ECL). For a national pathfinder survey, more sampling sites on the same index age is required.[9] The current study was planned to estimate the frequency and pattern of DFS consumption among school-going children and to investigate its association with ECL and caries history.

Subjects and Methods

The cross-sectional study was conducted from January to May 2016 in two rural and five urban schools of Bhakkar district in the Punjab province of Pakistan, and comprised of school children aged 11-12 years.

Approval was obtained from the ethics committee of the Faculty of Dentistry, University of Malaya, Kuala Lumpur, Malaysia, and permission to conduct the study on school premises was obtained from the administration of each school. Parental consent was obtained from the children enrolled in the study.

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The sample size was estimated using a proportion formula based on reported prevalence of dental caries at 71%[10] with an assumption of 95% confidence interval (CI) and margin of error of 5%.

All school children aged 11-12 years were included as this is the index age group recommended by the World Health Organisation (WHO).[9] Subjects outside the age group or those with mental or physical disabilities, or who were undergoing orthodontic treatment were excluded, and so were those who did not furnish parental consent. The schools were selected on the basis of convenience sampling and the subjects were randomly selected from the school register.

Dental caries was assessed using the International Caries Detection and Assessment System (ICDAS) index which ranges from 0 to 6, depending on the severity of the lesion.[11] The current study used the modified ICDAS as it allows caries assessments to be carried out without the need to dry the surfaces of the teeth.[11] Under this system, codes 1 and 2 of the full ICDAS system is merged and renamed as code A. A single examiner underwent training and calibration in using this system at the University of Malaya. Calibration process was carried out over two days on 62 mounted teeth, which have been coded by the Malaysian ICDAS taskforce group. The inter-examiner and intra-examiner kappa score achieved was 0.69 and 0.82. Intra-oral examinations were performed on the school premises with the subject seated on the dental chair.

A three-day diet diary was used to estimate the frequency of DFS intake. Three-day diet diary was selected because there is a low chance of missing information and estimation error compared to other techniques.[12] Participants were asked to record all food and beverages intake for three days, which included a weekend and two weekdays. Other information in the diet diary included the time the food was taken which would indirectly reflect whether the intake was at home or at school, the amount eaten or drunk, and the time of the last meal before bedtime.

A pilot study was conducted on 23 school-children to assess the ease of use, clarity and readability of items in the diet diary, and some modifications were made. Participants were given instructions on how to fill up the food diary after their intra-oral examination. Upon submission, which was after 3 days, the diaries were checked and a short interview with the participants was conducted to ensure the accuracy of the information provided. Items were counted as the number of eating or drinking occasions containing DFS at meals or between meals. Intake of two portions of sugary beverage or food within an eating event was counted as one occasion. Frequency of DFS intake was used for further analysis.

Chi-square test and independent sample t-test were used to evaluate the association between sociodemographic variables, ECL and caries history. Independent sample t-test was performed to compare the mean frequency of DFS intake between genders and between locations at home/school and during weekday/weekends. ECL corresponded to teeth with modified ICDAS codes 1-3, while caries history took into account teeth with dentinal lesions and the decayed, missing and filled teeth (D4-6 MFT). Dependent sample t-test was used to compare ECL as well as caries history with frequency of cariogenic food intake, and cariogenic intake during main meals, between meals and before bedtime. Regression analysis was performed to evaluate the predictability of caries experience. The level of significance was set at 0.05.

Results

Initially, 322 students were selected. Of them, 300(93%)

Table-1: The association of sociodemographic back ground with the prevalence of and the mean number of teeth with caries.

Variable	Proportions of subjects having caries free or with caries lesions n (%)									Mean number of sound teeth, ECL, and caries history (S.D)					
	Caries Yes	Caries No	p	ECL No	ECL Yes	p	D4-6MFT	D4-6MFT	p	Sound	p	ECL	p	D4-6MFT	p
All subjects	169 (74.8)	57 (25)		115 (51)	111 (49)		54 (24)	172 (76)		22.7 (5.2)		3.0 (1.8)		1.4 (0.9)	
Boys	90 (53)	33 (58)	0.54	63 (55)	60 (54)	0.91	27 (50)	96 (56)	0.45	22.0 (5.2)	0.24	2.9 (1.9)	0.85	1.4 (1.0)	0.55
Girls	79 (47)	24 (42)		52 (45)	51 (46)		27 (50)	76 (44)		23.7 (5.2)		3.0 (1.8)		1.3 (0.7)	
Public School	124 (73)	33 (58)	0.03	86 (75)	71 (64)	0.085	38 (70)	119 (69)	0.86	22.6 (5.5)	0.91	3.1 (1.9)	0.04	1.4 (1.0)	0.86
Private School	45 (27)	24 (42)		29 (25)	40 (36)		16 (29)	53 (31)		22.8 (5.1)		2.3 (1.3)		1.3 (0.6)	
Urban	139 (82)	47 (82)	0.97	94 (81)	92 (83)	0.82	45 (83)	141 (82)	1	22.0 (5.4)	0.004	2.8 (1.7)	0.14	1.3 (0.8)	0.34
Rural	30 (18)	10 (18)		21 (19)	19 (17)		9 (17)	31 (18)		25.9 (2.8)		3.5 (2.2)		1.6 (1.0)	
				Chi square Test								Independent Sample t test			

ECL: Early carious lesion
S.D: Standard Deviation
D4-6MFT: Decayed, missing and filled teeth.

Table-2: Frequency of sugar intake among school children at home and at school, and during weekend and weekdays.

Time and place of sugar intake	All Subjects Mean (S.D)	Boys Mean (S.D)	Girls Mean (S.D)	P	Urban Mean (S.D)	Rural Mean (S.D)	P
Home	6.9(3.0)	6.8(2.8)	7.0(3.3)	0.92	6.8(3.0)	7.2(3.1)	0.82
School	2.9(1.6)	2.8(1.5)	3.1(1.7)	0.47	2.9(1.6)	2.8(1.6)	0.85
Total	5.2(3.2)	5.0(3.1)	5.3(3.3)	0.70	5.2(3.2)	5.3(3.4)	0.66
Weekend	2.8(1.5)	2.8(1.5)	2.8(1.6)	0.79	2.8(1.5)	2.8(1.6)	0.98
Weekdays	6.9(3.0)	6.6(2.8)	7.2(3.2)	0.21	6.8(3.0)	7.2(3.1)	0.45
Total	5.2(3.2)	5.0(3.0)	5.3(3.4)	0.31	5.2(3.2)	5.3(3.4)	0.64

Independent Sample t Test SD: Standard deviation.

Table-3: Mean and standard deviation (SD) of the number of sound, ECLs and dentinal caries according to the pattern and frequency of sugar intake.

	f	Sound Mean(S.D)	p	ECL Mean(S.D)	p	D4-6MFT Mean(S.D)	p
Daily intake of cariogenic food	>4	22.5(5.2)	0.69	3.0(1.9)	0.51	1.4(1.0)	0.51
	<4	23.1(5.5)		2.8(1.7)		1.3(0.4)	
Cariogenic food during main meals	No	21.1(5.7)	0.14	2.6(1.4)	0.41	1.3(0.4)	0.74
	Yes	23.4(4.9)		3.0(2.9)		1.4(1.0)	
Cariogenic food between meal	No	23.0(5.0)	0.36	3.3(1.8)	0.54	1.0(0)	0.01
	Yes	21.4(6.1)		2.9(1.8)		1.4(0.9)	
Cariogenic food 2 hr before bed time	No	22.7(4.8)	0.97	2.9(1.8)	0.86	1.0(0.2)	0.04
	Yes	22.7(5.5)		3.0(1.9)		1.6(1.0)	

Dependent sample t Test.
f: Frequency
ECL: Early carious lesion.

Table-4: Variables included in linear regression model.

Variables	ECL p	D4-6MFT p
Daily intake of cariogenic food	0.40	0.67
Cariogenic food during main meals	0.32	0.70
Cariogenic food between meal	0.88	0.91
Cariogenic food before bed time	0.69	0.02

Linear Regression Analysis.
ECL: Early carious lesion
D4-6MFT: Decayed, missing and filled teeth.

Table-5: Logistic regression analysis of cariogenic food intake before bedtime and caries history (D4-6MFT).

	F	β	p	R^2
Caries History	-	-	0.00	-
Cariogenic food before bed time	5.4	-.30	0.02	0.7

Logistic Regression.
F: F Statistics β: Beta Coeffcient R^2: Adjusted R Square
D4-6MFT: Decayed, missing and filled teeth.

returned with parental consent. Subsequently, 35(11.6%) students refused to participate and another 35(11.6%) did not return the diet diaries. The final sample stood at 226(70.2%) subjects. Within the sample, 115(51%) subjects had ECL (Table-1). Mean ECL score was 3.0±1.8 which was higher than the mean D4-6MFT score of 1.4±0.9. The number of children who were caries-free was higher among boys (p>0.05), among those who lived in urban area (p>0.05), and those who attended public schools (p<0.03). Mean ECL scores in children of public school were statistically higher compared to their private school counterparts (p=0.04).

Overall mean frequency of DFS intake was 5.2±3.2 times per day. The mean frequency of sugar intake at home was 6.9±3.0 and during weekdays it was 6.8±3.0. The values were higher compared to the frequency taken at schools 2.9±1.6 (p>0.05) and during weekends 2.8±1.5 (p>0.05) (Table-2).

Children who consumed cariogenic food or drinks in between main meals (p=0.01) and within two hours before bedtime (p=0.04) had significantly higher mean D4-6MFT compared to children who did not do so (Table-3). Those who took sugars less than 4 times a day and only during main meals had higher mean number of sound teeth and lower mean number of ECL, but they were not

statistically significant (p>0.05).

Univariate analysis showed the intake of cariogenic food before bedtime as having a significant effect on caries history (Table-4). The remaining variables were excluded in regression analysis (Table-5).

Discussion

The assessment of DFS intake in children in terms of its frequency and patterns of consumption is important not only in preventing the incidence of dental caries, but also other sugar-associated non-communicable diseases. The current study shows that the mean frequency of DFS intake in school-children was approximately 5 times per day. Studies have shown that caries development among children is low when the intake is limited to four times a day.[13-15] As observed in the study, children who took DFS less than 4 times a day had lower mean number of ECL and lower overall caries experience compared to those who had higher frequency of DFS intake. Increase in the frequency of DFS intake can cause a reduction in potential of hydrogen (pH) value of dental plaque for a longer duration and lengthen the effective clearance period. This consequently leads to higher risk of initial enamel dissolution.[16]

The participants' frequency of DFS intake was also higher when they were at home compared to when they were at school. This is similar to a recent study in the United States which reported that more than 60% of added sugars consumed were taken at home as opposed to when away from home.[17] One possible explanation for this observation in the current sample is that in Pakistan, the majority of parents did not encourage children to adhere to a healthy diet.[18] This may be related to the parents' own oral health literacy. Presently there are no studies that have reported on the level of health or oral health literacy among parents in Pakistan.

The patterns or the timing of DFS intake can influence the development of caries. The present study shows that the intake of DFS in between main meals, and within two hours before bedtime were significantly related to children's caries history. DFS should only be consumed at mealtimes when the salivary flow is greater due to stimulation during meals. When salivary flow is high, plaque acids can be neutralised rapidly and this will consequently lower the risk of caries incidence.[1] The significant relationship between intake of DFS before bedtime and $D_{4-6}MFT$ concurred with previous studies.[5,19] Both the current and an earlier[5] study found that DFS intake before bedtime explained about 70% of caries experience. The other study[5] also reported that the DMFT increment for subjects who consumed one DFS snack before bedtime was over twice those who did not. Salivary flow rate is low during bedtime and its buffering capacity is also reduced. These factors could cause sustained low plaque pH level, which then may lead to caries.

In terms of limitations, the study relied heavily on the information obtained from the diet diaries, which are open to recall bias and under-reporting of food intake. As children were requested to fill in the diaries after the intra-oral examination, this could further cause bias as their oral health awareness may be heightened after the clinical examination. However, short interviews with the participants were conducted at the time of submission to verify the data reported in order to overcome some of these limitations.

Conclusion

The frequency of DFS intake among the children was slightly higher than the recommended level of four times per day. DFS intake between main meals and before bedtime was significantly associated with caries history. Health promotion efforts at home, schools and community levels need to be intensified to reduce DFS intake amongst Pakistani school-children.

Disclaimer: The study is part of a PhD project that had the two Malaysian co-authors as supervisors.

Conflict of Interest: None.

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