Association of sugary foods and drinks consumption with behavioral risk and oral health status of 12- and 15-year-old Indian school children

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Abstract:

AIM: This study aims to assess the association of sugary foods and drinks consumption with behavioral risk and oral health status of 12- and 15-year-old government school children in Udaipur.

MATERIALS AND METHODS: A descriptive cross-sectional study was conducted among of 12- and 15-year-old government schoolchildren of Udaipur. A survey pro forma designed based on HBSC (Health behaviour in School-aged Children) study protocol and WHO Oral Health Assessment Form for Children (2013) was used. Chi-Square test, Independent Sample *t*-test, and Multinomial Logistic Regression analysis were used with 95% confidence interval and 5% significance level.

RESULTS: Out of 710 participants, 455 (64.1%) were males and 255 females (35.9%). Majority of 15 years age (57.3%) consumed more soft drinks than 12-year-old. Males showed a comparatively greater tendency to have sugar sweetened products than females. The decayed, missing, and filled teeth (dmft) and DMFT scores were relatively higher for subjects who consumed sugary substances more than once/day than who had less than once/day. Gingivitis was associated with high sugar diet.

CONCLUSION: Sugary foods and drinks consumption is significantly associated with behavioral habits of children and is a clear behavioral risk for oral health.

Keywords:
Lifestyle, oral hygiene, schoolchildren

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Introduction

Dental Caries has sugar sweetened foods as prime risk factors. A study by Øverby *et al*.[1] showed that children having a high intake of sugar consumed 30%–40% less fruits and vegetables. Caries is common in schoolchildren as they have poor oral hygiene maintenance and improper dietary habits.[2]

Since there is dearth of literature evaluating the influence of sugary foods on both behavior and oral health of schoolchildren, this study was conducted with the objective to assess the association of sugary foods and drinks consumption with behavioral risk and oral health status of 12- and 15-year-old government school children in Udaipur.

Materials and Methods

Study design, study area, duration, and population

A descriptive cross-sectional study was conducted among government school children of 12 and 15 years age of Udaipur city, Rajasthan, India from August to September 2016.

Ethical approval

The study protocol was reviewed and approved by the Institutional Review Board of Pacific Dental College and Hospital and was granted ethical clearance.

Informed consent

Informed consent letter explaining the purpose and details of the study was given by the investigator to all the schoolchildren before the start of the study, and a written consent was obtained from parents whose children were willing to participate in the survey. Consent letter was sent to parents of 750 school children keeping in mind of nonresponse or opposition to participate in the study.

Training and calibration

Before the commencement of the study, the examiner was standardized and calibrated The intraexaminer reliability for WHO oral health assessment form for Children, 2013 was assessed using Kappa statistics which was found to be 90%.

Inclusion criteria

Children who had completed chronological age of 12- and 15-year-old.

Exclusion criteria

Children with craniofacial anomalies (clefts and syndromes), undergoing or who have a history of orthodontic treatment, whose parents did not give informed consent and with special needs.

Proforma details

A survey Proforma designed based on HBSC (Health behaviour in School-aged Children)[3] study protocol and WHO Oral Health Assessment Form for Children (2013) consisted of three sections:
- Section I consisted of 3 closed-ended questions to assess the sugary foods and drinks consumption (soft drinks, sweets/chocolates and cakes/pastries)
- Section II consisted of 8 close-ended questions relating to various health related behavioral habits
- Section III consisted of the WHO Oral Health Assessment Form for Children (2013).

Pilot study

A pilot study was carried out among 10 school children of 12- and 15-year-old from one randomly selected Government school to determine the feasibility of the study. The prevalence of dental caries in group 1 was 100% and group 2 was 87.5%. Depending on the prevalence obtained from the pilot study, using 95% confidence interval (CI), 5% allowable error and 80% power of the study, sample size was calculated to be 690, using the formula:

$$n = \frac{\left[Z_{1-\alpha/2} \cdot \sqrt{\{2p(1-p)\}} + Z_{1-\beta} \sqrt{\{p_1(1-p_1) + p_2(1-p_2)\}} \right]^2}{(p_1 - p_2)^2}$$

Methodology

Before the instigation of the study, a list of Government schools of Udaipur city was obtained. The list obtained comprised of total 122 Government schools of Udaipur city. The study sample was recruited by a multistage stratified random sampling procedure. Two schools were selected randomly from each of the 4 zones of Udaipur city, i.e. North-West, North-East, South-West, and South-East. In each school, the school children were grouped into different strata based on age, and from the two stratas, i.e. 12- and 15-year-old, the required number of subjects were selected randomly. Parents of 40 children out of 750, failed to give informed consent, so final sample of the study comprised of 710 children with 455 males and 255 females.

Instruments used during the examination were: plain mouth mirrors, CPI probes which conform to WHO specifications, tweezers, kidney trays, disposable mouth masks and gloves, cotton swabs.

The schools were visited on the predetermined dates according to the convenience of the school authorities. Selected ones were given informed consent forms to get them signed from their parents/guardians who were also notified by the school teachers on request of the examiner. On the subsequent visits to the schools, school authorities were requested to provide an area for examination with adequate illumination. Class teacher was requested to send the students in a controlled way.

Subjects were examined by the investigator standing on the right side of the chair. General information and the questionnaire sections were recorded by interviewing the study subjects. The examination was done (Type III) according to the WHO Oral Health Survey Basic Methods 2013. The duplicate examination was conducted on 5% (n = 36) of the population during the study with a kappa statistic of 92%. The assessment of all the filled pro formas were done on the same day, for the completeness and accuracy of recordings.

Statistical analysis

The recorded data were compiled and entered into Microsoft Excel 2013 and then exported to data editor page of SPSS version 20.0 (SPSS Inc., Chicago, Illinois, USA) and analyzed. Descriptive statistics included computation of percentages, means, and standard deviations (SDs). Chi-square test, Independent Sample *t*-test and Multinomial Logistic Regression analysis

was done. For all tests, confidence interval and P = 95% and ≤0.05 respectively.

Results

Table 1: A total of 710 (100%) study subjects participated in the study. Demographic data showed that majority of the respondents were males (n = 455 [64.1%]). Most of the participants were from the periurban area (n = 423 [59.6%]) of Udaipur. Subjects who went to school for 10–12 years were comparatively more in number (n = 478 [67.3%]).

Table 2 shows the association of demographic variables with sugary drinks and foods consumption among the study subjects. It was found that 15-year-old study subjects consumed more soft drinks than

12-year-old (P = 0.001). Males showed a comparatively greater tendency to have sugar sweetened food products than females. Pupils who are attending school for 7–9 years have less intake of sugared food stuff as compared to those attending for 10–12 years (P = 0.021).

Table 3 depicts the association of health related habits with sugary drinks and foods consumption among study subjects. Participants who did not have fresh fruits and vegetables daily showed greater consumption of soft drinks and other confectionery products in everyday life (P = 0.001). Oral health habits like tooth brushing frequency were observed to have a significant association with chocolates and cake/pastries consumption (P = 0.001). Quite a large number of study participants were found to brush less than once a day (n = 215 [30.3%]) and were never involved in sports/exercise (n = 314 [44.2%]). Out of 89 subjects with smoking habit, the majority of them (n = 83) significantly were observed to have a sugary beverage (P = 0.001). The two parameters indicating physical activity included in the current study, i.e. sports or exercising regularity and sedentary leisure activity in day-to-day life were significantly associated with high sugar containing diet of the study population (P = 0.001). Chocolates, cakes, and sugary drinks intake were comparatively more in respondents who had a poor lifestyle than those with a decent routine of life (P = 0.001). Majority of the study population watched television for 2–3 h regularly (n = 444 [62.5%]).

Table 4 shows the association of mean decayed, missing, and filled teeth (dmft) and DMFT (Mean ± SD), gingival bleeding, dental erosion and dental trauma with sugary

Table 1: Distribution of study population according to several demographic variables

Variables	n (%)
Age (years)	
12	368 (51.8)
15	342 (48.2)
Gender	
Male	455 (64.1)
Female	255 (35.9)
Years in school	
7-9	232 (32.7)
10-12	478 (67.3)
Location	
Urban	287 (40.4)
Periurban	423 (59.6)
Rural	0
Total	710 (100)

Table 2: Association of demographic variables with sugary drinks and foods consumption among study subjects

Demographic Variables	Soft drinks consumption		Sweets/chocolates consumption		Cakes/pastries consumption	
	Once or more than once a day, n (%)	Less than once a day, n (%)	Once or more than once a day, n (%)	Less than once a day, n (%)	Once or more than once a day, n (%)	Less than once a day, n (%)
Age (years)						
12	150 (40.8)	218 (59.2)	214 (58.2)	154 (41.8)	172 (46.7)	196 (53.3)
15	196 (57.3)	146 (42.7)	175 (51.2)	167 (48.8)	175 (51.2)	167 (48.8)
P	0.001*		0.062		0.238	
Gender						
Male	212 (46.6)	243 (53.4)	261 (57.4)	194 (42.6)	224 (49.2)	231 (50.8)
Female	134 (52.5)	121 (47.5)	128 (50.2)	127 (49.8)	123 (48.2)	132 (51.8)
P	0.128		0.066		0.799	
Years in school						
7-9	103 (44.4)	129 (55.6)	120 (51.7)	112 (48.3)	99 (42.7)	133 (57.3)
10-12	243 (50.8)	235 (49.2)	269 (56.3)	209 (43.7)	248 (51.9)	230 (48.1)
P	0.107		0.253		0.021*	
Location						
Urban	137 (47.7)	150 (52.3)	160 (55.7)	127 (44.3)	142 (48.5)	145 (50.5)
Periurban	209 (49.4)	214 (50.6)	229 (54.1)	194 (45.9)	205 (48.5)	218 (51.5)
Rural	0	0	0	0	0	0
P	0.661		0.672		0.791	

Test applied: Chi-square test, *P≤0.05 statistically significant

Table 3: Association of health related habits with sugary drinks and foods consumption among study subjects

Health related habits	Soft drinks consumption		Sweets/chocolates consumption		Cakes/pastries consumption		Total, *n* (%)
	Once or more than once a day, *n* (%)	Less than once a day, *n* (%)	Once or more than once a day, *n* (%)	Less than once a day, *n* (%)	Once or more than once a day, *n* (%)	Less than once a day, *n* (%)	
Eating fruits and vegetables							
Daily	171 (35.4)	312 (64.6)	189 (39.1)	294 (60.9)	156 (32.3)	327 (67.7)	483 (68.0)
Not daily	175 (77.1)	52 (22.9)	200 (88.1)	27 (11.9)	191 (84.1)	36 (15.9)	227 (32.0)
P	0.001*		0.001*		0.001*		
Tooth brushing							
More than once a day	23 (51.1)	22 (48.9)	28 (62.2)	17 (37.8)	23 (51.1)	22 (48.9)	45 (6.3)
Once a day	175 (38.9)	275 (61.1)	169 (37.6)	281 (62.4)	132 (29.3)	318 (70.7)	450 (63.4)
Less than once a day	148 (68.8)	67 (31.2)	192 (89.3)	23 (10.7)	192 (89.3)	23 (10.7)	215 (30.3)
P	0.055		0.001*		0.001*		
Smoking							
No	308 (46.0)	362 (54.0)	361 (53.9)	309 (46.1)	321 (47.9)	349 (52.1)	670 (94.4)
Yes	38 (95.0)	2 (0.5)	28 (70.0)	12 (30.0)	26 0 (65.0)	14 (35.0)	40 (5.6)
P	0.001*		0.052		0.087		
Sports/exercise							
Daily	5 (16.1)	26 (83.9)	0	31 (100)	0	31 (100)	31 (4.4)
Weekly	174 (47.7)	191 (52.30)	204 (55.9)	161 (44.1)	162 (44.4)	203 (55.6)	365 (51.4)
Rarely/never	167 (53.2)	147 (46.8)	185 (58.9)	129 (41.1)	185 (58.9)	129 (41.1)	314 (44.2)
P	0.001*		0.001*		0.001*		
Sedentary leisure activity (watching TV)							
<1 h/day	33 (16.6)	166 (83.4)	33 (16.6)	166 (83.4)	0	199 (100)	199 (28.0)
2-3 h/day	313 (70.5)	131 (29.5)	312 (70.3)	132 (29.7)	303 (68.2)	141 (31.8)	444 (62.5)
4 h or more/day	0	67 (100)	44 (65.7)	23 (34.3)	44 (65.7)	23 (34.3)	67 (9.4)
P	0.001*		0.001*		0.001*		

Test applied: Chi-square test, *P*≤ 0.05 statistically significant

drinks and foods consumption among study subjects. The mean dmft and DMFT scores are significantly higher for the ones who consume soft drinks, sweets/chocolates and cakes/pastries once or more than once a day (daily) in comparison with those subjects who do not have regular ingestion (not daily) (*P* = 0.001). The absence of gingival bleeding was reported in those participants who had less intake of sweets/chocolates and cakes/pastries (*P* = 0.001). Dental trauma and dental erosion showed significant association with sugar sweetened drinks intake amongst the study population (*P* = 0.001).

Table 5 reveals the Odds ratio and 95% CI according to Multinomial Logistic Regression with dental caries, gingival bleeding as dependent variables. Subjects with consumption of soft drinks, sweets/chocolates and cakes/pastries less than once a day have 0.766 and 0.768 times less chances of developing dental caries, respectively. This table also presents the finding that the Odds ratio for gingival bleeding of the respondents was significantly high among those who consumed sweets and cakes once or more than once a day.

Discussion

Children are the future and foundation of any nation. Children spend their formative years mostly in school when parents and teachers have a tremendous responsibility towards inculcating in their young minds a sense of discipline and proper lifestyle. Sugary drinks and foods consumption have become a habit which has gigantically leaped forward nowadays in school aged children, having bitter consequences on their oral health and life pattern. Our research showed that 15-year-old subjects had more sweetened drinks consumption than 12-year-old and those who are in school for a longer duration (10–12 years) had more of cakes/pastries. This is predictable because as their age is increasing, their years spent in school are also increasing, they become more exposed to the adverse lifestyle and also might be getting pocket-money to spend on such food stuffs. In general, it is observed that females are more fond of sweets and chocolates but a contrary finding has been noted in the present study that boys were found to have greater affinity towards sugary food substances as compared to girls, which might be because males might be preferred more by parents[4] and lead a more

Table 4: Association of mean decayed, missing, and filled teeth and Decayed, Missing, and Filled teeth scores (mean±standard deviation), gingival bleeding, dental erosion and dental trauma with sugary drinks and foods consumption among study subjects

Oral health-related variables	Soft drinks consumption		Sweets/chocolates consumption		Cakes/pastries consumption	
	Once or more than once a day, *n* (%)	Less than once a day, *n* (%)	Once or more than once a day, *n* (%)	Less than once a day, *n* (%)	Once or more than once a day, *n* (%)	Less than once a day, *n* (%)
dmft score# (mean±SD)	1.96±2.54	0.73±1.44	2.02±2.49	0.49±1.18	2.00±2.60	4.96±4.38
P		0.001*		0.001*		0.001*
DMFT score# (mean±SD)	4.98±4.45	1.60±1.30	4.71±4.24	1.48±1.40	0.69±1.29	1.61±1.52
P		0.001*		0.001*		0.001*
Gingival bleeding@						
Present	124 (35.8)	142 (39.0)	222 (69.2)	99 (30.8)	181 (52.2)	100 (27.5)
Absent	222 (64.2)	222 (61.0)	167 (42.9)	222 (69.2)	166 (47.8)	222 (69.2)
P		0.383		0.001*		0.001*
Dental erosion@						
No sign	182 (52.6)	312 (85.7)	225 (57.8)	269 (83.8)	183 (52.7)	311 (85.7)
Enamel lesion	74 (21.4)	52 (14.3)	74 (19.0)	52 (16.2)	74 (21.3)	52 (16.2)
Dentinal lesion	0	0	0	0	0	0
Pulp involvement	90 (26.0)	0	90 (23.1)	90 (12.7)	90 (25.9)	0
P		0.001*		0.059		0.365
Dental trauma@						
No sign	291 (84.1)	266 (73.1)	290 (74.6)	267 (83.2)	253 (72.9)	304 (83.7)
Treated injury	13 (3.8)	0 (0)	13 (3.3)	0 (0)	13 (3.7)	0
Enamel fracture	25 (7.2)	64 (17.6)	67 (17.2)	22 (6.9)	67 (19.3)	22 (6.1)
Enamel and dentin fracture	13 (3.8)	33 (9.1)	15 (3.9)	31 (9.7)	10 (2.9)	36 (9.9)
Pulp involved	4 (1.2)	4 (1.2)	4 (1.0)	1 (0.3)	4 (1.2)	1 (0.3)
Missing tooth due to trauma	0	0	0	0	0	0
Other damage	0	0	0	0	0	0
P		0.001*		0.077		0.068

Test applied: #Independent sample *t*-test, @Chi-square test, *$P \leq 0.05$ statistically significant. SD=Standard deviation, DMFT=Decayed, Missing, and Filled teeth, dmft=decayed, missing, and filled teeth

Table 5: Multinomial logistic regression analysis with dental caries, gingival bleeding as dependent variables

Variables	*n*	OR (95% CI)	*P*
Dental caries			
Soft drinks consumption			
Once or more than once a day	346	0.234 (0.142-0.384)	0.001*
Less than once a day	364	1	
Sweets/chocolates consumption			
Once or more than once a day	389	0.234 (0.148-0.377)	0.001*
Less than once a day	326	1	
Cakes/pastries consumption			
Once or more than once a day	347	0.232 (0.141-0.381)	0.001*
Less than once a day	363	1	
Gingival bleeding			
Sweets/chocolates consumption			
Once or more than once a day	389	0.679 (0.535-0.887)	0.005*
Less than once a day	321	1	
Cakes/pastries consumption			
Once or more than once a day	347	0.677 (0.503-0.798)	0.001*
Less than once a day	363	1	

CI=Confidence interval, OR=Odds ratio, *$P \leq 0.05$ statistically significant

independent and indisciplined lifestyle as compared to females as also shown in a study by Fiala and Brázdová.[5]

The current research depicted that students consume less fruits/vegetables, and they have a tendency of having more sugary foods and drinks which is in accordance with the study by Montenegro-Bethancourt *et al*.[6] on third and fourth-grade school students of public and private schools in Gautemala city, where the authors found that there was inadequate fruits/vegetables consumption in the study sample. 95% of the subjects who smoked (*n* = 40) were noticeably observed to drink tea/coffee more than those who did not, which is a common habit of people. The study by Treur *et al*.[7] also confirmed the above-mentioned fact that smoking was associated positively with coffee consumption and colas, smoking initiation was associated with consuming on average 52.8 mg and 59.5 mg more caffeine per day, each additional cigarette smoked per day was associated with 3.7 and 8.4 mg higher daily caffeine consumption, although a contrary finding in their study was that tea consumption was relatively less in smokers.

The current study highlighted a fact that 89.3% of students who brushed teeth less than once a day were consuming more cakes/sweets/chocolates, may be because students following inappropriate lifestyle would

have tendency not to maintain oral hygiene and be on improper diet, which can ultimately lead to dental caries as portrayed in a study by Praveena *et al.*[8] This is in contrast with the study conducted by Honkala *et al.*,[9] where the authors found no significant association between tooth brushing and sugary diet.

The provision of physical education has declined in many countries. In Sweden, at least 30% adolescents do not achieve appropriate levels of physical activity as reported in a study by Ekelund *et al.*[10] The present study showed that subjects who were involved less in daily exercising ate more sugar-sweetened foods as also revealed in the report by Centers for Disease Control and Prevention, U. S.[11] where adolescents who consumed sports drinks more than once a day were more likely to eat at fast-food restaurants more than once a week, and be physically inactive. Such children on towering sugar diet with less bodily activity will be exposed to the risk of developing obesity in the future.

Labor saving equipment has significantly reduced the amount of physical activity, and electronic devices have found their way into homes, encouraging a more sedentary lifestyle. The results of a cross-sectional study performed in Europe by Olstad and McCargar[12] suggested a dose-response correlation with the amount of time spent in front of the television, playing electronic games, consuming sugary foods such as cold drinks, cookies, chocolates with it and the level of obesity.[13] The same has been noted in the current research that 83.4%, 83.4%, and 100% of students who watch TV <1 h/day have sweetened drinks, sweets/chocolates, and cakes/pastries less than once a day respectively.

Several studies conducted before confirmed that sucrose facilitates the colonization of teeth by Mutans Streptococci. Diet containing sugars are metabolized to acids by dental plaque bacteria, and the resultant low pH favors the growth of acidogenic and aciduric bacteria.[14] For the same reason, in the present study, the mean dmft and DMFT scores were high for those who took soft drinks, cakes, sweets on a higher incline as also observed in the study by Petti *et al.*[14] Another study by Iftikhar *et al.*[15] also showed that caries was 3.89 (95% CI, 2.16–7.01) times more in children consuming cookies as compared to children who did not consume. On the contrary, Mathiesen *et al.*[16] carried out a research on 14-year-old and found a weak association between sugar exposure and dental caries development among the subjects.

The present study illustrated that those who had more intake of sugary foods had poor gingival condition, which is in accordance with the study by Sidi and Ashley[17] where they had observed gingival inflammation in lower anterior teeth due to high sugar diet. Probable reason may be that sugar gets deposited in dental plaque surrounding the gingiva and lowers pH of oral environment in which the periodontal pathogens thrive well. As observed in the present study that subjects with behavioral risk such as poor oral hygiene practices and sedentary lifestyle were having more sugary foods, which may be causing gingivitis leading to periodontal problems in future.

Dental erosion and trauma showed significant association with sugary drinks ingestion of the students in the current research. Soft drinks containing inherent acids and sugars have both acidogenic and cariogenic potential. Early signs of erosion were observed in study subjects due to fruit juice consumption in a study by Zhang *et al.*[18] Study by Lazarchik and Filler[19] has confirmed that enamel erosion weakens tooth structure due to demineralization which makes the tooth more prone to fracture on trauma.

However, the present research has some limitations. The present study had considered students of Government schools only which in Indian scenario are usually from lower socioeconomic status strata. The factors taken into consideration in this study holds true for higher strata also. Hence, further studies involving other school children should be conducted. Secondly, the study associates sugary foods and drinks consumption with oral health status, but various other factors also affect the oral health of students such as genetic factors, and host factors which have not been taken into consideration in this research.

Education and motivation of school children is of paramount importance. School dental health programs teaching oral hygiene maintenance skills such as tooth brushing, flossing and inculcating behavioral habits such as reading books, involving in creative lessons are necessary to reduce dental caries. Further, teachers and parents should be taught and encouraged to introduce healthy diet and lifestyle habits in children.

Conclusion

The current study results propose that sugary foods and drinks consumption is a clear behavioral risk for oral health, especially dental caries. It is noticeably observed in this research that students' poor diet and lifestyle, behavioral habits and oral health are interrelated with each other. A significant association has been found among behavioral habits. Dental caries and gingival inflammation were found to be related with high sugar diet whereas, dental erosion and dental trauma were more commonly found in students having more soft drinks.

Conflicts of interest
There are no conflicts of interest.

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