ORIGINAL RESEARCH

Correlation between Nutritional Status and Dental Caries in 3–18-year-old Indian School-going Children: A Cross-sectional Study

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Abstract

Aim: This study aimed to examine the prevalence of dental caries and its correlation with nutritional status in 3–18-year olds.

Materials and methods: The cross-sectional study was conducted among 3–18-year olds from public schools in a rural district in India. A total of 829 subjects from 29 schools participated in the study. The body mass index (BMI) was used to assess the nutritional status of participants. The anthropometric measurements for BMI were recorded within the school premises. The World Health Organization (WHO) Child Growth Standards Reference for BMI was used to categorize the participants into obese/overweight, normal, or underweight for age. Dental caries was assessed using decayed, missing, and filled primary teeth (DMFT) and decayed extracted filled teeth (deft) index. A parent-administered questionnaire was used to obtain data on oral hygiene practice, parental education, dental visits, and sugar exposure.

Results: The prevalence of dental caries was found to be 48.8%. A total of 54.6% of students were malnourished, and 47.7 % were underweight for their age. The nutritional status was found to be inversely related to dental caries. The children with higher BMI (obese and overweight) were likely to have less caries experience.

Conclusion: Nutritional status was found to be inversely related to dental caries. Children with lesser BMI were at higher risk of having dental caries and *vice versa*.

Clinical significance: Dental caries and nutritional status have common risk factors. Diet is the major risk factor, common to both conditions. Diet is a modifiable risk factor. Therefore, strategies can be developed and targeted at the prevention of both dental caries, and malnutrition in the community. Healthy dietary habits and practices can be promoted for the control of dental caries and malnutrition.

Keywords: Body mass index, Dental caries, Nutritional status.

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Introduction

There is an alarming burden of malnutrition in India. United Nations Children's Fund report states, that malnutrition is still a matter of concern and impacts the lives of young children.[1] Undernutrition and susceptibility to infections form a vicious cycle of deteriorating health and poor nutritional status. Poor nutrition during the developmental stage of a child's life can also lead to stunted growth. While the South Asian countries have shown to have the maximum occurrence of stunted growth and malnutrition in children, obesity is very less prevalent.[1]

Assessment of nutritional status can be done through various methods. These methods include clinical, biochemical, anthropometric methods, functional, and emotional assessments. Anthropometry measures size, weight, and body mass. Commonly used anthropometric measures are height, weight, head circumference, body mass index, and skin fold. Body mass index has been commonly used to assess nutritional status owing to its simplicity, noninvasiveness, and good validity. BMI is calculated as a person's weight in kilograms divided by the square of height in meters (kg/m^2). BMI helps to assess a measurement of a person's chubbiness for the given gender and age. It is indicative of whether a person has optimum weight corresponding to his height. It has been used to make age growth charts and has more relevance in growing age. Depending on the calculated BMI value, a person is categorized as underweight, normal, overweight, or obese.

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Common oral diseases such as dental caries and periodontitis and systemic diseases such as type II diabetes, obesity, and cardiovascular disease are similar in their multifactorial and behavioral characteristics. There are two possibilities identified with the association of common oral diseases and systemic diseases. One that they may have common risk factors, or either may be itself, a risk factor for the other.[2] The common risk factors associated with oral health are diet, oral hygiene, smoking, alcohol use, and trauma.

Since these factors are common to a number of other chronic diseases, a study of their mutual risk factor approach seems to be more rational.

Diet is considered a common risk factor for both dental caries and malnutrition. Dental caries is one of the most common noncommunicable diseases worldwide, especially in children, which is usually untreated.[3] Dental caries is strongly associated with the frequency and amount of intake of sugar-rich foods.[4] Dental caries during childhood continue to remain a significant public health problem.

Dental caries has been on a declining trend over the past two decades. However, this trend is not uniform across the globe. The decline in caries was mostly observed in developed countries. Moreover, recent studies indicate that it is on the increase again due to various factors affecting health.[5] According to a systematic analysis of the global burden of diseases in 2015, "dental caries, especially permanent caries, was ranked the first in prevalence and the third in incidence among all chronic diseases in a general sense."[6] Despite the changing trends, lifestyle has contributed significantly to increased consumption of refined sugar and packaged foods lacking healthy nutrition. This has resulted in weight gain and an increased incidence of dental caries in some countries globally.[7]

Schools are ideal settings for implementing health-promoting measures and inculcating healthy eating behavior. Considering India is a developing country that has a multicultural background, it can be assumed that there are some risk factors that are unique to Indian children. Hence, this study is designed to survey the prevalence of dental caries and correlate its association with nutritional status in 3–18-year-old school-going children in the Vadodara district. It was hypothesized that malnourishment might be a marker for dental caries in children.

Materials and Methods

Selection of Participants

The cross-sectional study was conducted among 3–18-year-old children from rural municipal schools of the Vadodara district in the Gujarat state of India. Public schools are government-run schools, which mostly is attended by children from poor socioeconomic backgrounds. The research proposal was reviewed and approved by University Ethics Committee (SVIEC/ON/DENTHRRP/180). Prior permissions were taken from the District Education Officer and principals of the participating schools. Written informed consent was obtained from the parents/guardians of the selected children. The study was conducted according to the World Medical Association's Declaration of Helsinki and conformed to the International Committee of Medical Journal Editors recommendations for the conduct, reporting, editing, and publication of scholarly work in medical journals.

A list of 106 government schools in rural areas of the district was obtained from District Education Office. All the children in the age range of 3–18 years enrolled in these 29 schools were invited to participate in the study. Participants with any systemic illness, undergoing any treatment, having physical/mental deformities, or those who were absent on the day of examination were excluded from the study. A final sample of 859 participants was obtained.

Demographic Data

Data on sociodemographic characteristics and oral hygiene behavior of the children was collected using a questionnaire administered to the parents. The sociodemographic data included information on the age of the child, parental educational level, the child's oral hygiene practice, sugar consumption, and previous dental visit.

Anthropometric Measurements for Assessment of Nutritional Status

Nutritional assessment was done using anthropometric measures. Body mass index based on height and weight for age was used to assess the nutritional status of children. Since the study group comprised children, this noninvasive anthropometric index reflecting the growth was the index of choice. The height and weight of the children were measured by the primary researcher using a Hesley BMI Digital Body Analyzer (Hesley Inc). The children stood in an upright position, without any footwear. An average of two readings was recorded for the analysis. The BMI was calculated as a measure of weight adjusted for height. The WHO Child Growth Standards Reference was referred to gauge the nutritional status of children based on BMI.[8] "This new growth reference is recommended for young children and provides a scientifically reliable standard of children's growth achieved under desirable health and nutritional conditions."[9]

Interpretation of Cut-offs

- Overweight: > +1 standard deviation above mean (1SD).
- Obesity: > +2SD.
- Thinness: < –2SD>.

Oral Examination

A single examiner performed the dental examination using a mouth mirror and explorer in sufficient natural daylight. World Health Organization modification of DMFT/deft was used to assess dental caries. For primary dentition, the number of decayed (d), missing of indicated for extraction due to caries (e) and filled (f) teeth (t), the deft index was recorded. The κ coefficient of intraexaminer reliability was 0.81 in this study.

Statistical Analysis

Data were analyzed using IBM statistical package for the social sciences (SPSS) statistics 24 [IBM SPSS Statistic, Inc., Chicago, IL, United States of America (USA)]. Descriptive analysis was performed and presented in the form of frequencies and percentages for categorical variables. Chi-squared test was used as a test of significance for categorical variables. Spearman's correlation test was used to test the correlation between dental caries and BMI. The level of significance was kept at 5% for statistical analysis.

Results

The data for a total of 859 participants were analyzed. It was found that 79.27% of the mothers had education below the primary education level. Of these, 164 mothers were illiterate. Only 10.5% of mothers had an education of graduation or higher level. When the tooth brushing habit was analyzed, it was found that 86.2% of participants brushed daily. Only 10.1% reported brushing twice daily. Medium sugar consumption frequency was reported by 50.2% of participants, and 36.7% reported high sugar consumption frequency. Out of the total sample, 84. 1% reported having never visited a dentist before (Table 1).

The sample comprised 403 males and 456 females. The mean DMFT score was 0.54 ± 1.16, while the mean deft score for the sample was 0.79 ± 1.60. The participants were grouped into three

groups by age depending on dentition status. The primary dentition group comprised 69 children from 3 to 5 years of age. 586 Children in the age range of 6–14 were grouped in mixed dentition, and 204 those above 14 years were in permanent dentition. Age-wise mean deft and DMFT are given in Table 2.

When compared by the nutritional status, it was found that more than half of the participants were malnourished (54.6%), which majorly comprised undernourished children (45.4%). Only 2.2% were obese, while 4.7% were at risk of obesity. However, there was no statistically significant difference between males and females with respect to any BMI category. The representation was almost similar between the two sexes across all BMI groups (Table 3).

The caries prevalence in the study population was found to be 48.8%. However, when caries experience was compared between males and females, there was no significant difference found. A high dental caries score (total caries score >3) was found in 13% of participants only (Table 4).

The correlation between BMI and DMFT was not significant. However, there was an inverse relationship between BMI and deft observed ($p = 0.006$). This negative correlation was also observed for total caries experience (DMFT + deft) and BMI (0.045) (Table 5).

Discussion

The cross-sectional study was conducted to assess the relationship, if any, between dental caries and BMI in children and adolescents 3–18 years of age. Considering the multicultural background of India coupled with a major rural-urban divide, it was rational to evaluate this relationship against this different backdrop. The participants were recruited only from public schools, which serves as a proxy indicator for socioeconomic background.

Table 1: Sociodemographic data of the sample

Parameter	*Category*	*N (859)*	*%*
Mother's education	Uneducated	164	15.6
	Primary school	517	55.4
	Higher secondary school	159	18.5
	Graduate and above	19	10.5
Frequency of tooth brushing	>1/day	87	10.1
	Once a day	741	86.2
	<1/day	31	3.7
Sugar consumption frequency	Low	112	13.1
	Medium	431	50.2
	High	316	36.7
Previous dental visit	Yes	137	15.9
	No	722	84.1

Table 2: Age-wise distribution with mean caries experience

		Gender			*DMFT*		*deft*	
Dentition	*Age range in years*	*Female*	*Male*	*Total*	*Mean*	*± SD*	*Mean*	*± SD*
Primary dentition	(3–5 years)	27	42	69	0	0	0.96	1.46
Mixed dentition	(6–14 years)	272	314	586	0.377	0.88	1.23	1.613
Permanent dentition	(15–18 years)	104	100	204	1.11	1.68	0	0
Total		**403**	**456**	**859**	**0.54**	**1.16**	**0.79**	**1.6**

Bold text is indicative of overall sample estimate. The rows above show the caries experience of group stratified by age, while the last row shows caries experience as DMFT or deft score is given for total sample

Table 3: Distribution of participants by nutritional status

Categories by BMI	*Frequency*	*Percentage*	*p-value*	*Gender*	*Frequency*	*Percentage*	*p-value*
Underweight	410	47.7	**<0.001***	Females	176	42.9	0.15
				Males	234	57.1	
Normal	390	45.4		Females	199	51.02	
				Males	191	48.98	
Risk of overweight	40	4.7		Females	19	47.5	
				Males	21	52.5	
Overweight	19	2.2		Females	9	47.3	
				Males	10	52.7	

*difference is significant at the 0.05 level; χ^2 test

Table 4: Total caries experience stratified by gender

Total caries score	*N*	*Percentage*	*Female*	*Male*	*p-value*
0	440	51.2	199	237	0.35
1–3	307	35.7	142	165	
>3	112	13.0	61	55	
Total	**859**	**100.0**	**402**	**457**	

Bold row is only a summative statement; *difference is significant at the 0.05 level; χ^2 test

Table 5: Correlation between dental caries and the BMI categories

Correlation	*BMI*	*deft*
Correlation coefficient	0.022	1.000
Sig. (2-tailed)	0.533	.
N	790	790
	BMI	***deft***
Correlation coefficient	–0.115(**)	1.000
Sig. (2-tailed)	0.006	.
N	566	566
	BMI	***Total caries experience***
Correlation coefficient	–0.068(*)	1.000
Sig. (2-tailed)	0.045	.
N	859	859

The last row in bold gives the correlation between BMI and total caries experience i.e. (sum of DMFT and deft); *, difference is significant at the 0.05 level; Spearman's correlation test

Rural areas conjoined with public schools implied that the sample belonged to lower-middle and lower socioeconomic strata. Enrolment in school in India does not necessarily translate into attendance. Low attendance and dropouts are major challenges with education in India. Hence, all the students enrolled in selected schools were invited to participate. A wide age range of participants was chosen so as to include the two extreme ends of age for school-going children in rural areas.

The study found a negative correlation between BMI and dental caries experience. It is noteworthy that this relationship was found statistically significant only with total caries experience (total of DMFT and deft scores). However, this relation was not significant independently with caries experience in permanent dentition and primary dentition. As expressed through the inverse relationship between BMI and dental caries, overweight and obese children were more likely to be caries-free.

The present study had a predominantly greater percentage of underweight and normal-weight children. This aligns well with the fact that children were from rural backgrounds and lower socioeconomic strata. In a recent obesity update, the percentage of the population with obesity by the age of 15 in India is only 5%, whereas, in the USA, it is 38.2%.[10] There was no significant difference between males and females with respect to the BMI categories.

The prevalence of dental caries in our study was relatively low. The possible reasons could be the sample was from rural areas and largely came from lower socioeconomic strata. India is a developing country, where the caries experience shows an upward incline in children from urban places; rural parts have remained to be less affected. This is because of lifestyle changes, increased consumption of refined sugars, and more sedentary lifestyles in children from urban areas. Children in rural areas are yet not under the influence of the shift in eating habits. Moreover, they lead a physically more active life. These reasons, together with poor affordability for westernized food, contribute to lesser caries experience in children from rural backgrounds and lower socioeconomic strata. It was found that a greater number of males were caries-free compared to females. The number of males was also higher for caries score of <3. However, the difference was not statistically significant. With the known cultural difference, an Indian diet is different from a Western diet. This also highlights the finding that <7% of children in the sample were either obese or at risk of obesity.

The current study noted that in primary teeth, underweight children had higher caries experience than normal-weight children. This was in accordance with a study in Peruvian children, which reported that those who were malnourished had higher dental caries prevalence in primary dentition and delay in tooth eruption.[11]

The Association between Caries and BMI

Caries and obesity have common risk factors like unhealthy diet, poor lifestyle, and fermentable sugars. However, the research results on the association between caries and BMI have been inconclusive. Kopycka-Kedzierawski et al. suggested that being overweight may be associated with decreased risk of caries in children 2–18 years of age in the USA.[12] Alkarimi et al. also reported an inverse relationship between dental caries and anthropometric measures in the children of Saudi Arabia.[13] Similar finding was reported in a Chinese study, which found a weak negative association between caries and weight status.[14] There have been numerous research studies conducted that report otherwise. Willershausen et al. found a positive association between weight and primary caries among the German population.[15] Similar relationship was reported by Marshall et al. in a group of USA-based, obese subjects.[16] Also, there are studies that report no relation between caries and BMI.[17–19]

The disparity and heterogenicity between the studies can be attributed to (1) wide variation in sample sizes across the studies. There are limited studies on a sample of greater than 1000, (2) inconsistency in the criteria used for classifying the groups based on BMI. There are various reference guidelines given for the same by the Centers for Disease Control,[16,17,20] WHO,[13,21] International Obesity Task Force,[22] and Group of China Obesity Task Force.[23] Also, there has been a lack of uniformity in the index used for the assessment of dental caries. The various indices used are deft, defs, DMFT, and decayed, missing, or filled tooth surfaces. Also, it is noteworthy that there are no universally accepted indexes for dental caries in mixed dentition. Most of the researchers calculated caries experience by summing the caries experience of deciduous

and permanent teeth. This is done considering the cumulative effect of caries. However, the inferences so drawn must be read with caution. Additionally, caries is a disease of multifactorial origin; therefore the impact of diet can get confounded by many other factors like salivary composition, physical activity, nature of food, toothache leading to decreased food intake, genetic predisposition, etc. Therefore, establishing a cause-and-effect relationship gets complicated.

Limitations

Though the study was conducted on a large sample of a wide age range with similar representation from both sexes, there are some limitations to it. The study design to establish a causal relation is not appropriate. The school setting for dental examination is not the ideal site. There is a possibility of underestimation of caries. Various possible confounders, importantly, the physical activity has not been considered incorporating confounding bias in the results obtained. Rural background and public school were used as proxy indicators of socioeconomic status. Research inclusive of samples from both rural and urban backgrounds is warranted to better understand the difference, if any exists, between the children from different backdrops.

Conclusion

The study found the prevalence of dental caries to be 48.8%. More than 50% of the study population was malnourished, the majority being underweight. The study reported a negative correlation between BMI and dental caries. With an increase in BMI, there were fewer chances of developing caries, implying that overweight and obese children are at a lesser risk of dental caries. This relation was more pronounced in the primary dentition group.

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