

Correlation Between Oral Hygiene Practices and Caries Index in Underprivileged Children

Sibghat E Rasool¹, Dr Bisma Hafeez¹, Dr Syeda Momina Ali Shah¹, Dr Iqra Haroon¹, Dr Momina Amjad¹, Dr Alina Tahir¹

¹ CMH Lahore Medical College and Institute of Dentistry, Lahore, Pakistan

*Corresponding author: Sibghat E Rasool, sibghatr295@gmail.com

ABSTRACT

Background: Dental caries remains one of the most common chronic childhood oral diseases and disproportionately affects children living in socioeconomically disadvantaged communities where access to preventive care and oral health education is limited. **Objective:** To determine the caries burden among school-going children from underserved communities in Lahore, Pakistan, and to evaluate the association of brushing frequency, fluoridated toothpaste use, and parental supervision with dental caries experience. **Methods:** This retrospective analytical cross-sectional study included 270 children aged 5–15 years screened in community-based outreach camps. Data were collected using structured questionnaires and clinical oral examination. Caries status was assessed using DMFT and deft indices, and oral hygiene was evaluated using plaque, gingival, and calculus indices. Descriptive statistics were computed, while group comparisons were performed using independent-samples t-test, one-way ANOVA, chi-square test, and Pearson correlation analysis in SPSS version 26, with $p < 0.05$ considered statistically significant. **Results:** The mean DMFT was 2.85 ± 1.70 and the mean deft was 3.12 ± 1.90 , indicating moderate caries burden. Children who brushed twice daily had lower mean DMFT scores (2.34 ± 1.30) than those brushing once daily (3.12 ± 1.80) or irregularly (3.68 ± 1.90) ($F = 4.36$, $p = 0.014$). Supervised brushing was associated with lower mean DMFT than unsupervised brushing (2.41 ± 1.40 vs 3.18 ± 1.80 ; $t = 2.97$, $p = 0.003$). Plaque index showed a strong positive correlation with DMFT ($r = 0.78$, $p = 0.001$). **Conclusion:** Poorer oral hygiene practices, especially reduced brushing frequency and lack of parental supervision, were associated with higher dental caries burden in underprivileged children. Preventive strategies integrating school-based oral health promotion and caregiver engagement may help reduce caries in underserved populations. **Keywords:** Dental caries, DMFT, oral hygiene, plaque index, fluoridated toothpaste, parental supervision, underprivileged children, Lahore.

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INTRODUCTION

Dental caries remains one of the most prevalent chronic oral diseases affecting children worldwide and continues to impose a disproportionate burden on socioeconomically disadvantaged populations. It is a biofilm-mediated, diet-modulated, multifactorial disease characterized by demineralization of dental hard tissues following repeated acid exposure generated by bacterial fermentation of dietary carbohydrates. Although largely preventable, dental caries persists as a major public health concern in low-resource settings where access to preventive care, oral health education, and basic hygiene materials is often limited (1,2). The burden is particularly severe among school-aged children, in whom untreated caries may adversely affect nutrition, sleep, school attendance, concentration, speech, and overall quality of life (3,4).

The occurrence of dental caries in childhood is shaped not only by biological susceptibility but also by behavioral and social determinants. Regular toothbrushing, effective plaque removal, and the use of fluoridated toothpaste are well-established preventive measures that reduce cariogenic challenge and support enamel remineralization (5,6). However, these protective practices are less consistently adopted in children from underserved communities, where household poverty, limited caregiver literacy, poor health awareness, and restricted access to dental services can undermine routine oral hygiene

behaviors (7,8). In such settings, children are often exposed to multiple risk factors simultaneously, including frequent intake of sugary snacks and beverages, inadequate brushing technique, irregular use of fluoride-containing dentifrices, and lack of parental supervision during oral hygiene practices (9,10).

A growing body of literature has demonstrated that socioeconomic disadvantage is strongly associated with poorer oral health outcomes in children. Studies from low- and middle-income settings have shown that children residing in deprived communities experience higher caries prevalence, worse plaque control, and reduced uptake of preventive dental practices than their more advantaged peers (11,12). Social inequality affects oral health both directly, through constrained access to care and oral hygiene products, and indirectly, through parental education, household practices, and health-seeking behavior (13,14). Among these determinants, parental involvement appears especially important during childhood because effective toothbrushing requires not only access to a toothbrush and toothpaste but also reinforcement, supervision, and habit formation within the home environment (15,16).

Parental supervision during toothbrushing has been repeatedly identified as a meaningful contributor to better oral hygiene and lower caries experience in younger children. Caregivers who oversee brushing are more likely to ensure adequate brushing duration, proper technique, and regular use of fluoridated toothpaste, thereby reducing plaque accumulation and cariogenic exposure (17,18). Likewise, brushing frequency has consistently shown an inverse association with caries burden, particularly when performed at least twice daily with fluoride toothpaste (19). Despite this evidence, the implementation of these behaviors remains inconsistent in marginalized populations, where structural deprivation may override awareness and intention. In Pakistan, oral health inequalities among underprivileged children are increasingly recognized, yet community-based evidence linking daily oral hygiene practices with observed caries experience in low-income urban populations remains limited (20).

Lahore contains densely populated underserved communities in which children may face overlapping social and behavioral risks for poor oral health. Although previous work has explored selected determinants such as dietary patterns, there remains insufficient locally grounded evidence on how routine oral hygiene practices, particularly brushing frequency, fluoride toothpaste use, and caregiver supervision, relate to caries burden among school-going children living in disadvantaged environments. This gap is important because interventions targeting schoolchildren in low-resource communities require context-specific evidence to inform realistic and scalable preventive strategies (21). Clarifying these relationships may help guide school-based oral health promotion, parental counseling, and community outreach initiatives directed at reducing the burden of childhood dental caries in underserved populations.

Therefore, this study was designed to examine the association between oral hygiene practices and dental caries among school-going children from socioeconomically disadvantaged communities in Lahore, Pakistan. Specifically, it aimed to determine the caries burden in this population and to evaluate whether brushing frequency, use of fluoridated toothpaste, and parental supervision during toothbrushing were associated with differences in caries experience. It was hypothesized that children who brushed more frequently, used fluoridated toothpaste, and received parental supervision during brushing would demonstrate lower caries scores than those with less favorable oral hygiene practices.

MATERIALS AND METHODS

This retrospective analytical cross-sectional study was conducted using data obtained from structured community-based oral health screening camps organized for school-going children residing in underserved areas of Lahore, Pakistan. The screening activities were carried out at the Door of Awareness School, which serves children from socioeconomically disadvantaged households and

therefore provided an appropriate setting for examining oral hygiene practices and caries burden in a resource-constrained population. The study used previously collected camp data to evaluate the association between oral hygiene behaviors and dental caries status at a single observational time point, making the design suitable for estimating prevalence and identifying behavioral correlates of oral disease in this population (22).

The study population comprised children aged 5 to 15 years who were enrolled at the participating school and were present on the day of the screening activity. This age range was selected to capture both primary and mixed/permanent dentition stages, permitting assessment of caries experience across childhood using age-appropriate dental indices. Children were included if they were within the specified age range, enrolled in the school, participated in the screening process, and had parental or guardian consent for examination and use of de-identified data for research purposes. Children were excluded if consent was not available or if severe systemic or cognitive conditions were documented that could materially affect oral hygiene behavior or compromise the validity of the oral examination. A camp-based convenience sampling approach was used, whereby all eligible and available children attending the screening were invited to participate. Although non-probability sampling limits generalizability, this strategy enabled practical access to a hard-to-reach underserved pediatric population and allowed inclusion of a sample larger than the calculated minimum requirement.

The required minimum sample size was estimated using the single population proportion formula, assuming a 95% confidence level, 7% margin of error, and an expected prevalence of 50% to yield the most conservative estimate in the absence of precise local prevalence data. This calculation produced a minimum sample of 196 participants. To improve precision and analytical power, a total of 270 eligible children were included in the final dataset. Recruiting beyond the minimum sample size enhanced the stability of group comparisons and reduced the effect of random error in the estimation of caries-related outcomes.

Data were collected using a structured screening form designed to capture demographic, behavioral, and clinical information relevant to oral health. Demographic variables included age, sex, and parental educational status. Behavioral variables included toothbrushing frequency, use of fluoridated toothpaste, parental supervision during brushing, and reported consumption of sugary snacks or drinks. For analytical consistency, brushing frequency was operationally categorized as once daily, twice daily, or irregular. Fluoride toothpaste use was recorded as yes or no on the basis of participant or caregiver report. Brushing supervision was categorized as supervised or unsupervised according to whether a parent or guardian routinely observed or assisted the child during brushing. Sugary snack or drink consumption was also classified dichotomously. The principal outcome variable was dental caries experience, measured clinically using the DMFT index for permanent dentition and the deft index for primary dentition in accordance with accepted oral epidemiological criteria (23). Additional clinical indices documented during screening included plaque status, gingival status, and calculus deposition, allowing broader characterization of oral hygiene and periodontal condition.

Clinical oral examinations were performed using a visual-tactile approach under field conditions by trained examiners following standardized oral assessment procedures. The DMFT and deft indices were used to quantify caries burden, while plaque, gingival, and calculus indices were used to assess oral cleanliness and soft tissue health. To improve consistency of measurements, examiners underwent calibration before field implementation, and the screening process followed a uniform assessment format for all participants. Data were recorded contemporaneously on standardized forms and subsequently entered into the analytical dataset. Data integrity was supported by structured coding, verification during data entry, and review for internal consistency prior to analysis.

Several steps were taken to reduce bias and improve analytical validity. Standardized forms and examiner calibration were used to minimize measurement variability. Uniform screening procedures were applied to all participants to reduce differential assessment. Because some exposure variables,

such as brushing frequency and fluoride toothpaste use, relied on child or caregiver report, the risk of recall and social desirability bias was recognized and mitigated by using simple, behavior-based response categories. Potential confounding was addressed at the analysis stage by examining the distribution of major sociodemographic and behavioral variables and by selecting inferential tests appropriate to variable structure and comparison groups. Although the camp-based convenience sample may have introduced selection bias, the use of an inclusive recruitment strategy for all eligible attendees reduced discretionary selection within the screening setting.

Data were entered and analyzed using SPSS version 26. Descriptive statistics were used to summarize participant characteristics and oral health indicators. Categorical variables were reported as frequencies and percentages, whereas continuous variables were summarized using means and standard deviations. For inferential analysis, mean DMFT scores were compared across brushing-frequency groups using one-way analysis of variance, and mean DMFT scores between supervised and unsupervised brushing groups were compared using the independent-samples t-test. Associations between categorical variables were assessed using the chi-square test where appropriate, and Pearson correlation analysis was used to evaluate the relationship between plaque index scores and DMFT values. All statistical tests were two-tailed, and a p-value of less than 0.05 was considered statistically significant. Records with incomplete data for a given variable were excluded only from the relevant analysis, while all remaining available observations were retained to maximize use of the dataset. Results were interpreted with attention to the observational design and the possibility of residual confounding.

The study was conducted in accordance with accepted ethical principles for research involving human participants, including respect for privacy, confidentiality, and voluntary participation. Administrative permission was obtained from the participating school and outreach organizers. Data used for this analysis were de-identified prior to statistical evaluation, and all records were stored securely with restricted access. Ethical approval for retrospective analysis of the screening dataset was obtained from the Institutional Review Board of CMH LMC & IOD. The study procedures adhered to internationally recognized ethical standards for human research, including informed participation, confidentiality protection, and the right to withdraw without consequence (24).

RESULTS

A total of 270 school-going children aged 5–15 years were included in the final analysis. Males comprised 180 (66.7%) participants and females 90 (33.3%). The largest age category was 9–12 years with 130 (48.1%) children, followed by 5–8 years with 90 (33.3%) and 13–15 years with 50 (18.6%). Regarding oral hygiene practices, 160 (59.3%) children reported brushing once daily, 80 (29.6%) brushed twice daily, and 30 (11.1%) brushed irregularly. Fluoridated toothpaste use was reported by 200 (74.1%) participants, whereas 120 (44.4%) brushed under parental supervision and 150 (55.6%) brushed without supervision. Frequent sugary snack or drink consumption was present in 210 (77.8%) children, indicating a substantial dietary risk load within the cohort.

Table 1. Sociodemographic and Behavioral Characteristics of Participants (n = 270)

Variable	Category	Frequency (n)	Percentage (%)
Gender	Male	180	66.7
	Female	90	33.3
Age group (years)	5–8	90	33.3
	9–12	130	48.1
	13–15	50	18.6
Father's education	Illiterate	45	16.7
	Primary	100	37.0
	Secondary	90	33.3
	Graduate and above	35	13.0
Mother's education	Illiterate	60	22.2

Variable	Category	Frequency (n)	Percentage (%)
	Primary	120	44.4
	Secondary	70	25.9
	Graduate and above	20	7.4
Brushing frequency	Once daily	160	59.3
	Twice daily	80	29.6
	Irregular	30	11.1
Use of fluoridated toothpaste	Yes	200	74.1
	No	70	25.9
Supervised brushing	Yes	120	44.4
	No	150	55.6
Sugary snacks/drinks	Yes	210	77.8
	No	60	22.2

Clinical examination showed a moderate caries burden in both dentitions. The mean DMFT score was 2.85 ± 1.70 , while the mean deft score was 3.12 ± 1.90 . Oral hygiene indicators were also suboptimal, with a mean Plaque Index of 1.54 ± 0.60 and mean Gingival Index of 1.31 ± 0.50 , suggesting fair oral hygiene with mild gingival inflammation. The Calculus Index was 0.78 ± 0.40 , reflecting relatively lower calculus accumulation compared with plaque burden. The positive correlation between plaque accumulation and caries burden was strong, with Pearson’s $r = 0.78$ and $p = 0.001$, indicating that higher plaque scores were associated with substantially greater DMFT values.

Table 2. Clinical Oral Health Indices and Correlation with DMFT (n = 270)

Measure	Mean ± SD	Additional statistic	p-value	Interpretation
DMFT (permanent teeth)	2.85 ± 1.70	—	—	Moderate caries experience
deft (primary teeth)	3.12 ± 1.90	—	—	Moderate caries in deciduous dentition
Plaque Index	1.54 ± 0.60	$r = 0.78$ with DMFT	0.001	Strong positive correlation
Gingival Index	1.31 ± 0.50	—	—	Mild gingival inflammation
Calculus Index	0.78 ± 0.40	—	—	Low calculus deposition

Mean DMFT differed significantly across brushing-frequency groups. Children who brushed twice daily had the lowest mean DMFT (2.34 ± 1.30), whereas those brushing once daily had a higher mean DMFT (3.12 ± 1.80) and those with irregular brushing had the highest burden (3.68 ± 1.90). One-way ANOVA demonstrated a statistically significant between-group difference ($F = 4.36$, $p = 0.014$). Using the twice-daily group as the clinical reference, the absolute mean difference was 0.78 teeth for once-daily brushing and 1.34 teeth for irregular brushing. Approximate 95% confidence intervals derived from the reported summary statistics were 0.38 to 1.18 for once daily versus twice daily and 0.60 to 2.08 for irregular versus twice daily, reinforcing a graded worsening of caries burden as brushing regularity decreased.

Table 3. Mean DMFT Scores by Brushing Frequency (ANOVA)

Brushing frequency	n	Mean DMFT ± SD	Mean difference vs twice-daily	95% CI of difference	F-value	p-value	Interpretation
Twice daily	80	2.34 ± 1.30	Reference	—	4.36	0.014	Lowest caries burden
Once daily	160	3.12 ± 1.80	+0.78	0.38 to 1.18			Higher caries burden
Irregular	30	3.68 ± 1.90	+1.34	0.60 to 2.08			Highest caries burden

Parental supervision during brushing was also significantly associated with lower caries experience. Children who brushed under supervision had a mean DMFT of 2.41 ± 1.40 , compared with 3.18 ± 1.80 among unsupervised children. The independent-samples t-test showed this difference to be statistically significant ($t = 2.97$, $p = 0.003$). The absolute mean difference was 0.77 teeth, with an approximate 95% confidence interval of 0.39 to 1.15, indicating that lack of supervision was associated with a clinically meaningful increase in caries burden.

Table 4. Comparison of Mean DMFT by Brushing Supervision (Independent-Samples t-test)

Brushing supervision	n	Mean DMFT ± SD	Mean difference	95% CI of difference	t-value	p-value	Interpretation
Supervised	120	2.41 ± 1.40	Reference	—	2.97	0.003	Lower caries occurrence
Not supervised	150	3.18 ± 1.80	+0.77	0.39 to 1.15			Higher caries occurrence

Numeric-Rich Description of the Tables

Table 1 shows that the study population was predominantly male (66.7%) and centered largely in the 9–12-year age bracket (48.1%). Behavioral findings indicate that optimal oral hygiene practices were not widespread: fewer than one-third of participants brushed twice daily (29.6%), while the majority brushed only once daily (59.3%). Although 74.1% reported using fluoridated toothpaste, only 44.4% received parental supervision during brushing, and 77.8% consumed sugary snacks or drinks, highlighting the coexistence of both protective and harmful oral health behaviors within the same population.

Table 2 demonstrates a moderate burden of disease, with mean values of 2.85 ± 1.70 for DMFT and 3.12 ± 1.90 for deft. The oral hygiene profile was unfavorable, particularly in relation to plaque accumulation, with a mean Plaque Index of 1.54 ± 0.60 . The observed correlation between plaque and DMFT was strong and statistically significant ($r = 0.78$, $p = 0.001$), indicating that worsening plaque control tracked closely with increasing caries burden. The mean Gingival Index of 1.31 ± 0.50 further suggests that soft tissue inflammation accompanied these hygiene deficits.

Table 3 reveals a clear dose-response pattern between brushing frequency and caries experience. Children who brushed twice daily had the lowest mean DMFT (2.34), those brushing once daily had a higher mean score (3.12), and irregular brushers showed the highest mean burden (3.68). The difference across groups was statistically significant ($F = 4.36$, $p = 0.014$). Relative to twice-daily brushing, once-daily brushing was associated with an excess mean DMFT of 0.78 teeth, while irregular brushing was associated with an excess of 1.34 teeth, supporting a clinically important gradient in caries burden as oral hygiene frequency declined.

Table 4 shows that supervision during brushing was associated with lower caries experience. The mean DMFT among supervised children was 2.41 ± 1.40 , compared with 3.18 ± 1.80 among unsupervised children. This difference of 0.77 teeth was statistically significant ($t = 2.97$, $p = 0.003$) and remained clinically meaningful when expressed with its approximate 95% confidence interval of 0.39 to 1.15, suggesting that caregiver involvement may contribute materially to reduced caries burden in this setting.

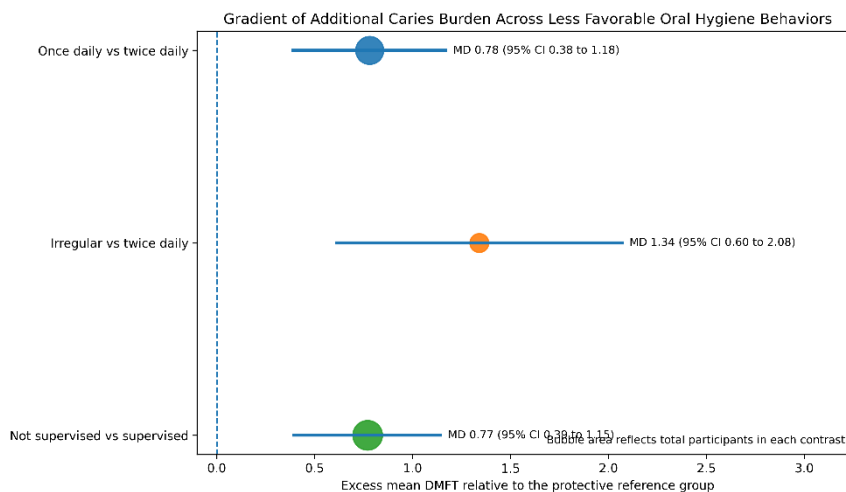


Figure 1 Magnitude of excess caries burden associated with less favorable oral hygiene behaviors

Figure description: The figure demonstrates a graded increase in excess mean DMFT when less favorable oral hygiene behaviors are compared with their protective reference groups. Relative to twice-daily brushing, once-daily brushing was associated with an additional 0.78 DMFT teeth (95% CI 0.38 to 1.18), while irregular brushing showed the largest excess burden at 1.34 DMFT teeth (95% CI 0.60 to 2.08). Lack of parental supervision was associated with an additional 0.77 DMFT teeth compared with supervised brushing (95% CI 0.39 to 1.15). The largest evidence base was contributed

by the supervision contrast ($n = 270$) and by the once-daily versus twice-daily comparison ($n = 240$), while the irregular-brushing contrast involved fewer children ($n = 110$) but still showed the steepest increase in caries burden. Collectively, the pattern indicates that both reduced brushing regularity and absence of caregiver supervision are associated with clinically meaningful increments in dental caries experience.

DISCUSSION

The present study evaluated the association between oral hygiene practices and dental caries among school-going children from socioeconomically disadvantaged communities in Lahore, Pakistan, and demonstrated that less favorable oral hygiene behaviors were associated with a higher caries burden. The mean DMFT of 2.85 ± 1.70 and mean deft of 3.12 ± 1.90 indicate a moderate level of caries experience in both permanent and primary dentitions within this underserved cohort. More importantly, the findings showed a consistent behavioral gradient: children who brushed twice daily had the lowest mean DMFT, those brushing once daily had a higher burden, and irregular brushers had the highest caries scores. Similarly, children whose brushing was supervised by parents or guardians had significantly lower DMFT values than those brushing without supervision. These observations support the study hypothesis and reinforce the importance of daily oral hygiene practices and caregiver involvement in childhood caries prevention, particularly in resource-limited settings (5,6,15,17).

The association observed between brushing frequency and caries burden is consistent with the broader preventive dentistry literature, which identifies twice-daily toothbrushing as one of the most practical and effective measures for reducing plaque accumulation and cariogenic exposure in children (14,19). In the current study, the mean DMFT increased from 2.34 in children brushing twice daily to 3.12 in those brushing once daily and 3.68 in those brushing irregularly, suggesting not only statistical significance but also clinical relevance. This graded pattern is important because it implies that even within disadvantaged populations, improvement in a single modifiable behavior may translate into a measurable reduction in caries burden. Similar findings have been reported in studies from other low- and middle-income countries, where insufficient brushing frequency has been associated with higher caries prevalence and poorer oral hygiene indices among children exposed to socioeconomic adversity (9,10,18).

The role of fluoride-containing toothpaste also remains central to interpretation of the present findings. Although a majority of participants reported using fluoridated toothpaste, the caries burden remained substantial, suggesting that access to fluoride alone may not be sufficient when brushing frequency, technique, or supervision is inadequate. Fluoride acts by enhancing remineralization and increasing enamel resistance to acid dissolution, but its preventive effect depends on regular and effective use (8,19). In populations where children may brush hurriedly, inconsistently, or without adult guidance, the biological benefit of fluoride may be diminished despite nominal use. This may partly explain why moderate caries levels persisted in the cohort even though nearly three-quarters of participants reported using fluoridated toothpaste. The finding underscores that oral health promotion in disadvantaged communities should not focus solely on product availability, but also on behavior quality and sustained household reinforcement (15,20).

A particularly important result of this study was the lower mean DMFT observed among children who brushed under parental supervision. The mean difference between supervised and unsupervised brushing was 0.77 teeth, and this relationship remained statistically significant. This is consistent with previous evidence indicating that caregiver participation is a key determinant of successful oral hygiene behavior in children, especially in younger age groups who may not yet possess the dexterity, motivation, or consistency required for effective plaque removal (16,17,19). In underprivileged settings, parental supervision may also function as a proxy marker for broader household engagement

with health behaviors. Caregivers who actively supervise brushing may also be more attentive to diet, hygiene materials, and help-seeking practices. Therefore, the observed association likely reflects both the immediate mechanical benefit of better brushing and the broader protective influence of family-level health behavior patterns (13,17).

The strong positive correlation between plaque index and DMFT in the present study further strengthens the biological plausibility of the reported behavioral associations. Plaque represents the local microbial substrate driving acid production and enamel demineralization; therefore, higher plaque accumulation would be expected to parallel worsening caries experience. The correlation coefficient of 0.78 indicates a robust relationship between poor plaque control and greater caries burden in this cohort, consistent with the established pathophysiology of dental caries and with findings from previous observational studies linking inadequate oral hygiene with deteriorating oral health outcomes (1,3,14). This result also helps integrate the behavioral and clinical observations of the study: children brushing less frequently or without supervision likely experienced poorer plaque removal, which in turn contributed to higher DMFT values.

The broader socioeconomic context of the study is critical to interpretation. Children living in deprived communities are often exposed to multiple concurrent risks, including constrained access to preventive care, limited caregiver literacy, financial barriers to oral hygiene products, and frequent consumption of sugary foods and drinks (7,11,13). In the current study, 77.8% of participants reported consuming sugary snacks or drinks, suggesting a highly cariogenic background environment that may amplify the effect of inadequate hygiene behaviors. This aligns with previous literature showing that childhood caries in disadvantaged groups reflects not only individual behavior but also structural inequality and household-level deprivation (11,12,20). Accordingly, the findings should be interpreted within a social-determinants framework rather than as simple individual-level noncompliance. Interventions are therefore likely to be most effective when they combine school-based education, caregiver engagement, access to fluoride products, and broader community oral health promotion strategies.

From a public health perspective, the findings have direct practical implications. School-based oral health programs in underserved areas may provide an efficient platform for delivering brushing instruction, dietary counseling, plaque-control education, and referral for dental care. However, the present results also show that school-level interventions alone may be insufficient if they do not include family engagement. Since supervised brushing was associated with lower DMFT values, community programs should incorporate parental counseling on brushing technique, timing, and monitoring. In addition, oral health promotion should address both the frequency and effectiveness of brushing, rather than relying on self-reported brushing alone. These findings support a combined preventive model in which schools reinforce knowledge, caregivers reinforce habits, and community outreach improves access to basic oral health resources (6,15,17,20).

The results should nevertheless be interpreted in light of the study limitations. First, the cross-sectional analytical nature of the study precludes causal inference. Although significant associations were identified between oral hygiene behaviors and caries experience, the temporal direction of these relationships cannot be definitively established. Second, the use of camp-based convenience sampling may have introduced selection bias, and the participants may not be fully representative of all school-going children in disadvantaged communities of Lahore. Third, several exposure variables, including brushing frequency, use of fluoridated toothpaste, and supervision status, were based on child or caregiver report and may therefore be affected by recall bias or social desirability bias. Fourth, although the analysis identified meaningful behavioral associations, residual confounding by unmeasured factors such as detailed dietary frequency, prior dental visits, household income, or caregiver oral health literacy cannot be excluded. These limitations do not negate the findings, but

they do suggest that the results should be interpreted as evidence of association rather than proof of causation (23,24).

Despite these limitations, the study contributes locally relevant evidence from an underrepresented population in which oral health needs are high and preventive resources are limited. The use of clinically assessed caries indices alongside behavioral variables strengthens the practical value of the findings, and the sample size of 270 children provides a useful basis for community-level interpretation. Future studies would benefit from longitudinal designs, probability-based sampling, multivariable modeling, and more detailed dietary and socioeconomic measurement to clarify causal pathways and isolate the independent contribution of specific hygiene behaviors. Interventional studies evaluating supervised brushing programs, fluoride access initiatives, and parent-focused oral health education in slum and low-income school settings would also be particularly valuable. Taken together, the present findings indicate that improving brushing regularity, promoting appropriate fluoride use, and strengthening parental supervision may represent feasible and clinically meaningful targets for reducing childhood caries in underserved Pakistani communities (5,15,19,20).

CONCLUSION

This study demonstrated that among school-going children from socioeconomically disadvantaged communities in Lahore, poorer oral hygiene practices were associated with a higher dental caries burden. Children who brushed twice daily had lower mean DMFT scores than those brushing once daily or irregularly, and parental supervision during brushing was associated with significantly better caries outcomes. Plaque accumulation also showed a strong positive correlation with DMFT, supporting the biological link between inadequate plaque control and worsening dental health. Although the cross-sectional design does not permit causal inference, the findings provide clinically and publicly relevant evidence that brushing regularity, effective fluoride toothpaste use, and caregiver involvement are important modifiable factors in pediatric oral health. Community- and school-based preventive strategies that combine oral health education with parental engagement may help reduce the burden of childhood dental caries in underserved populations.

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