

Original Research

Dietary Sugary Food Consumption, Toothbrushing, and Gender as Determinants of Dental Caries Among Primary and Secondary School Students in Hyderabad, Pakistan: A Cross-Sectional Study

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Abstract

Background and Objective: Dental caries remain a major public health issue among school-aged children where high sugar intake is recognized as a key modifiable risk factor for this disease. To estimate the prevalence of clinically recorded dental caries and examine its association with self-reported sweets/chocolate consumption and between-meal sugary snacking among students attending a government school in Hyderabad, Pakistan. **Materials and Methods:** This cross-sectional study was conducted from February to June 2026. Caries' presence was derived from clinicians recorded examination or provisional diagnosis. Associations were assessed using chi-square tests. Adjusted prevalence ratios (aPRs) and 95% confidence intervals (CIs) were estimated using modified Poisson regression with robust variance, controlling for age group, gender, toothbrushing, sweets/chocolate frequency, and between-meal snacking. **Results:** Mean age was 12.56 ± 2.88 years; 241 (63.1%) participants were male. Dental caries was recorded in 194 students (50.8%). Caries prevalence differed across sweets/chocolate-frequency categories (daily, 59.1%; sometimes, 44.3%; rarely, 50.7%; $p=0.034$) but not across between-meal snacking categories ($p=0.174$). In adjusted analysis, daily sweets/chocolate consumption was not independently associated with caries compared with rare consumption (aPR 1.15, 95% CI 0.87–1.53). Male gender (aPR 1.29, 95% CI 1.03–1.63) and reporting no toothbrushing (aPR 1.37, 95% CI 1.10–1.70) were independently associated with higher caries prevalence. **Conclusion:** Approximately half of the students analyzed had clinically recorded dental caries. Although caries prevalence varied across sweets/chocolate-frequency categories in unadjusted analysis, the dietary association attenuated after adjustment. Male gender and absence of toothbrushing remained associated with higher caries prevalence. The findings support integrated school-based dietary and oral-hygiene education. **Clinical application:** Routine dental assessments in school settings should incorporate brief dietary and oral-hygiene screening to identify students at increased risk of dental caries and facilitate targeted preventive counselling, timely referral, and follow-up care.

Keywords: Dental caries; Sugar intake; Sugar-sweetened beverages; DMFT index; School children; Oral health.

1. Introduction

Dental caries is among the most prevalent noncommunicable diseases and remains a major public-health concern across the life course. The World Health Organization (WHO) estimates that oral diseases affect nearly 3.7 billion people and identifies untreated caries in permanent teeth as the most common health condition in the Global Burden of Disease 2021.¹

The 2022 WHO global oral-health report estimated that caries affects approximately 2 billion people in permanent dentition and more than 500 million children in primary dentition.²

Caries is a biofilm-mediated, sugar-driven, multifactorial disease in which repeated exposure to fermentable carbohydrates promotes acid production, ecological dysbiosis, and net mineral loss from dental hard tissues.^{3,4} Frequent consumption of free sugars can increase the time during which plaque pH remains below the threshold for demineralization, whereas toothbrushing with fluoride toothpaste supports plaque control and remineralisation.^{1,5}

Contemporary evidence links frequent intake of sweets, processed sugar-containing foods, and sugar-sweetened drinks with caries among children, although effect estimates vary with exposure measurement, dentition, fluoride availability, oral-hygiene practices, and socioeconomic conditions.⁶⁻¹⁰ Dietary questionnaires are also vulnerable to recall and social-desirability bias, particularly when broad frequency categories are used.

Pakistan carries a substantial and heterogeneous caries burden. A national systematic review estimated an overall prevalence of 56.3%, with considerable variation between regions and dentitions.¹¹ Studies from Quetta, Sargodha, Karachi, and other Pakistani settings similarly demonstrate that caries coexists with differences in oral-hygiene practices, dietary patterns, fluoride exposure, and social circumstances.¹²⁻¹⁵ However, published school-based evidence from Hyderabad, Sindh, remains limited.

This study aimed to estimate the prevalence of clinically recorded dental caries and examine its association with self-reported frequency of sweets/chocolate consumption and between-meal sugary snacking among primary and secondary students attending a government school in Hyderabad, Pakistan.

2. Materials and Methods

This was a cross-sectional, analytical study conducted from February to June 2026 at Government Naval Rai Hiranand High School, Hyderabad, Sindh, Pakistan. The institution was selected as it represents a government-sector setting serving a socioeconomically diverse school-going population across both primary and secondary levels.

The target population comprised school-going children enrolled in primary and secondary classes at the selected institution. A total of 387 students were recruited using a convenience sampling technique on the day of data collection. Students aged 5–19 years who were present and whose parents or legal guardians provided written informed consent were eligible for inclusion. Children with special educational needs, those undergoing active dental treatment at the time of examination, and those whose guardians declined participation were excluded from the study.

Information was collected through an interviewer-administered electronic camp form completed by dental students under clinical supervision. The form captured age, gender, class, selected medical and dental history, toothbrushing, mouthwash use, sweets/chocolate frequency, between-meal sugary snacking, free-text clinical examination findings, provisional diagnosis, and treatment advice. It was designed for service documentation rather than as a formally validated dietary instrument; consequently, its broad response categories are treated as self-reported behavioural indicators rather than quantitative estimates of sugar intake.

The available database did not contain tooth-level decayed, missing, and filled teeth counts and did not contain a separate sugar-sweetened beverage variable. Accordingly, the outcome is reported as clinically recorded caries presence, not a DMFT/dmft score or caries-experience index, and the exposure is described as sugary-food consumption rather than food-and-beverage consumption.

The primary outcome was dental caries recorded by the clinical team examining. A record was classified as caries-positive when either the ‘Dental Examination’ or ‘Provisional Diagnosis’ field contained an explicit indication of decay or caries (including common spelling variants such as carious, carries, cavity, or cavities). A record was classified as caries-free when at least one of these two fields was completed and neither contained an indication of decay/caries. Records with both fields missing were excluded from outcome analysis.

The primary exposures were sweets/chocolate consumption (daily, sometimes, or rarely) and sugary snacks between meals (always, occasionally, or never), retained exactly as recorded. Toothbrushing was analysed as yes/no. Age was cleaned only for obvious formatting variants, analysed continuously for description, and grouped as 5–8, 9–11, 12–14, and 15–19 years for categorical analyses. Gender was recorded as male or female. Systemic health information was incompletely recorded and was therefore not used as an exclusion criterion or analytical covariate.

Data were checked for eligibility, internal consistency, missingness, and category spelling. Continuous age is presented as mean $\pm$ standard deviation (SD), median, and range. Categorical variables are presented as frequencies and percentages. Pearson’s chi-square test was used for tables with more than two categories; continuity-corrected chi-square tests were used for 2 $\times$ 2 comparisons. Because caries prevalence was approximately 50%, prevalence ratios (PRs) were preferred to odds ratios. Modified Poisson regression with robust variance was used to estimate adjusted prevalence ratios (aPRs) and 95% confidence intervals (CIs). The multivariable model included the two dietary exposures and three a priori available confounders: age group, gender, and toothbrushing. Complete-case analysis was used for the outcome; including covariates had no missing values in the analytical sample. Two-sided $p < 0.05$ was considered statistically significant. Analyses were independently reproduced from the supplied spreadsheet using Python 3.12 with pandas, NumPy, and SciPy.

The research protocol was reviewed and approved by the Research Ethics Committee, Liaquat University of Medical and Health Sciences, Jamshoro (LUMHS/REC/1945).

3. Results

A total of 387 participants were screened. After excluding one adult non-student and four records without usable caries-outcome documentation, 382 student records were analysed. Mean age was 12.56 ± 2.88 years, median age was 13 years, and the range was 5–19 years. Male students comprised 63.1% of the sample. Dental caries was recorded in 194 students, producing an overall prevalence of 50.8% (Table 1).

Table 1. Participant characteristics and clinically recorded dental caries ($n=382$)

Variable	Category	<i>n</i>	%
Gender	Male	241	63.1
	Female	141	36.9
Age group	5–8 years	50	13.1
	9–11 years	61	16.0
	12–14 years	166	43.5
	15–19 years	105	27.5
Sweets/chocolate frequency	Daily	137	35.9
	Sometimes	176	46.1
	Rarely	69	18.1
Between-meal sugary snacking	Always	156	40.8
	Occasionally	181	47.4
	Never	45	11.8
Toothbrushing	Yes	342	89.5
	No	40	10.5
Dental caries	Present	194	50.8
	Absent	188	49.2

**Percentages may not total 100.0 because of rounding.*

Caries prevalence differed across sweets/chocolate-frequency categories ($p=0.034$), with the highest prevalence among daily consumers (59.1%). The pattern was not monotonic: prevalence was 44.3% among students reporting ‘sometimes’ and 50.7% among those reporting ‘rarely.’ Between-meal snacking was not significantly associated with caries ($p=0.174$). Caries prevalence was higher among male than female students (55.6% versus 42.6%; $p=0.018$) and among students reporting no toothbrushing than those reporting toothbrushing (72.5% versus 48.2%; $p=0.006$). Age-group differences were not statistically significant ($p=0.100$) (Table 2).

Table 2. Unadjusted distribution of dental caries by participant characteristics.

Variable	Category	Caries <i>n/N</i> (%)	Crude PR (95% CI)	Overall <i>p</i>
Sweets/chocolate frequency	Rarely	35/69 (50.7)	Reference	0.034
	Sometimes	78/176 (44.3)	0.87 (0.66–1.16)	
	Daily	81/137 (59.1)	1.17 (0.89–1.53)	
Between-meal sugary snacking	Never	17/45 (37.8)	Reference	0.174
	Occasionally	96/181 (53.0)	1.40 (0.94–2.09)	
	Always	81/156 (51.9)	1.37 (0.92–2.06)	
Gender	Female	60/141 (42.6)	Reference	0.018
	Male	134/241 (55.6)	1.31 (1.05–1.63)	
Age group	5–8 years	29/50 (58.0)	Reference	0.100
	9–11 years	38/61 (62.3)	1.07 (0.79–1.46)	
	12–14 years	80/166 (48.2)	0.83 (0.63–1.10)	
	15–19 years	47/105 (44.8)	0.77 (0.56–1.06)	
Toothbrushing	Yes	165/342 (48.2)	Reference	0.006
	No	29/40 (72.5)	1.50 (1.21–1.87)	

CI, confidence interval; PR, prevalence ratio. Overall p-values were obtained using chi-square tests.

After simultaneous adjustment for age group, gender, toothbrushing, sweets/chocolate frequency, and between-meal snacking, daily sweets/chocolate consumption was not independently associated with caries relative to rare consumption (aPR 1.15, 95% CI 0.87–1.53). Male students had 29% higher adjusted caries prevalence than female students (aPR 1.29, 95% CI 1.03–1.63), and students reporting no toothbrushing had 37% higher adjusted prevalence than those who brushed (aPR 1.37, 95% CI 1.10–1.70). Neither between-meal snacking nor age group was independently associated with caries (Table 3), (Figure 1).

Table 3. Multivariable modified Poisson regression for clinically recorded dental caries (*n*=382).

Variable	Comparison	aPR	95% CI	<i>p</i> -value
Sweets/chocolate frequency	Daily vs rarely	1.15	0.87–1.53	0.329

Variable	Comparison	aPR	95% CI	<i>p</i> -value
Between-meal snacking	Sometimes vs rarely	0.83	0.63–1.11	0.217
	Always vs never	1.18	0.78–1.79	0.437
	Occasionally vs never	1.44	0.97–2.16	0.074
Gender	Male vs female	1.29	1.03–1.63	0.027
Age group	9–11 vs 5–8 years	1.10	0.80–1.51	0.549
	12–14 vs 5–8 years	0.82	0.62–1.10	0.181
	15–19 vs 5–8 years	0.77	0.56–1.06	0.113
Toothbrushing	No vs yes	1.37	1.10–1.70	0.005

aPR, adjusted prevalence ratio; CI, confidence interval. One model included all variables shown

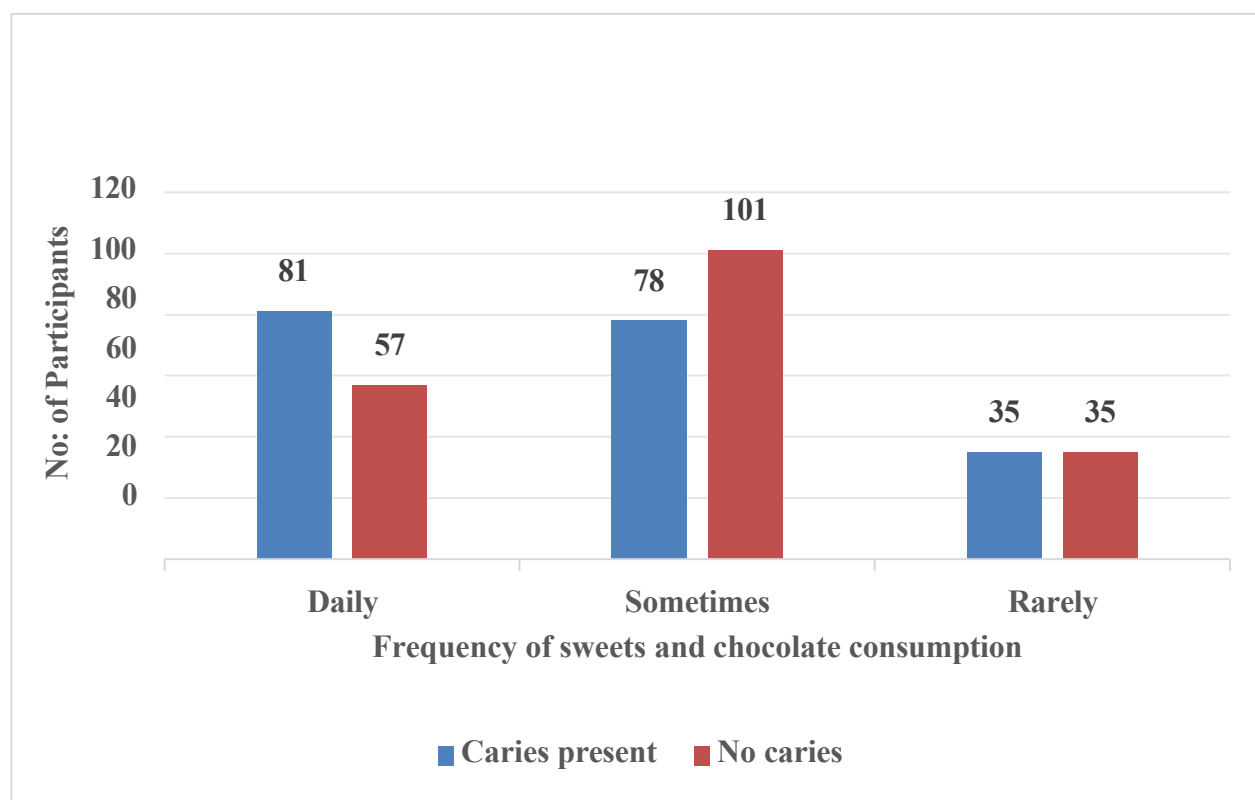


Figure 1: Dental caries prevalence by frequency of sweets and chocolate consumption among school-going children, Hyderabad.

4. Discussion

This study was conducted to examine the association between sugary food and beverage consumption and dental caries among children in government schools in Hyderabad. Approximately one in two students had clinically recorded dental caries. Sweets/chocolate

frequency was associated with caries in the unadjusted categorical comparison, but the association was non-monotonic and attenuated after control for age group, gender, toothbrushing, and between-meal snacking. Male gender and reporting no toothbrushing remained independently associated with higher caries prevalence. Between-meal sugary snacking was not statistically significant.

The observed prevalence of 50.8% is close to the pooled Pakistani estimate of 56.3%, although direct comparison should be cautious because the national meta-analysis included heterogeneous ages, dentitions, diagnostic criteria, and settings.¹¹ School-based studies in Quetta, Sargodha, Karachi, and Peshawar have likewise reported substantial but variable caries burdens, reflecting differences in sampling, deprivation, fluoride exposure, diagnostic thresholds, and access to care.¹²⁻¹⁵

The higher prevalence among daily sweets/chocolate consumers is biologically plausible and broadly consistent with longitudinal and cross-sectional evidence linking repeated sugar exposure with caries.^{6,7,8,9,10,14} Nevertheless, the present three-category pattern was not graded, and the daily-versus-rarely adjusted estimate included the null. The finding should therefore be interpreted as an unadjusted group difference rather than proof of an independent dose–response relationship. Broad, undefined categories may have obscured the quantity, timing, adhesiveness, and total daily frequency of sugar exposure.

The lack of a significant between-meal-snacking association should not be interpreted as evidence that snacking is harmless. The ‘never’ group was small, and the questionnaire did not quantify snack composition or frequency. Recall error, social-desirability bias, exposure misclassification, fluoride use, and unmeasured socioeconomic or dental-care factors may have attenuated the association.

Male students had higher caries prevalence in this sample. Evidence on gender differences is context-dependent; South Asian literature indicates that biological timing, diet, hygiene, care-seeking, household roles, and cultural practices may produce different male–female patterns across populations.¹⁶ Because the present database did not measure these mechanisms, the male association should be treated as hypothesis-generating rather than causal.

The independent association with no toothbrushing reinforces the importance of plaque control, although the available yes/no measure did not capture technique, fluoride concentration, duration, supervision, or adherence. WHO recommends twice-daily brushing with fluoride toothpaste alongside reduced free-sugar intake.¹

Strengths include analysis of the complete available camp dataset, transparent correction of the ineligible adult record, explicit handling of missing outcome data, reporting of overall caries prevalence, estimation of prevalence ratios with confidence intervals, and adjustment for available confounders. The analysis also distinguishes unadjusted from adjusted findings and avoids unsupported DMFT/dmft and beverage claims.

Several limitations are important. First, the cross-sectional design establishes temporal co-occurrence rather than causality. Second, records came from one government school and a single-day camp using non-probability participation; selection by school attendance and camp participation limits generalizability. Third, the dietary form was not a validated quantitative instrument and used broad self-reported categories, creating recall and misclassification bias.

Fourth, tooth-level DMFT/dmft components were unavailable, primary and permanent dentitions could not be analysed separately, and formal inter- or intra-examiner reliability statistics were not recorded. Fifth, systemic illness, socioeconomic status, parental education, fluoride exposure, dental-care access, detailed brushing practices, and total sugar quantity were absent or too incomplete for adjustment. Residual confounding is therefore likely. Sixth, classification relied on clinicians' free-text examination and diagnosis entries; four records lacking both fields were excluded. These limitations may have biased associations in either direction or reduce precision, particularly for the smallest exposure categories.

The findings support integrated school-based prevention combining dietary education, twice-daily fluoride-toothpaste promotion, and referral pathways for identified disease. They do not directly evaluate a fluoride-application Programme and therefore cannot establish the effectiveness of such an intervention. Future multicenter prospective studies should use probability sampling; calibrated examiners; dentition-specific dmft/DMFT or ICDAS recording; validated, quantitatively defined dietary measures; and multivariable assessment of fluoride, hygiene, socioeconomic, and care-access factors. Age- and dentition-stratified analyses would be particularly valuable.

5. Conclusion

Clinically recorded dental caries affected 50.8% of analysed students. Caries prevalence varied across sweets/chocolate-frequency categories in unadjusted analysis, with the highest prevalence among daily consumers, but daily consumption was not independently associated with caries relative to rare consumption after adjustment. Male gender and absence of toothbrushing remained associated with higher caries prevalence. These findings justify integrated school-based dietary and oral-hygiene education while underscoring the need for stronger prospective studies.

Abbreviation	Full Form
DMFT	Decayed, Missing, Filled, Teeth
ICDAS	International Caries Detection and Assessment System

Declarations:

Supplementary Materials: REC Approval file.

Author Contributions: Conceptualization, A.U. and M.B.; methodology, D.K.; software, A.U.; validation, M.B. and J.S.; formal analysis, A.U.; writing and preparing original draft preparation, A.R. J.S. and S.S.; writing and editing, M.B.; visualization, S.S.; Supervision and final approval R.P.; All authors have read and agreed to the published version of the manuscript

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Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

Data Availability Statement: Data cannot be shared openly but are available on request from authors.

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