

# Assessment of Nutritional Status and Its Impact on Oral Health in Low-Income Communities

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## ABSTRACT

**Background:** Dental caries and undernutrition frequently coexist among children living in low-income communities, where limited access to preventive dental care, irregular dietary patterns, and frequent sugar exposure may contribute to poor oral health outcomes. **Objective:** This study assessed nutritional status, dietary habits, and their association with dental caries experience among school-going children aged 5–15 years from low-income communities of Lahore, Pakistan. **Methods:** A community-based cross-sectional study was conducted during oral health screening and dietary assessment camps. A total of 250 children were assessed using structured demographic and dietary questionnaires, anthropometric measurements, and clinical oral examination. BMI-for-age was categorized using WHO growth references. Dental caries experience was assessed using DMFT and DEFT indices. Associations were examined using chi-square tests and binary logistic regression. **Results:** Overall caries prevalence was 68.4%, with mean DMFT of  $2.14 \pm 1.63$  and mean DEFT of  $3.08 \pm 1.92$ . Underweight status was observed in 44.8% of participants. Daily sugary snack consumption was reported by 63.2%, and frequent breakfast skipping by 61.2%. Underweight children showed higher caries prevalence than normal-weight children. In adjusted analysis, daily sugary snack consumption (AOR = 2.84; 95% CI: 1.42–5.69;  $p = 0.003$ ) and underweight status (AOR = 1.95; 95% CI: 1.07–3.54;  $p = 0.028$ ) remained significant predictors of substantial caries experience. **Conclusion:** Dental caries was highly prevalent among children from low-income communities and was significantly associated with daily sugary snack intake and underweight nutritional status. Integrated school- and community-based interventions combining oral health education, dietary counseling, nutrition support, and early dental referral are needed. **Keywords:** Nutrition, Dental Caries, Oral Health, Low-Income Communities, BMI-for-Age, Sugary Snacks.

## INTRODUCTION

Oral health is an essential component of child growth, nutrition, school participation, and overall quality of life, yet oral diseases remain highly prevalent among socioeconomically disadvantaged children. Dental caries, gingival inflammation, and poor oral hygiene are particularly important in low-income communities because they often remain untreated and may coexist with nutritional deficiencies, limited access to preventive dental care, and inadequate health education. Evidence from low-income pediatric populations indicates that nutritional status is closely associated with dental caries experience, suggesting that oral health and nutrition should be evaluated together rather than as separate public health concerns (1). Socioeconomic deprivation further compounds this burden, as household income, parental education, food insecurity, and limited access to dental services influence both dietary choices and oral health behaviors (2).

Children living in underserved urban communities are frequently exposed to inexpensive, energy-dense, carbohydrate-rich foods and sweetened beverages, while access to balanced diets, fluoridated toothpaste, routine dental visits, and structured oral health education may be limited. These conditions can create a pattern in which poor dietary quality, frequent sugar exposure, and irregular toothbrushing collectively increase the likelihood of dental caries and gingival disease. Public health literature has emphasized that low-income populations require targeted oral health promotion strategies because conventional dental-care models often fail to reach those at greatest risk (3). Studies among school-aged children have also shown that socioeconomic status, nutritional status, oral hygiene practices, and dietary behavior are interrelated determinants of dental health, supporting the need for community-based assessment in vulnerable pediatric groups (4). In addition, evidence from other underserved populations suggests that preventive oral health needs are often under-recognized when broader socioeconomic barriers are not considered (5).

The biological and behavioral relationship between diet and oral health is clinically important. Frequent exposure to fermentable carbohydrates and free sugars promotes acid production by cariogenic bacteria, contributing to enamel demineralization and caries development, particularly when oral hygiene practices are inadequate. Preventive oral health interventions for low-income children have therefore increasingly emphasized interdisciplinary approaches that combine dental screening, oral hygiene education, nutritional counseling, and community-based service delivery (6). At the same time, oral health problems may affect eating comfort, food selection, and nutritional intake, indicating a potentially bidirectional relationship between oral health and nutritional status. Broader nutritional research has shown that compromised oral conditions may be linked with poorer nutritional outcomes and food insecurity, although such relationships vary by age group and context (7). Similar associations between oral frailty and nutritional status have been reported in community settings, reinforcing the concept that oral function and dietary adequacy are closely connected across populations (8).

In Pakistan, child undernutrition and oral disease remain important public health concerns, particularly in low-income urban communities where food insecurity, limited caregiver awareness, and restricted access to preventive dental services may overlap. Local evidence has reported associations between oral health status, body mass index, and eating habits among vulnerable Pakistani children, highlighting the need to examine nutritional and oral health indicators together in pediatric community settings (9). Studies among school-aged Pakistani children have further demonstrated that socioeconomic and lifestyle factors are associated with oral health status, but data from marginalized urban slum populations remain limited (10). Evidence from marginalized groups in Karachi has also shown substantial oral health needs among underserved populations, supporting the relevance of locally grounded research in socially disadvantaged communities (11). Similarly, research from urban slum dwellers in Rawalpindi and Islamabad has documented poor oral hygiene practices and oral health challenges, but there remains a need for child-focused evidence linking BMI-for-age, dietary habits, sugar intake, and clinically assessed dental outcomes in low-income communities of Lahore (12).

Despite established global evidence on sugar intake and dental caries, there is limited community-based evidence from Lahore's underserved pediatric populations on how nutritional status and dietary behavior relate to oral health outcomes measured through standardized clinical indices. This gap is important because children aged 5–15 years represent a critical developmental group in whom early identification of modifiable dietary and oral hygiene risks may guide school-based and community-based prevention programs. In PICO terms, the population of interest is school-going children aged 5–15 years from low-income communities in Lahore; the key exposures are underweight nutritional status, irregular dietary habits, frequent sugary snack or beverage consumption, and oral health practices; the comparison groups include children with normal BMI-for-age, less frequent sugar intake, and better reported oral hygiene behaviors; and the outcomes are dental caries experience and oral

health status assessed using DMFT/DEFT and related clinical indicators. Therefore, this study aimed to assess nutritional status, dietary habits, oral hygiene-related practices, and their associations with dental caries experience among children aged 5–15 years living in low-income communities of Lahore, Pakistan.

## MATERIALS AND METHODS

A community-based cross-sectional observational study was conducted to assess the relationship between nutritional status, dietary habits, oral hygiene-related practices, and dental caries experience among school-going children aged 5–15 years from low-income communities of Lahore, Pakistan. The study was carried out during oral health screening and dietary assessment camps organized in collaboration with the selected school-based community setting serving children from nearby underserved urban neighborhoods. A cross-sectional design was considered appropriate because the study aimed to estimate the prevalence of nutritional and oral health conditions and examine associations between BMI-for-age, dietary exposures, oral hygiene practices, and dental caries at a single point in time.

The study population comprised children aged 5–15 years who were enrolled at the selected community school, resided in surrounding low-income localities, were present during the data collection sessions, and had parental or guardian consent with child assent. Children were excluded if they had a known systemic, metabolic, endocrine, or growth-related disorder that could independently affect nutritional status or oral health outcomes, or if they were unable to cooperate with anthropometric measurement, dietary interview, or clinical oral examination. Participants were selected through convenience sampling from children attending the screening camps, which was feasible for community-based outreach work and allowed inclusion of children who were accessible during the scheduled assessment sessions.

The sample size was calculated using a single-population proportion formula based on an assumed dental caries prevalence of 20%, a 95% confidence level, a 5% margin of error, and a design effect of 1. The minimum required sample size was approximately 246 participants, and the final target was increased to 250 children to ensure adequate precision and account for possible non-response or incomplete records (13). Data were collected using a structured screening and nutritional assessment form administered by trained investigators in a clean, well-lit area within the school premises. The form included demographic details, parental education, medical history, anthropometric measurements, dietary habits, oral hygiene-related practices, and clinical oral examination findings.

Demographic variables included age in completed years, sex, class level, locality of residence, and parental education. Parental education was recorded as a socioeconomic indicator because it may influence dietary choices, oral hygiene behavior, and access to preventive health information. Medical history was documented to identify conditions relevant to exclusion criteria and to support safe participation in the screening process. Nutritional status was assessed through anthropometric measurements. Height was measured to the nearest 0.1 cm using a standardized stadiometer, with the child standing upright without shoes, and weight was measured to the nearest 0.1 kg using a calibrated scale while the child wore light clothing. Body mass index was calculated as weight in kilograms divided by height in meters squared. BMI-for-age was classified according to age- and sex-specific percentile categories based on the WHO 2007 growth reference for children and adolescents aged 5–19 years, with underweight defined as below the 5th percentile, normal weight as the 5th to 85th percentile, and overweight or obesity as above the 85th percentile.

Dietary habits were assessed using a shortened, locally adapted food-frequency questionnaire administered through child interview and, where necessary, supported by information from a guardian or school representative. The dietary assessment recorded the number of daily meals, breakfast regularity, frequency of sugary snack intake, frequency of sweetened beverage consumption, fast-food

intake, and approximate daily water intake. Sugary snack consumption included candies, biscuits, chocolates, confectionery items, and other sugar-rich foods commonly available in the local setting. Sugary beverage intake included carbonated drinks, packaged juices, and other sweetened drinks. Dietary exposure categories were operationalized according to reported frequency, including daily intake, intake three to four times per week, and once weekly or rare intake. Breakfast habit was categorized as regular breakfast or frequent skipping based on reported usual behavior.

Oral health status was assessed through clinical oral examination performed by calibrated dental professionals using sterile mouth mirrors, WHO periodontal probes where required, and adequate illumination under field conditions. Dental caries experience was assessed using the DMFT index for permanent dentition and the DEFT index for primary dentition, following standardized clinical criteria. The DMFT index represented the number of decayed, missing, and filled permanent teeth, while the DEFT index represented the number of decayed, extracted, and filled primary teeth. Dental caries prevalence was defined as the presence of at least one decayed, missing or extracted due to caries, or filled tooth, according to the dentition status of the child. Significant caries experience was operationally defined as  $DMFT/DEFT \geq 3$  for regression analysis. Gingival health, visible plaque, calculus deposits, enamel hypoplasia, delayed eruption, malocclusion, and fluorosis were also recorded during the oral examination where applicable, using standardized field-screening criteria.

To improve data quality and reduce measurement bias, investigators underwent training before data collection. Examiner calibration was conducted under supervision to standardize anthropometric measurement procedures, dietary interview technique, and clinical assessment of caries indices. A pilot assessment was performed on a small group of children who were not included in the final analysis to evaluate the clarity, sequence, and feasibility of the data collection form. Clinical and anthropometric instruments were checked before use, and measurements were recorded immediately on structured forms to reduce transcription error. Inter-examiner agreement for clinical assessments was evaluated using kappa statistics, with a target agreement level of at least 0.80 considered acceptable for reliable field assessment.

The primary outcome was dental caries experience, measured through DMFT and DEFT indices and reported as caries prevalence. The main exposure variables were BMI-for-age category, sugary snack consumption, breakfast habit, fast-food intake, water intake, and oral hygiene-related practices. Potential confounders included age, sex, and parental education. Descriptive statistics were used to summarize participant characteristics, nutritional status, dietary habits, and oral health outcomes. Frequencies and percentages were calculated for categorical variables, while means and standard deviations were calculated for continuous variables with approximately normal distribution. Median and interquartile range were used for skewed continuous variables where appropriate (14,15).

Associations between categorical variables, such as BMI-for-age category, dietary behavior, oral hygiene practice, and caries presence, were assessed using the chi-square test. Differences in mean DMFT or DEFT scores across participant groups were assessed using independent-sample tests or non-parametric alternatives according to distributional assumptions. Binary logistic regression was performed as a secondary multivariable analysis to identify independent predictors of significant dental caries, defined as  $DMFT/DEFT \geq 3$ . The model included BMI-for-age category, sugary snack consumption, breakfast habit, age, sex, and parental education. Adjusted odds ratios with 95% confidence intervals were reported, and statistical significance was set at  $p < 0.05$ . Data were entered, cleaned, and analyzed using statistical software, and incomplete or inconsistent records were checked before final analysis to preserve data integrity (16).

Ethical approval was obtained from the relevant institutional ethics review committee in collaboration with the participating institution and community organization. Administrative permission was obtained before conducting the screening and assessment activities. Written informed consent was obtained from parents or legal guardians, and verbal assent was obtained from participating children

in an age-appropriate manner before assessment. Participation was voluntary, and children were examined using non-invasive procedures. All collected data were anonymized before analysis, and no personal identifiers were retained in the analytical dataset. The study was conducted in accordance with ethical principles for human participant research, including respect for autonomy, confidentiality, beneficence, and minimal risk (13).

## RESULTS

A total of 250 school-going children aged 5–15 years were included in the analysis. Of these, 130 participants were male and 120 were female. Nutritional assessment using BMI-for-age percentiles showed that 112 children were underweight, representing 44.8% of the study population, while 118 children were in the normal-weight category and 20 were overweight or obese. Underweight status was slightly more frequent among males than females, with 61 males and 51 females classified below the 5th percentile. Dietary assessment showed a high frequency of irregular eating patterns and sugar exposure: 153 children frequently skipped breakfast, 158 reported daily sugary snack consumption, and 145 consumed fast food once or twice weekly.

*Table 1. Nutritional Status and Dietary Characteristics of Study Participants (N = 250)*

Variable	Category	Male n (%)	Female n (%)	Total n (%)
<b>BMI-for-age category</b>	Underweight, <5th percentile	61 (47.0)	51 (42.5)	112 (44.8)
	Normal weight, 5th–85th percentile	58 (44.6)	60 (50.0)	118 (47.2)
	Overweight/obese, >85th percentile	11 (8.4)	9 (7.5)	20 (8.0)
	Total	130 (100.0)	120 (100.0)	250 (100.0)
<b>Meals per day</b>	1–2 meals			83 (33.2)
	3 meals			97 (38.8)
	>3 meals			70 (28.0)
<b>Breakfast habit</b>	Regular breakfast			97 (38.8)
	Frequently skipped			153 (61.2)
<b>Sugary snack consumption</b>	Daily			158 (63.2)
	3–4 times per week			38 (15.2)
	Once weekly or rarely			54 (21.6)
<b>Fast-food intake</b>	Once/twice weekly			145 (58.0)
	Rarely/never			105 (42.0)
<b>Water intake</b>	<5 glasses/day			96 (38.4)
	5–8 glasses/day			128 (51.2)
	>8 glasses/day			26 (10.4)

Clinical oral examination showed a high burden of dental caries. The overall mean DMFT score for permanent dentition was  $2.14 \pm 1.63$ , while the mean DEFT score for primary dentition was  $3.08 \pm 1.92$ . Overall caries prevalence was 68.4%. Caries prevalence increased across age groups, from 65.5% among children aged 5–8 years to 70.2% among those aged 9–12 years and 74.1% among those aged 13–15 years. Mean DMFT also increased with age, rising from  $1.62 \pm 1.30$  in the youngest group to  $2.78 \pm 1.68$  in the oldest group. By sex, females had slightly higher mean DMFT, mean DEFT, and caries prevalence than males, although the difference was not statistically significant.

*Table 2. Oral Health Status by Age Group and Sex (N = 250)*

Variable	Category	Mean DMFT $\pm$ SD	Mean DEFT $\pm$ SD	Caries Prevalence (%)	p-value
<b>Age group</b>	5–8 years	$1.62 \pm 1.30$	$3.45 \pm 1.80$	65.5	
	9–12 years	$2.11 \pm 1.55$	$2.98 \pm 1.90$	70.2	
	13–15 years	$2.78 \pm 1.68$	$2.55 \pm 1.75$	74.1	
<b>Sex</b>	Male	$2.05 \pm 1.67$	$3.01 \pm 1.88$	67.6	>0.05
	Female	$2.24 \pm 1.58$	$3.16 \pm 1.96$	69.3	
<b>Total</b>	Overall	$2.14 \pm 1.63$	$3.08 \pm 1.92$	68.4	

Nutritional status was significantly associated with dental caries experience. Children classified as underweight had the highest mean DMFT/DEFT score, at  $3.46 \pm 1.72$ , and the highest caries prevalence, at 75.9%. In comparison, children with normal BMI-for-age had a mean DMFT/DEFT score of  $2.37 \pm 1.51$  and caries prevalence of 61.0%, while overweight or obese children had the lowest mean score and prevalence, at  $1.84 \pm 1.33$  and 45.0%, respectively. In crude analysis, underweight children had approximately twice the odds of caries compared with normal-weight children.

Dietary behavior also showed clinically meaningful variation in caries experience. Children who consumed sugary snacks daily had the highest mean DMFT/DEFT score, at  $3.42 \pm 1.68$ , and the highest caries prevalence, at 78.3%. In contrast, children who consumed sugary snacks once weekly or rarely had a lower mean DMFT/DEFT score of  $1.89 \pm 1.40$  and caries prevalence of 52.0%. Daily sugary snack consumption was significantly associated with dental caries and showed more than threefold higher crude odds of caries compared with rare intake. Breakfast skipping was also significantly associated with caries: children who frequently skipped breakfast had a mean DMFT/DEFT score of  $3.02 \pm 1.70$  and caries prevalence of 72.5%, compared with  $2.15 \pm 1.61$  and 59.8% among those who regularly consumed breakfast. Fast-food intake showed a higher caries prevalence among children consuming fast food once or twice weekly, but this association was not statistically significant.

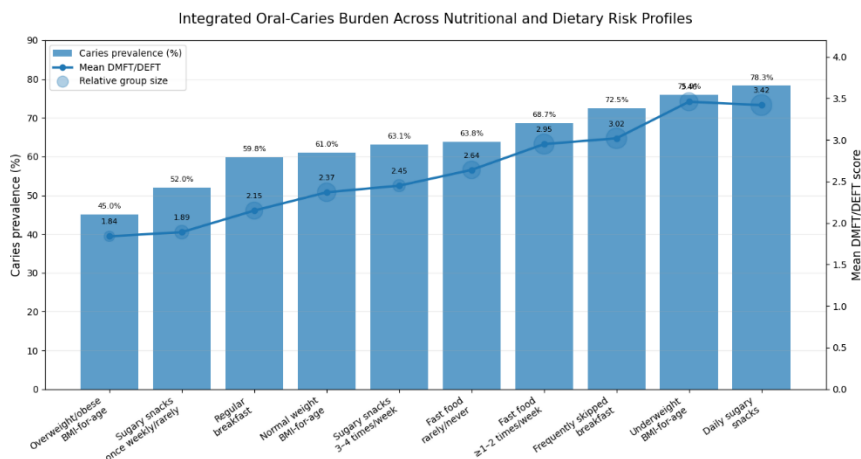
**Table 3. Association Between BMI-for-Age Category and Dental Caries Experience (N = 250)**

BMI-for-age Category	n	Mean DMFT/DEFT ± SD	Caries Present n (%)	OR (95% CI)	p-value
Underweight, <5th percentile	112	3.46 ± 1.72	85 (75.9)	2.01 (1.14–3.55)	0.021
Normal weight, 5th–85th percentile	118	2.37 ± 1.51	72 (61.0)	Reference	
Overweight/obese, >85th percentile	20	1.84 ± 1.33	9 (45.0)	0.52 (0.20–1.36)	

**Table 4. Association Between Dietary Habits and Dental Caries Experience (N = 250)**

Dietary Behavior	Category	Mean DMFT/DEFT ± SD	Caries Prevalence (%)	OR (95% CI)	p-value
Sugary snack consumption	Daily	3.42 ± 1.68	78.3	3.39 (1.76–6.52)	0.013
	3–4 times/week	2.45 ± 1.52	63.1	1.59 (0.68–3.72)	—
	Once weekly or rarely	1.89 ± 1.40	52.0	Reference	—
Breakfast habit	Regular breakfast	2.15 ± 1.61	59.8	Reference	0.042
	Frequently skipped	3.02 ± 1.70	72.5	1.78 (1.04–3.05)	—
Fast-food intake	≥1–2 times/week	2.95 ± 1.66	68.7	1.26 (0.74–2.14)	0.087
	Rarely/never	2.64 ± 1.57	63.8	Reference	—

In the secondary multivariable logistic regression model, significant dental caries was defined as DMFT/DEFT  $\geq 3$ . The model was statistically significant, with  $\chi^2 = 22.47$  and  $p = 0.001$ , and explained 31.4% of the variance in significant caries experience based on Nagelkerke  $R^2$ . After adjustment for BMI-for-age category, sugary snack consumption, breakfast habit, age, sex, and parental education, daily sugary snack consumption and underweight status remained statistically significant predictors. Children who consumed sugary snacks daily had 2.84 times higher adjusted odds of significant caries than those with lower intake, while underweight children had 1.95 times higher adjusted odds compared with normal-weight children. Overweight/obesity, breakfast skipping, age, sex, and parental education were not statistically significant.



**Figure 1. Integrated Oral-Caries Burden Across Nutritional and Dietary Risk Profiles**

This integrated risk-gradient figure shows that caries burden rose consistently across nutritional and dietary risk profiles, with the lowest caries prevalence observed among overweight/obese children at 45.0% and children consuming sugary snacks once weekly or rarely at 52.0%, while the highest prevalence occurred among underweight children at 75.9% and daily sugary-snack consumers at 78.3%. Mean DMFT/DEFT followed a similar upward pattern, increasing from 1.84–1.89 in the lowest-burden groups to 3.42–3.46 in the highest-burden groups. The combined visualization demonstrates that both caries prevalence and severity were concentrated among children with underweight nutritional status and frequent sugar exposure, supporting the clinical relevance of integrated dietary and oral-health risk assessment in this low-income pediatric population.

*Table 5. Binary Logistic Regression Analysis for Predictors of Significant Dental Caries, Defined as DMFT/DEFT  $\geq 3$*

Predictor Variable	Adjusted Odds Ratio (AOR)	95% Confidence Interval	p-value
Underweight vs normal weight	1.95	1.07–3.54	0.028
Overweight/obese vs normal weight	0.71	0.24–2.08	0.535
Daily sugary snack consumption	2.84	1.42–5.69	0.003
Frequent breakfast skipping	1.46	0.80–2.64	0.203
Age, per year increase	1.08	0.94–1.25	0.256
Female sex vs male sex	1.21	0.69–2.10	0.500
Low vs high parental education	1.37	0.79–2.35	0.266

Overall, the results show a high burden of dental caries in this low-income pediatric population, with caries prevalence increasing across age groups and with poorer nutritional and dietary profiles. The strongest adjusted association was observed for daily sugary snack consumption, followed by underweight nutritional status. These findings indicate that both dietary sugar exposure and BMI-for-age category were independently associated with significant dental caries in the study population.

## DISCUSSION

The present study demonstrated a substantial burden of dental caries among school-going children aged 5–15 years from low-income communities of Lahore, with overall caries prevalence of 68.4%, mean DMFT of  $2.14 \pm 1.63$ , and mean DEFT of  $3.08 \pm 1.92$ . This high burden indicates that dental caries remains a major unmet oral health concern in underserved pediatric populations, where preventive dental care, regular oral screening, dietary counseling, and early restorative treatment are often limited. The increasing caries prevalence across age groups, from 65.5% in children aged 5–8 years to 74.1% in those aged 13–15 years, suggests cumulative exposure to cariogenic dietary patterns and insufficient preventive oral health practices over time. Similar patterns have been reported in children from low- and middle-income settings, where individual, family, and socioeconomic factors contribute substantially to dental caries risk (17).

A key finding of this study was the significant association between underweight nutritional status and dental caries experience. Underweight children had the highest caries prevalence at 75.9% and the highest mean DMFT/DEFT score at  $3.46 \pm 1.72$ , compared with 61.0% and  $2.37 \pm 1.51$  among normal-weight children, and 45.0% and  $1.84 \pm 1.33$  among overweight or obese children. In adjusted analysis, underweight status remained independently associated with significant dental caries, with an adjusted odds ratio of 1.95. This finding supports the concept that nutritional vulnerability and oral disease may coexist in disadvantaged children. Undernutrition may be linked with impaired enamel development, reduced salivary protection, altered immune response, and poor dietary quality, while untreated caries may further interfere with chewing comfort, appetite, and food selection. The cross-sectional nature of the study does not establish directionality, but the observed association emphasizes the need to consider oral health and nutritional status together when assessing child health in low-income communities. Comparable findings have been reported in previous studies showing that children with compromised nutritional status may have greater susceptibility to dental caries (18).

Daily sugary snack consumption showed the strongest association with significant dental caries. Children consuming sugary snacks daily had a caries prevalence of 78.3% and a mean DMFT/DEFT

score of  $3.42 \pm 1.68$ , while children consuming sugary snacks once weekly or rarely had a lower prevalence of 52.0% and mean score of  $1.89 \pm 1.40$ . After adjustment for nutritional status, breakfast habit, age, sex, and parental education, daily sugary snack consumption remained a significant predictor, with an adjusted odds ratio of 2.84. This finding is biologically plausible because frequent exposure to fermentable carbohydrates promotes acid production by cariogenic bacteria, prolongs periods of low oral pH, and increases enamel demineralization. In low-income settings, inexpensive sugary snacks and sweetened beverages may be widely accessible and socially normalized, while healthier alternatives may be less affordable or less available. Previous research has similarly shown that frequent sugar exposure and poor dietary patterns are important contributors to dental caries among children and underserved populations (19).

Breakfast skipping was also associated with higher caries prevalence in crude analysis, with caries observed in 72.5% of children who frequently skipped breakfast compared with 59.8% among those who consumed breakfast regularly. Although this association did not remain statistically significant after adjustment in the multivariable model, the pattern remains clinically relevant because breakfast skipping may reflect broader dietary instability, household food insecurity, irregular meal structure, and greater reliance on snack-based calorie intake during the day. In this population, 61.2% of children frequently skipped breakfast, indicating that irregular dietary behavior was common. Fast-food intake showed a higher caries prevalence among children consuming fast food once or twice weekly, but the association was not statistically significant. This may reflect the stronger cariogenic effect of frequent sugary snack exposure compared with less frequent fast-food intake, or the limited ability of broad dietary categories to capture portion size, timing, food composition, and total sugar exposure.

The findings are consistent with evidence from other low-income and marginalized communities where dental caries remains common among children and is associated with poor oral hygiene, dietary risk behaviors, and socioeconomic disadvantage. Studies conducted in comparable settings have reported high caries prevalence and have emphasized the importance of preventive oral health strategies, caregiver education, and school-based dental programs (20). The present findings also align with research from Pakistani underserved populations showing that poor oral hygiene practices, limited dental service use, and unfavorable dietary habits contribute to oral disease burden. However, the results should be interpreted as associations rather than causal effects because exposure and outcome were measured at the same time. Longitudinal studies are needed to determine whether nutritional improvement, reduced sugar exposure, and structured oral hygiene interventions lead to measurable reductions in caries incidence over time (21).

The high proportion of children with underweight status and frequent sugar consumption highlights the double burden of poor diet quality in low-income communities. Children may consume sufficient or frequent calorie-dense foods while still lacking balanced nutrition, adequate protein intake, micronutrient sufficiency, and structured meals. This pattern can simultaneously contribute to undernutrition and dental caries, especially when sugary snacks and sweetened beverages replace nutrient-dense foods. The findings therefore support an integrated preventive model in which oral health education is combined with nutrition counseling, school-based screening, caregiver engagement, and referral pathways for children with untreated dental disease. Such an approach may be more effective than isolated dental advice because the major risk factors identified in this study are embedded within household food access, caregiver knowledge, school environment, and community-level resource limitations.

This study has several strengths. It included a community-based sample of 250 children from an underserved setting, used anthropometric assessment to classify BMI-for-age, and incorporated clinical oral examination using standardized indices. The inclusion of both dietary behavior and nutritional status allowed a broader assessment of factors associated with caries experience. The use of multivariable logistic regression also strengthened interpretation by adjusting for relevant covariates,

including age, sex, breakfast habit, and parental education. Nevertheless, the study has limitations. The cross-sectional design prevents causal inference, and convenience sampling limits generalizability beyond the selected community setting. Dietary habits and oral hygiene-related practices were partly self-reported and may be affected by recall or social desirability bias. The study also used broad dietary frequency categories, which may not fully capture sugar quantity, timing of exposure, food texture, fluoride exposure, or total dietary quality. Despite these limitations, the findings provide useful evidence that underweight status and daily sugary snack consumption are important markers of increased caries burden in children from low-income urban communities.

Overall, the study reinforces the close relationship between nutritional vulnerability, dietary sugar exposure, and oral health among disadvantaged children. The observed associations suggest that school-based and community-based prevention programs should not focus only on toothbrushing messages but should also address dietary behavior, breakfast regularity, caregiver awareness, access to affordable nutritious foods, and early dental referral. Integrating nutrition and oral health services within outreach camps, schools, and community programs may help identify high-risk children earlier and support more comprehensive child health interventions in underserved areas of Lahore.

## CONCLUSION

This study found a high burden of dental caries among school-going children aged 5–15 years from low-income communities of Lahore, with caries experience closely associated with nutritional and dietary risk profiles. Underweight children and those consuming sugary snacks daily showed higher caries prevalence and greater mean DMFT/DEFT scores, while daily sugary snack consumption and underweight status remained significant predictors of substantial caries experience after adjustment for relevant covariates. These findings suggest that oral health disparities in underserved pediatric populations are linked not only to hygiene practices but also to broader nutritional vulnerability, irregular dietary patterns, and frequent sugar exposure. Because the cross-sectional design supports association rather than causation, further longitudinal studies are required to clarify temporal relationships and evaluate intervention effects. Integrated school- and community-based programs combining oral health education, dietary counseling, nutrition support, caregiver engagement, and timely dental referral may help reduce the combined burden of malnutrition and dental caries among vulnerable children.

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