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IMPACT OF DIETARY AND SUGAR RELATED BEHAVIORS ON DENTAL CARIES AMONG CHILDREN AGED 3-6 YEARS: A CROSS- SECTIONAL STUDY.

Dentistry

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ABSTRACT

Background: Dental caries is the most prevalent oral health issue among school-aged children. Excessive consumption of added sugars not only contributes to early childhood caries but also impacts overall growth and development due to poor nutrient intake. Early identification and prevention strategies are essential. Diet diaries are valuable tools for assessing dietary habits and sugar consumption. This study aims to evaluate the impact of dietary patterns and sugar- related behaviours on dental caries in children aged 3 to 6 years. **Methodology:** A total of 500 children aged 3–6 years were selected based on inclusion and exclusion criteria. Dental caries was assessed using defs (decayed, extracted, filled surfaces) and deft (decayed, extracted, filled teeth) indices. Mothers were asked to record a 24-hour diet diary for 1 week, recording all meals, snacks, and added sugar intake. **Results:** A weak positive correlation was found between food group score, nutrient score, and the duration of food intake with deft scores. The dental health diet score showed a weak negative correlation with deft scores. Regression analysis revealed that free sugar intake significantly predicted both deft and defs scores. **Conclusion:** Despite good food group and nutrient scores, a lower dental health diet score was significantly associated with increased caries. The positive effects of nutrient intake were offset by high free sugar consumption. Limiting free sugar intake is crucial for effective caries prevention in young children.

KEYWORDS

Diet, Free Sugars, Dental Varies, Nutrition, Diet Dairy

INTRODUCTION

Dental caries remains the most common oral disease among school-aged children worldwide and continues to impose a considerable burden on health systems and quality of life.[1] Caries development is closely linked to dietary habits, and there is extensive evidence that free sugars are the primary necessary factor in the initiation and progression of dental caries.[2]

The World Health Organization (WHO) identifies sugar consumption as the most important modifiable risk factor for dental caries and recommends that free sugars should contribute less than 10% of total energy intake, with further benefits for oral and general health when intake is reduced below 5%.[3] Free sugars (also termed "added sugars") are those added to foods and beverages by manufacturers, cooks or consumers, as well as sugars naturally present in honey, syrups, fruit juices and fruit juice concentrates, but excluding intrinsic sugars in whole fruits, vegetables and milk.[3-4]

High intake of added sugars is associated not only with dental caries but also with adverse systemic health outcomes, including obesity, micronutrient dilution and non-communicable diseases.[4-5] The "empty calories" supplied by added sugars may displace nutrient-dense foods, thereby impairing growth and development in children.[5] A suboptimal diet is also recognized as a contributor to tooth decay, periodontal problems and compromised oral health-related quality of life.[6,7,10] Recent literature has highlighted the systemic role of diet in both the development and arrest of caries, underlining that caries is not purely a local disease of the tooth surface but tightly linked to broader dietary patterns.[10]

Despite this, most dental caries prevention strategies in clinical practice still emphasize tooth-level approaches such as fluoride varnish, fissure sealants and restorative treatments.[4] These important interventions, however, do not address upstream drivers such as frequent ingestion of sugar-sweetened foods and beverages, prolonged snacking and high free sugar exposure from an early age.[4-8] Evidence suggests that early identification and modification of these behaviors in young children may yield substantial long-term benefits in terms of caries prevention and improved oral health-related quality of life.[6,7]

Diet diaries offer a simple, low-cost tool to capture food choices, frequency and timing of intake, and sugar exposure in individual patients. By assigning scores to different food groups and sugar-containing items, diet diaries can be converted into quantitative indices such as sweet scores and overall diet scores, which may be linked to caries experience. However, there is limited data from Indian preschool populations using such structured diet-based tools to explore how free sugar–related dietary behaviors relate to dental caries.

Therefore, the present study was undertaken in a high-caries-risk group of 3–6-year-old children to assess dietary patterns and sugar-related behaviors using diet diaries and to examine their association with dental caries experience.

MATERIALS AND METHODS

Study Design and Criteria of Selection

A cross-sectional observational study was conducted among 500 children aged 3–6 years reporting to the Department of Pediatric and Preventive Dentistry, M. R. Ambedkar Dental College and Hospital, Bengaluru, Karnataka. **Inclusion criteria were,** 1. Children aged 3–6 years. 2. Parents willing to participate. 3. Mothers able to read and write English. 4. Children from nuclear families. **Exclusion criteria were,** 1. Children requiring pulp therapy. 2. Medically compromised children. 3. Uncooperative children. 4. Systemic or pathological conditions. 5. Children with disability. 5. Mothers unable to read or write English.

The study was approved by the Institutional Ethics Committee of M R Ambedkar Dental College and Hospital, Bengaluru (Approval No: IEC/MRADC&H/EC-198/2025). Written informed consent was obtained from participants.

Diet Diary Protocol and Data Collection

Parents completed a structured 24-hour diet diary for documenting: Foods consumed at breakfast, lunch, dinner, and snacks; whether sugar was added; Time taken to consume each item.

Mothers were provided with a structured diet diary handout and were instructed to record the child's usual dietary intake for: Pre Breakfast Snacks, Breakfast, In between snacks, Lunch,In between snacks, Dinner and Post-dinner snacks.

For each eating occasion, the mothers recorded: The type of food or beverage consumed, whether sugar was added (yes/no) and the approximate duration (in minutes) the child took to consume the meal or snack.

Scoring System

Each food item in the diet diary was assigned a predefined constant value reflecting its likely impact on dental health (favourable, neutral or unfavourable). Based on these constants, the following scores were derived for each child:

1. **Food Group Score**

o Summation of scores for different food groups (e.g., cereals,

pulses, fruits, vegetables, dairy, etc.) consumed over the day.
- o Higher scores indicated more favourable food group choices.

2. Nutrient Score
- o Derived from the nutrient quality of the diet (e.g., presence of protein-rich foods, fibre-rich foods, and micronutrient-dense items).
- o Higher scores reflected better nutrient density of the diet.

3. Sweet Score
- o Summation of scores assigned to items high in free sugars or with added sugar (e.g., sweets, confectionery, sugar-sweetened beverages, sugary snacks, sweetened milk products).
- o Higher scores indicated greater free sugar exposure.

4. Dental Health Diet Score
- o Each food item was assigned a predefined constant value based on its dental health impact. Diet scores were calculated using the formula:
- o Diet score = Food group score + Nutrient score − Sweet score
- o Higher values denoted a more favorable diet for dental health, whereas lower values indicated that any benefits of good food group and nutrient intake were undermined by high sweet consumption.

Clinical Examination
A calibrated examiner recorded dental caries status using:
- deft index (decayed, extracted, filled teeth in primary dentition)
- defs index (decayed, extracted, filled tooth surfaces in primary dentition)

Statistical Analysis
Data were entered into a spreadsheet and subjected to statistical analysis.

Descriptive Statistics: mean and standard deviation (SD) for continuous variables; frequency and percentage for categorical variables.

Correlation Analysis: Spearman's rank correlation test was used to assess the relationship between:
- o deft/defs scores and Food Group, Nutrient, Sweet and Dental Health Diet scores.
- o defs scores and duration (in minutes) of food intake at different time intervals.

Group Comparisons: Mann–Whitney U test was used to compare mean diet scores, caries indices and meal durations:
- o Between age groups (3–4 vs 5–6 years)
- o Between genders (males vs females)

Regression Analysis: Simple linear regression was used to predict deft and defs scores from Sweet Score.

A p-value <0.05 was considered statistically significant.

RESULTS
Sample Characteristics
A total of 500 children were included. The mean age was 4.58 ± 1.03 years (range 3–6 years). 47.6% were 3–4 years (n = 238) and 52.4% were 5–6 years (n = 262). 52.8% were males (n = 264) and 47.2% were females (n = 236).

The analysis showed a weak positive correlation between deft scores and both food group (ρ=0.29, p<0.001) and nutrient scores (ρ=0.31, p<0.001), indicating a slight increase in caries experience with higher dietary variety and nutrient intake. In contrast, sweet score demonstrated a strong positive correlation with deft (ρ=0.82, p<0.001), showing that greater sugar consumption was consistently associated with markedly higher caries levels. The dental health diet score showed a weak negative correlation with deft (ρ=−0.26, p<0.001), suggesting a slight reduction in caries with healthier dietary practices. Overall, sweet intake was the strongest dietary predictor of caries, whereas general diet quality showed weaker, mixed associations.

For deft scores (Table no .1): Food Group Score: $\rho = 0.29$; $p < 0.001$. Nutrient Score: $\rho = 0.31$; $p < 0.001$. Sweet Score: $\rho = 0.82$; $p < 0.001$. Dental Health Diet Score: $\rho = -0.26$; $p < 0.001$.

Table no. 1 Relationship Between Deft Scores, Diet and Dental Health Scores

Variable	Values	Food Group Score	Nutrient Score	Sweet Score	Dental Health Diet Score
deft score	rho	0.29	0.31	0.82	-0.26
	p-value	<0.001*	<0.001*	<0.001*	<0.001*

For defs scores (Table no .2): Food Group Score: $\rho = 0.31$; $p < 0.001$. Nutrient Score: $\rho = 0.33$; $p < 0.001$. Sweet Score: $\rho = 0.83$; $p < 0.001$. Dental Health Diet Score: $\rho = -0.25$; $p < 0.001$.

Table No. 2 Relationship Between Deft Scores, Diet and Dental Health Scores

Variable	Values	Food Group Score	Nutrient Score	Sweet Score	Dental Health Diet Score
defs score	rho	0.31	0.33	0.83	-0.25
	p-value	<0.001*	<0.001*	<0.001*	<0.001*

Thus, while better food group and nutrient scores showed only weak-to-moderate positive associations with caries experience, the Sweet Score exhibited a very strong positive correlation with both deft and defs. In contrast, higher Dental Health Diet Scores were significantly associated with lower caries experience. (Figure no. 1)

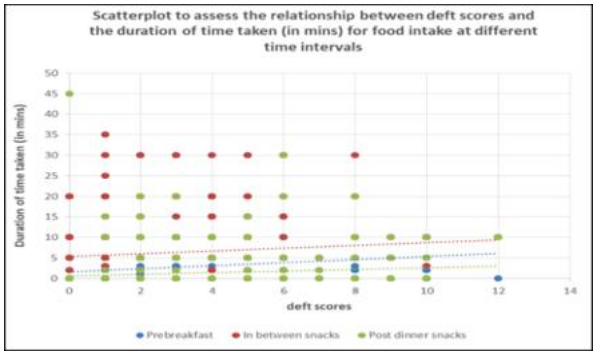

Figure no. 1 Relationship Between Deft Scores and the Duration of Time Taken (in mins) For Food Intake at Different Time Intervals

Significant positive correlations were observed between defs and: Pre-breakfast duration ($\rho = 0.24$; $p < 0.001$). In-between snacks (morning/afternoon) duration ($\rho = 0.25$; $p < 0.001$). Post-dinner snacks duration ($\rho = 0.21$; $p < 0.001$(Figure no. 2)

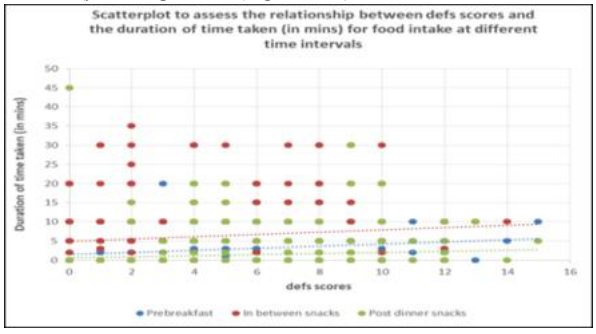

Figure no. 2 Relationship Between Defs Scores and the Duration of Time Taken (in mins) For Food Intake at Different Time Intervals

Age-wise comparison of diet scores, meal duration and caries indices between 3–4-year-olds and 5–6-year-olds. Overall, no significant age-related differences were observed in diet quality, sweet exposure, caries experience or eating duration.

Prediction of Caries from Sweet Score
Simple linear regression analysis (Table no. 3) demonstrated that Sweet Score was a strong predictor of both deft and defs scores:

For deft:
- o Constant (β_0) = 0.26 (SE = 0.13; p = 0.04)
- o Sweet Score coefficient (β_1) = 0.22 (SE = 0.01; t = 29.1; p < 0.001)
- o Coefficient of determination: $R^2 = 0.63$

For defs:
- o Constant (β_0) = 0.80 (SE = 0.16; p < 0.001)
- o Sweet Score coefficient (β_1) = 0.30 (SE = 0.01; t = 32.9; p < 0.001)
- o Coefficient of determination: $R^2 = 0.69$

The regression coefficient for sweet score was 0.30 with a standard error of 0.01, suggesting that for every one-unit increase in sweet score, the defs score increased by 0.30 units. These findings indicate that 63% of the variance in deft and 69% in defs can be explained by variations in Sweet Score alone, highlighting its central role as a behavioral determinant of caries in this population.

Table No. 3 Linear Regression Predicting Caries From Sweet Score

DV	IV	Unstd. Coefficients		t	p- value	R2
		β	SE			
deft	Constant	0.26	0.13	2.049	0.04*	0.63
	Sweet Score	0.22	0.01	29.068	<0.001*	
defs	Constant	0.80	0.16	5.095	<0.001*	0.69
	Sweet Score	0.30	0.01	32.948	<0.001*	

Digital Device Usage and Content Preference

Among the study population, mobile phones emerged as the most frequently used digital device, with more than half of the children reporting regular mobile use during daily activities, followed by tablet use, while television usage was comparatively lower. Furthermore, analysis of content preference showed that a large proportion of children (70%) predominantly engaged with cartoon-based media, whereas only 30% preferred rhyme-based content. The high prevalence of mobile phone usage, coupled with the preference for visually stimulating, fast-paced cartoon content, suggests that preschool children are primarily exposed to interactive, handheld digital media rather than conventional screen-based platforms. This pattern may be of particular relevance in the context of eating behavior, as portable devices are more likely to be used during meal times, potentially facilitating distracted feeding practices. (Figure no. 3)

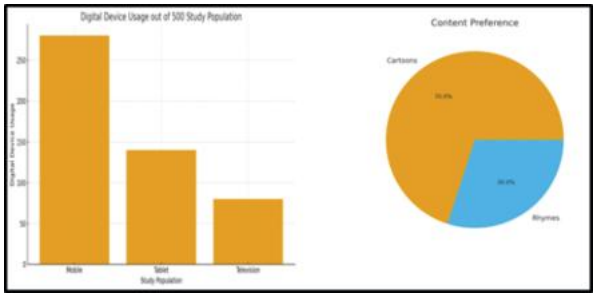

Figure No. 3 Distribution of Digital Device Usage and Content Preference Among Study Participants

DISCUSSION

The results of this study support the strong and independent role of free sugar exposure as a behavioral determinant of early childhood caries. A notable finding was that nutrient-rich diets failed to mitigate caries risk, likely because children consuming healthier foods also consumed significant quantities of sweetened snacks and beverages. This dietary coexistence reflects modern feeding practices, where parents prioritize nutrition but continue to provide sugar-dense foods for convenience or child preference.

The significant associations identified between prolonged snacking and caries emphasize the importance of exposure time rather than total sugar volume. Frequent and prolonged eating events limit salivary clearance and extend demineralization periods. Additionally, late-night sugar intake is particularly harmful due to reduced salivary flow during sleep.

Digital device use may indirectly influence caries risk by altering feeding patterns, increasing meal duration, and encouraging passive consumption of sugar-dense foods. These findings suggest that caries prevention strategies must evolve beyond clinical interventions to address modifiable behaviors.

A key implication is that early establishment of structured meal patterns, avoidance of prolonged snacking, and reduction of sugary food frequency is essential in caries prevention. Diet diaries represent an efficient tool for capturing behavioral risk profiles and enabling targeted counseling.

CONCLUSION

Free sugar exposure is a strong predictor of dental caries in preschool children, explaining a significant proportion of caries variance. Behavioral variables related to meal frequency and duration further contributes to risk. Effective prevention requires shifting emphasis from solely clinical interventions toward behavioral dietary modification. Incorporation of diet diaries into pediatric dental practice can support personalized risk assessment and dietary counseling.

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