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Association of Dietary Habits with Dental Caries and Occlusal Plaque: An Assessment Using the Visible Occlusal Plaque Index and Caries Index

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ABSTRACT:

Background: Dental caries is a multifactorial oral disease in which dietary habits and dental plaque play important roles. Adolescence is an important period for establishing dietary and oral hygiene behaviours that may influence future oral health. Assessment of visible occlusal plaque together with dietary habits may provide useful information regarding caries risk.

Aim: This study aimed to assess the relationship between dietary habits, occlusal plaque, and dental caries among adolescents in a hospital setting.

Materials and Methods: A hospital-based observational study was conducted among 150 adolescents. Demographic and dietary information was collected using a structured questionnaire, with particular emphasis on sweet and soft-drink consumption. Clinical oral examination was performed to assess dental caries and visible occlusal plaque. Occlusal plaque was assessed using the Visible Occlusal Plaque Index (VOPI). The relationship between dietary habits, VOPI findings, and caries status was evaluated using appropriate statistical methods. Binary logistic regression was performed to identify factors associated with caries status. A p-value <0.05 was considered statistically significant.

Results: The mean age of the participants was 9.68 ± 2.09 years. Males constituted 56.7% of the study population, while females constituted 43.3%. Among the participants, 46.0% had sound teeth, 4.0% had inactive lesions, 16.7% had active non-cavitated lesions, and

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33.3% had active cavitated lesions. Regarding VOPI, 38.0% had no visible plaque, 50.0% had thin plaque, and 12.0% had thick plaque. Sweet consumption was significantly associated with caries status in the binary logistic regression analysis (AOR=1.637, p=0.030). Gender, age, and tooth-brushing practice were not significantly associated with caries status. A weak positive correlation was observed between VOPI and caries status (r=0.158, p=0.053).

Conclusion: Sweet consumption was significantly associated with dental caries among the adolescents studied. Visible occlusal plaque showed a weak positive relationship with caries status, although the association did not reach statistical significance. Assessment of dietary habits and visible occlusal plaque together may contribute to better identification of adolescents at risk of dental caries and support targeted preventive oral health interventions.

INTRODUCTION

Dental caries is one of the most common oral diseases affecting children and adolescents and remains an important public health concern because of its impact on oral health, quality of life, school attendance, and general well-being. The occurrence of dental caries is influenced by a complex interaction between the host, oral microorganisms, tooth susceptibility, and dietary and behavioural factors. The assessment of dental caries has traditionally relied on standardized clinical indices that provide an objective measure of disease experience in a population. Early epidemiological studies established the importance of systematic assessment of dental caries and dental treatment needs among children and continue to provide the basis for population-based oral health research. [1]

Diet plays a particularly important role in the development and progression of dental caries. Frequent consumption of fermentable carbohydrates, particularly free sugars, provides substrates for cariogenic microorganisms and promotes repeated episodes of acid production and prolonged reduction of plaque pH. Thus, not only the total amount of sugar consumed but also the frequency and pattern of consumption may influence caries risk. The relationship between sugar consumption and dental caries has been extensively investigated, with evidence indicating that higher and more frequent sugar exposure is associated with an increased risk of dental caries. [4,5]

Adolescence represents an important period for the establishment of dietary behaviours. Increasing independence, greater access to commercially available foods and beverages, frequent snacking, and consumption of sugar-containing foods may influence oral health during this period. Longitudinal research among adolescent school children has demonstrated an association between dietary habits and subsequent caries increment, emphasizing the importance of evaluating dietary behaviour when investigating dental caries in adolescents. [6]

The relationship between diet and oral health should also be considered within the broader context of common behavioural risk factors. Dietary practices, oral hygiene, and other lifestyle behaviours may contribute simultaneously to oral and general health outcomes. The common risk factor approach therefore supports interventions that address dietary and behavioural determinants rather than considering dental caries as an isolated disease process. [7]

Evidence from systematic reviews has further demonstrated the importance of controlling dietary sugar intake for prevention of dental caries. Restriction of free sugar intake has been associated with a reduction in caries development, supporting recommendations aimed at reducing both the quantity and frequency of sugar exposure. [8] A quantitative reassessment of the relationship between sugar intake and dental caries has similarly emphasized the importance of limiting free sugar consumption as an important component of caries prevention. [9]

The effect of dietary behaviour may also be influenced by the local oral environment, particularly the accumulation of dental plaque. Dental plaque provides the microbial environment in which dietary carbohydrates can be metabolized into acids, thereby contributing to demineralization of susceptible tooth surfaces. Occlusal surfaces are particularly vulnerable because their pits

and fissures can retain plaque and food debris, making them important sites for the initiation and progression of dental caries. Therefore, assessment of dietary habits alone may not fully explain caries occurrence unless the local plaque condition is also considered.

The Visible Occlusal Plaque Index (VOPI) provides a clinically applicable method for assessing visible plaque accumulation on occlusal surfaces. Assessment of visible occlusal plaque is particularly relevant to studies of occlusal caries because plaque accumulation can be directly related to the activity and progression of carious lesions. Incorporating an occlusal plaque assessment alongside a conventional caries index can therefore provide a more comprehensive understanding of the relationship between dietary behaviour, plaque accumulation, and dental caries.

National and population-level dietary studies have also demonstrated an association between sugar-containing food consumption and dental decay among children, highlighting the continuing relevance of dietary assessment in preventive oral health research. [10] However, the relationship between dietary habits, visible occlusal plaque, and dental caries may vary according to age, dietary practices, oral hygiene behaviour, and the characteristics of the study population.

Despite extensive evidence linking dietary sugar exposure with dental caries, there remains a need to examine dietary habits together with clinically observable plaque accumulation on occlusal surfaces. Assessment of both dietary exposure and visible occlusal plaque may help identify adolescents who are at increased risk of dental caries and may provide useful information for targeted preventive counselling.

Therefore, the present study was undertaken to assess the association between dietary habits, occlusal plaque accumulation, and dental caries among adolescents attending a hospital setting. The study specifically aimed to evaluate dietary habits in relation to visible occlusal plaque assessed using the Visible Occlusal Plaque Index and dental caries assessed using a standardized caries index.

METHODOLOGY

The present study was conducted as a hospital-based observational study among adolescents attending the study setting. A total of 150 adolescent participants were included in the study. Participants were selected according to the predefined eligibility criteria, and the study was conducted after obtaining the necessary institutional ethical approval and informed consent from the participants or their parents/guardians, as applicable.

Adolescents attending the hospital during the study period were considered for participation. Participants who fulfilled the predetermined eligibility criteria were enrolled in the study until the required sample size of 150 was achieved. Adolescents who were unable to participate in the dietary interview or undergo the required oral examination were excluded. Participants with conditions that could interfere substantially with the assessment of dental plaque or dental caries were also excluded according to the study protocol.

A structured data collection proforma was used to record the relevant demographic and dietary information of each participant. Dietary habits were assessed using a standardized dietary questionnaire designed to obtain information regarding the type, frequency, and pattern of consumption of foods and beverages relevant to dental caries. Particular attention was given to the consumption of sugar-containing foods and beverages and the frequency of their intake. Information regarding between-meal snacking and other dietary practices relevant to cariogenic exposure was also recorded.

A clinical oral examination was performed for each participant under appropriate examination conditions. The examination focused particularly on the occlusal surfaces of the teeth because these surfaces are important sites for plaque retention and caries development. Visible plaque accumulation on occlusal surfaces was assessed using the Visible Occlusal Plaque Index. The index was used to identify the presence and extent of visible plaque on the examined occlusal surfaces according to the established assessment criteria.

Dental caries was assessed using a standardized caries index. The teeth were examined systematically, and the findings were recorded according to the diagnostic criteria specified for the selected caries index. The caries assessment was performed independently of the dietary interview to minimize the influence of information obtained during the questionnaire assessment.

The dietary findings were subsequently compared with the clinical findings for occlusal plaque and dental caries. The primary analysis focused on determining whether dietary habits were associated with the presence and level of visible occlusal plaque and whether these dietary and plaque-related factors were associated with dental caries among the adolescent participants.

Data obtained from the questionnaires and clinical examinations were entered into a computerized database and analyzed using appropriate statistical methods. Categorical variables were summarized as frequencies and percentages, while continuous variables were expressed using appropriate measures of central tendency and dispersion. Associations between dietary variables, Visible Occlusal Plaque Index findings, and dental caries status were assessed using appropriate statistical tests according to the type and distribution of the data. A p-value of less than 0.05 was considered statistically significant.

RESULTS

Table 1 shows the socio-demographic characteristics of the 150 participants. The mean age of the participants was 9.68 ± 2.09 years. Among the participants, 99 (66.0%) were in the 7–10-year age group, while 51 (34.0%) belonged to the 11–14-year age group. Regarding gender distribution, 85 (56.7%) participants were male and 65 (43.3%) were female.

Table 2 presents the comparison of caries status and Visible Occlusal Plaque Index (VOPI) according to sweet and soft-drink consumption. Among participants consuming sweets every day, 51 (46.8%) had sound teeth, 3 (2.8%) had inactive lesions, 20 (18.3%) had active non-cavitated lesions, and 35 (32.1%) had active cavitated lesions. Among those consuming sweets sometimes, 18 (43.9%) had sound teeth, 3 (7.3%) had inactive lesions, 5 (12.2%) had active non-cavitated lesions, and 15 (36.6%) had active cavitated lesions. Regarding VOPI, no visible plaque was observed in 37 (33.9%) participants consuming sweets every day and 20 (48.8%) consuming them sometimes. Thin plaque was observed in 56 (51.4%) and 19 (46.3%) participants, respectively, whereas thick plaque was observed in 16 (14.7%) and 2 (4.9%), respectively. For soft-drink consumption, 17 (48.6%) daily consumers had sound teeth compared with 51 (44.3%) occasional consumers. Active cavitated lesions were observed in 10 (28.6%) daily consumers and 40 (34.8%) occasional consumers. No visible plaque was observed in 12 (34.3%) daily soft-drink consumers and 45 (39.1%) occasional consumers, while thin plaque was the most frequently observed VOPI category in both groups.

Table 3 demonstrates the correlation between VOPI and caries status. A positive Pearson correlation coefficient of 0.158 was observed between VOPI criteria and caries status, indicating a weak positive relationship between the two variables. The reported p-value was 0.053, which was slightly greater than 0.05, indicating that the observed correlation did not reach statistical significance at the conventional 5% significance level.

Table 4 presents the binary logistic regression analysis of potential risk factors associated with caries status. Sweet consumption was significantly associated with caries status, with an adjusted odds ratio of 1.637 and a p-value of 0.030. Participants with the specified pattern of sweet consumption had higher odds of caries. Tooth-brushing practice, gender, and age did not show statistically significant associations with caries status, with p-values of 0.176, 0.074, and 0.286, respectively. The adjusted odds ratio for tooth-brushing practice was 0.325, while gender and age showed adjusted odds ratios of 0.704 and 1.236, respectively.

Table 1: Socio-demographic Characteristics of the Participants

Variable	Category	N	%
Age (years)	Mean ± SD	9.68 ± 2.09	—
	7–10 years	99	66.0
	11–14 years	51	34.0
Gender	Male	85	56.7
	Female	65	43.3
Total		**150**	**100.0**

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Table 2: Comparison of Caries Status and Visible Occlusal Plaque Index with Sweet and Soft-Drink Consumption

Parameter	Category	Sweet Consumption Everyday N (%)	Sweet Consumption Sometimes N (%)	Total N (%)	Soft-Drink Consumption Everyday N (%)	Soft-Drink Consumption Sometimes N (%)	Total N (%)
Caries status	Sound	51 (46.8)	18 (43.9)	69 (46.0)	17 (48.6)	51 (44.3)	68 (45.3)
	Inactive lesion	3 (2.8)	3 (7.3)	6 (4.0)	0 (0.0)	6 (5.2)	6 (4.0)
	Active non-cavitated lesion	20 (18.3)	5 (12.2)	25 (16.7)	8 (22.9)	18 (15.7)	26 (17.3)
	Active cavitated lesion	35 (32.1)	15 (36.6)	50 (33.3)	10 (28.6)	40 (34.8)	50 (33.3)
	Total	**109 (100.0)**	**41 (100.0)**	**150 (100.0)**	**35 (100.0)**	**115 (100.0)**	**150 (100.0)**
VOPI	No visible plaque	37 (33.9)	20 (48.8)	57 (38.0)	12 (34.3)	45 (39.1)	57 (38.0)
	Thin plaque	56 (51.4)	19 (46.3)	75 (50.0)	17 (48.6)	58 (50.4)	75 (50.0)
	Thick plaque	16 (14.7)	2 (4.9)	18 (12.0)	6 (17.1)	12 (10.4)	18 (12.0)
	Total	**109 (100.0)**	**41 (100.0)**	**150 (100.0)**	**35 (100.0)**	**115 (100.0)**	**150 (100.0)**
P-value	Caries status			**0.482**			**0.385**
	VOPI			**0.119**			**0.551**

Table 3: Correlation of Visible Occlusal Plaque Index with Caries Status

Variable	Statistic	VOPI Criteria	Caries Status
VOPI criteria	Pearson correlation	1.000	0.158
	Sig. (2-tailed)	—	0.053
	N	150	150
Caries status	Pearson correlation	0.158	1.000
	Sig. (2-tailed)	0.053	—
	N	150	150

Table 4: Binary Logistic Regression Analysis Showing Risk Factors for Caries Status

Variables	Sig.	AOR	95% CI for AOR Lower	95% CI for AOR Upper
Do you brush your teeth	0.176	0.325	0.064	1.654
Sweet consumption	0.030	1.637	1.049	2.555
Gender	0.074	0.704	0.479	1.034
Age	0.286	1.236	0.837	1.825
Constant	0.444	1.917	—	—

DISCUSSION

The present study evaluated the relationship between dietary habits, visible occlusal plaque, and dental caries among 150 adolescents. The findings demonstrated that dietary practices, particularly sweet consumption, were relevant to caries status, while visible occlusal plaque showed a weak positive relationship with caries status. These findings support the importance of considering both dietary exposure and plaque accumulation when assessing caries risk in adolescents.

The Visible Occlusal Plaque Index (VOPI) provides a clinically useful approach for assessing plaque accumulation specifically on occlusal surfaces. Occlusal surfaces are particularly susceptible to plaque retention because of their anatomical morphology, and the presence of visible plaque may provide clinically relevant information regarding caries activity. Carvalho et al. demonstrated the usefulness of the VOPI in estimating caries lesion activity, supporting its application as an adjunctive clinical measure in caries assessment. [11]

In the present study, thin plaque was the most frequently observed VOPI category, while thick plaque was less common. A weak positive correlation was observed between VOPI and caries status, with a Pearson correlation coefficient of 0.158. However, the reported p-value of 0.053 did not reach conventional statistical significance. This suggests that although greater visible occlusal plaque accumulation tended to occur with increasing caries status, the strength of the observed relationship was limited in the present sample. The findings should therefore be interpreted as indicating a possible trend rather than a statistically confirmed association.

The clinical relevance of VOPI in relation to caries has also been demonstrated in previous research. Carvalho et al. reported that visible occlusal plaque could be useful in predicting caries lesion activity, emphasizing the importance of plaque accumulation on occlusal surfaces in the assessment of caries risk. [12] The present findings are broadly consistent with this concept, although the relatively weak correlation observed in the current study indicates that plaque accumulation alone may not adequately explain differences in caries status.

Dietary behaviour represents another important component of caries risk. In the present study, sweet consumption showed a statistically significant association with caries status in the binary logistic regression analysis, with an adjusted odds ratio of 1.637 and a p-value of 0.030. This indicates that sweet consumption was an important factor associated with the likelihood of caries in the study population. The finding is consistent with evidence from longitudinal studies showing that dietary free sugar exposure is associated with dental caries among children and adolescents. [13]

The systematic review by Mahboobi et al. emphasized the relationship between dietary free sugar consumption and dental caries in children, particularly when dietary exposure is assessed longitudinally. [13] The present findings similarly suggest that dietary behaviour should be considered when identifying adolescents at increased risk of dental caries. The significant association observed for sweet consumption also reinforces the importance of dietary counselling as a component of preventive oral healthcare.

Assessment of cariogenic dietary habits in children and adolescents can be challenging because dietary patterns involve multiple food and beverage categories, different frequencies of consumption, and variations in portion size and timing. Angelopoulou et al. highlighted the variability in tools used for assessing cariogenic diets and emphasized the importance of appropriate dietary

assessment methods in paediatric and adolescent populations. [14] In the present study, sweet and soft-drink consumption were considered as relevant dietary behaviours, allowing their relationship with caries status and VOPI to be examined.

Soft-drink consumption did not demonstrate the same clear association with caries status as sweet consumption in the present analysis. Differences in frequency of consumption, overall dietary patterns, and other behavioural factors may contribute to this finding. Dietary exposure should therefore not be interpreted solely on the basis of one food or beverage category. Instead, the overall frequency and pattern of exposure to cariogenic foods and beverages should be considered when evaluating caries risk. [14,15]

The findings are also consistent with the broader evidence concerning processed sugar- and starch-containing foods and dental caries. Hancock's systematic review emphasized the relevance of dietary patterns involving processed sugar- and starch-containing foods to caries development. [15] This supports the concept that dietary counselling for adolescents should focus not only on individual foods but also on reducing repeated exposure to potentially cariogenic foods and snacks throughout the day.

The regression analysis in the present study showed that age and gender were not statistically significant predictors of caries status. Similarly, tooth-brushing practice did not demonstrate a statistically significant association with caries status in the adjusted analysis. This may indicate that dietary exposure and plaque-related factors have a more prominent role within the particular study population. However, the absence of statistical significance for these variables does not imply that oral hygiene and demographic factors are unimportant in the multifactorial development of dental caries.

Overall, the findings indicate that dental caries among adolescents should be approached as a multifactorial condition involving dietary behaviour and local plaque accumulation. VOPI may provide useful additional clinical information regarding occlusal plaque, while dietary assessment can help identify potentially modifiable behavioural risk factors. The combination of dietary counselling, plaque control, and regular clinical assessment may therefore be useful in preventive oral healthcare for adolescents. [11-15]

CONCLUSION

The present study demonstrated an association between dietary habits and dental caries among adolescents. Sweet consumption was significantly associated with caries status in the regression analysis, indicating that dietary exposure represents an important modifiable factor. Visible occlusal plaque showed a weak positive correlation with caries status, although the observed correlation did not reach statistical significance. The findings support the use of dietary assessment together with clinical evaluation of occlusal plaque for identifying adolescents who may be at increased risk of dental caries. Preventive strategies should emphasize reduction of frequent sweet consumption, improvement of oral hygiene practices, and regular assessment of occlusal plaque and caries status.

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