

Association Between Body Mass Index and Dental Caries Among Adolescents in Rangpur, Bangladesh

A Cross-Sectional Analysis: Evidence-Based Insights for Integrated Public Health Interventions in Urban School Populations

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Article Info	ABSTRACT
Article History: Received: September 18, 2025 Revised: November 18, 2025 Accepted: November 26, 2025 Available online: January 29, 2026 Keywords: Body Mass Index; Dental Caries; Adolescents; Bangladesh; DMFT Index; Public Health; Oral Hygiene	Background: Obesity and dental caries are two of the most prevalent chronic conditions affecting adolescents worldwide, and Bangladesh's rapid nutritional transition toward processed foods and sugary beverages has sharpened concern about their combined burden in urban school populations. Objective: This study examined the association between Body Mass Index (BMI) and dental caries (DMFT index) among adolescents aged 12–16 years in Rangpur Metropolitan City, Bangladesh, while assessing the influence of socioeconomic status, oral hygiene practices, and dietary habits. Methodology: A cross-sectional study of 300 students from Shishu Niketon High School used purposive sampling, WHO-standardized questionnaires, and clinical dental examinations. Multivariate logistic and linear regression modeled relationships between BMI, DMFT scores, and covariates. Key Findings: Dental caries prevalence (DMFT > 0) was 54.1%, and 32% of students were overweight or obese. BMI category was significantly associated with caries status ($P = 0.008$); counterintuitively, obese adolescents showed 1.79 times higher odds of being caries-free than normal-weight peers ($P = 0.02$). Higher socioeconomic status (OR = 1.26, $P = 0.005$) and fluoride toothpaste use (OR = 1.63) were protective, and physical activity was significantly associated with lower BMI ($P < 0.001$). Policy Impact: These findings complicate the assumption that obesity straightforwardly elevates caries risk, and support integrated school health programs addressing oral hygiene, nutrition, and physical activity together through multi-sectoral collaboration in Bangladesh's urban adolescent populations.

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1. INTRODUCTION & CONTEXT

1.1 Problem Statement and Background

The dual burden of obesity and dental caries among adolescents is a critical public health concern with long-term implications for health outcomes, quality of life, and healthcare system sustainability. Childhood obesity prevalence has risen two- to five-fold in developed nations and up to four-fold in developing countries over the past two decades (Sanyaolu et al., 2019), while dental caries remains the most prevalent chronic disease affecting children and adolescents worldwide, with a particularly high burden in low- and middle-income countries (Petersen et al., 2005).

In Bangladesh, rapid urbanization and nutritional transition have driven a shift toward refined carbohydrates, sugary beverages, and processed foods (Mallik, 2025). These dietary changes elevate risk for both conditions simultaneously, creating a syndemic that calls for integrated public health responses. The relationship between the two, however, remains poorly understood in Bangladeshi contexts, where cultural, socioeconomic, and behavioral factors may modify associations reported elsewhere.

1.2 Theoretical Framework and Contested Evidence

Elevated BMI and dental caries share common risk factors, including frequent sugar consumption, poor dietary quality, and inadequate oral hygiene (Macek & Mitola, 2006; Reddy et al., 2019): refined carbohydrates serve as substrates for cariogenic bacteria while contributing to caloric surplus and adiposity. Empirical evidence is nonetheless contradictory — some studies report positive associations between obesity and caries (Chen et al., 2018), others find no relationship or an inverse one (Macek & Mitola, 2006; Pinto, 2007) — suggesting that socioeconomic status, healthcare access, oral hygiene behavior, and measurement methodology substantially shape the observed relationship. BMI itself is a contested proxy for adiposity in pediatric populations, as it cannot distinguish fat mass from lean mass and may misclassify metabolically healthy adolescents (Swaminathan et al., 2019), while age- and sex-specific BMI-for-age percentiles complicate comparison across studies (De Onis & Lobstein, 2010).

1.3 Research Gap and Objectives

Despite extensive global literature on obesity-caries relationships, statistically controlled evidence from adolescents in Rangpur, Bangladesh, is limited. No prior study in this urban context has used multivariate methods to isolate the BMI–caries association while controlling for socioeconomic status, dietary patterns, and oral hygiene behavior.

Primary Objective: To investigate the association between BMI-for-age and dental caries (DMFT) among adolescents aged 12–16 years in Rangpur Metropolitan City, Bangladesh.

Secondary Objectives:

1. Assess the prevalence of dental caries and weight-status categories (underweight, normal, overweight, obese) in the study population.
2. Evaluate the independent effects of socioeconomic status, sugar consumption, fluoride toothpaste use, and physical activity on dental caries status.
3. Model the relationship between sociodemographic/behavioral predictors and BMI using multivariate linear regression.

4. Generate evidence-based recommendations for integrated school health interventions targeting oral health and obesity prevention together.

1.4 Relevance to Humanitarian and Social Development Goals

This research aligns with CHRSD Foundation's mission of evidence-based research for human development and social progress, informing four Sustainable Development Goals:

SDG	Relevance
SDG 3 — Good Health and Well-being	Positions obesity and oral health as integral to universal health coverage
SDG 2 — Zero Hunger	Surfaces nutritional-transition challenges and the double burden of malnutrition in urban Bangladesh
SDG 4 — Quality Education	Frames school-based health promotion as a platform for holistic child development
SDG 10 — Reduced Inequalities	Examines socioeconomic gradients in health outcomes and access to preventive services

By generating localized evidence, this study offers actionable insight for policymakers, educators, and practitioners designing culturally appropriate, resource-efficient interventions in comparable urban South Asian settings.

2. METHODOLOGY / ANALYTICAL FRAMEWORK

2.1 Study Design and Setting

This cross-sectional observational study was conducted in Rangpur Metropolitan City, Bangladesh. Rangpur, a major urban center in northwestern Bangladesh, has a socioeconomically diverse population undergoing nutritional transition.

Study Site: Shishu Niketon High School, a government-run institution selected purposively for accessibility, administrative cooperation, and representation of urban adolescents across mixed socioeconomic backgrounds.

2.2 Study Population and Sampling

Target Population: Adolescents aged 12–16 years enrolled in Classes VII, VIII, and IX.

Sampling Method: Purposive sampling recruited 300 students meeting inclusion criteria. Non-probability sampling limits generalizability but was necessitated by the geographically focused, school-based design.

Inclusion Criteria: Enrollment in Classes VII–IX at Shishu Niketon High School; age 12–16 years; written informed consent from parent/guardian and written assent from the student.

Exclusion Criteria: Known systemic disease affecting BMI or dental health (e.g., diabetes mellitus, diagnosed hormonal disorders); current orthodontic treatment (fixed or removable appliances).

Sample Size Justification: Using $n = z^2pq/d^2$ with 50% expected prevalence ($p = 0.5$), 95% confidence ($z = 1.96$), and 5% absolute precision ($d = 0.05$), the calculated minimum sample was 384. Resource and logistical constraints limited enrollment to 300 students, which nonetheless gave adequate power ($\geq 80\%$) to detect medium effect sizes in the multivariate analyses.

2.3 Data Collection Procedures

Questionnaire: A structured instrument adapted from the *WHO Oral Health Surveys: Basic Methods* (5th ed., 2013) captured sociodemographic characteristics (age, gender, religion, family income, family type, parental education), oral hygiene practices (brushing frequency and timing, fluoride toothpaste use), dietary habits (sugar-consumption frequency across eight food categories), physical activity, and smoking habits.

Clinical Dental Examination: Trained examiners conducted assessments using disposable mouth mirrors and dental probes under standardized lighting, with students seated upright. The DMFT index (Decayed, Missing due to caries, Filled Teeth) followed WHO criteria: **Decayed** — a lesion with a visible cavity, undermined enamel, or softened wall/base, or a restored tooth with recurrent decay; **Missing** — a permanent tooth extracted because of caries; **Filled** — a tooth with one or more permanent restorations and no evidence of caries. Teeth lost to trauma or other non-caries causes were excluded.

Anthropometric Measurements: Height and weight were measured with calibrated instruments; BMI was calculated as weight (kg) / height (m²). Age- and sex-specific BMI-for-age percentiles followed WHO growth-reference standards: underweight (<5th percentile), normal weight (5th–84th), overweight (85th–94th), obese (≥95th).

2.4 Quality Assurance and Reliability

The questionnaire's content validity rests on its adaptation from WHO standardized protocols. Before data collection, the principal investigator completed calibration training for dental examination; intra-examiner reliability on a subsample of 10 students yielded substantial agreement ($\kappa = 0.89$; 89.2% agreement). Data were double-entered and validated, with discrepancies resolved against source documents.

2.5 Statistical Analysis

Software: MATLAB and OriginPro 9 were used for statistical analysis.

Variable Construction: Primary outcome — dental caries as a binary variable (DMFT = 0 vs. DMFT > 0); primary predictor — BMI category (underweight, normal, overweight, obese); composite socioeconomic score derived by Principal Component Analysis of parental education and residential location; standardized sugar-consumption score derived from frequency responses across eight food items.

Statistical Methods:

1. *Multivariate logistic regression* (primary analysis) modeled the odds of healthy teeth (DMFT = 0) as a function of BMI category, socioeconomic score, fluoride toothpaste use, sugar consumption, physical activity, age, and gender, reporting odds ratios (ORs) with 95% confidence intervals.
2. *Multivariate linear regression* (secondary analysis) examined associations between sociodemographic/behavioral predictors and continuous BMI.
3. *Descriptive statistics* summarized sample characteristics (frequencies, percentages, means, standard deviations).
4. Statistical significance was set at $\alpha = 0.05$ (two-tailed) throughout.

Ethical Considerations: Informed consent and assent procedures followed Declaration of Helsinki principles, and participant confidentiality was maintained through anonymized data coding.

3. KEY FINDINGS & ANALYSIS

Editorial note: The original source article states the sample was “all males” in its Results section, yet Tables 1–4 of that same source report sex-disaggregated counts for boys and girls throughout (e.g., Table 4: boys $n=161$, girls $n=139$). This contradiction originates in the source publication itself and is carried here for transparency; CHRSD recommends verifying the true sex composition against the authors’ raw dataset before this figure is cited in policy contexts. See the data-completeness note at the end of this paper.

3.1 Sample Characteristics

The study enrolled 300 adolescents from Shishu Niketon High School, aged 12–15 years. The source data indicate a mixed-sex sample (boys and girls both represented in every results table), despite one passage in the original text describing the cohort as male-only — see the editorial note above.

3.2 Prevalence of Dental Caries and Weight Status

Dental caries category	Share
DMFT > 0 (any caries)	54.1%
DMFT = 0 (caries-free)	45.9%
DMFT 1–3	44%
DMFT > 3	10%

Weight status	Share
Underweight	24.8%
Normal weight	43.2%
Overweight	16%
Obese	16%

Combined overweight/obese prevalence reached 32%, well above typical South Asian adolescent averages and consistent with an emerging obesity epidemic in urban Bangladesh.

3.3 Sugar Consumption Patterns

Food category	Daily	Weekly
Soft drinks	50%	33%
Sweetened drinks	68%	24%
Biscuits & sweets	23%	48%
Sweet candies	29%	52%
Jams & honey	14%	37%
Chewing gums	16%	32%
Fruits	43%	47%

More than two-thirds of students reported daily consumption of sweetened drinks, and half consumed soft drinks daily — patterns linked to both dental caries and obesity risk.

3.4 Primary Analysis: BMI and Dental Caries Association

Predictor	OR	P-value
BMI category (overall)	—	0.008
Obese vs. normal	1.79	0.02
Socioeconomic status	1.26	0.005
Fluoride toothpaste use	1.63	—
Physical activity	—	NS

Obese adolescents showed **1.79 times higher odds of being caries-free** than normal-weight peers ($P = 0.02$) — a result that cuts against the common assumption that obesity straightforwardly elevates caries risk, and that sits closer to Macek & Mitola (2006) than to Chen et al. (2018).

Interpretation: Four non-exclusive mechanisms may explain the pattern: (1) dietary composition — obese adolescents may eat more frequently, including protective foods such as dairy and fruit, buffering cariogenic effects; (2) salivary factors — obesity-linked metabolic changes may alter saliva buffering capacity or flow rate; (3) oral hygiene access — socioeconomic status, correlated with obesity in this sample, may improve access to preventive dental care and fluoride products; (4) BMI's own limitations — its inability to separate fat mass from lean mass may obscure the true adiposity–caries relationship (Swaminathan et al., 2019).

Protective factors: Each one-unit increase in the composite socioeconomic score raised the odds of healthy teeth by 1.26 ($P = 0.005$), and fluoride toothpaste users had 1.63 times the odds of caries-free status.

Null findings: Physical activity showed no significant association with caries status ($P > 0.05$), and sugar consumption did not reach significance in the multivariate model.

3.5 Secondary Analysis: Determinants of BMI

Predictor	Direction	P-value
Physical activity	Negative	<0.001
Socioeconomic score	—	NS
Sugar consumption	—	NS

Higher physical activity was significantly associated with lower BMI ($P < 0.001$), reinforcing it as a modifiable protective factor against adolescent obesity. Neither socioeconomic status nor sugar consumption reached significance.

3.6 Dental Issues Distribution

Category	Boys	Girls	Total
Only decayed (D)	13	10	23
Only missing (M)	1	1	2

Only filled (F)	13	11	24
Decayed + missing (DM)	2	4	6
Decayed + filled (DF)	1	5	6
Missing + filled (MF)	2	2	4
Decayed + missing + filled (DMF)	3	1	4
No issues	126	106	232

Cumulative DMFT per capita was 0.7733 (116/150), indicating a moderate caries burden overall. Boys showed marginally higher mean DMFT (0.7826) than girls (0.7728), a difference that was not statistically significant ($P = 0.213$). This table is itself the clearest evidence of a mixed-sex sample — both sexes appear throughout, confirming the editorial note above.

3.7 Comparative Analysis with Global Data

Location	n	Mean DMFT (SD)	Median	Range
Sobrado, Portugal	132	4.1 (2.8)	3.5	0–12
Rangpur, Bangladesh	300	2.73 (1.68)	3.11	0–11
Tehran, Iran	49	3.9 (2.7)	4	0–9

Rangpur adolescents show a lower mean DMFT than the Portuguese and Iranian comparators, which may reflect a genuinely lower baseline caries burden, a treatment gap (fewer filled teeth), or dietary differences. Even so, a 54.1% caries prevalence remains a significant public health concern warranting intervention.

3.8 Oral Hygiene Practices and Caries

Brushing frequency	n	Mean DMFT (SD)
Less than once/day	0	5.1 (2.65)
Once/day	231	4.42 (2.88)
Twice/day	60	3.4 (2.71)
More than twice/day	9	2.13 (2.9)

DMFT fell as brushing frequency rose, a trend that approached but did not reach statistical significance ($P = 0.065$). Brushing timing showed no significant association with DMFT (all $P > 0.05$).

3.9 Fuzzy-Logic Classification

BMI category	Caries prevalence	Classification
Normal (18.5–24.99)	7–8%	Normal
Underweight (<18.5)	>8%	Poor
Overweight/obese (>25)	7–8%	Transitional

Both underweight and normal-weight adolescents show caries prevalence above 8%, while overweight/obese adolescents fall in the 7–8% range — the “transitional” label reflecting the protective association seen in the logistic regression above.

4. STRATEGIC IMPLICATIONS & POLICY RECOMMENDATIONS

4.1 Key Policy Insights

1. **The obesity–caries paradox demands nuanced understanding.** Obesity and caries likely have distinct, partly independent causal pathways despite sharing dietary risk factors; BMI alone is not a sufficient basis for caries-risk screening.
2. **Socioeconomic gradients in oral health are pronounced.** Higher socioeconomic status predicted better dental outcomes, likely via differential access to fluoridated products and preventive services.
3. **Fluoride toothpaste is a critical, modifiable protective factor**, with users showing 1.63 times the odds of caries-free status.
4. **Physical activity is central to obesity prevention**, given its significant negative association with BMI.
5. **High sugar consumption warrants urgent action** — 50–68% of students consume soft drinks or sweetened beverages daily.

4.2 Recommendations for Policymakers

1. **Integrate oral health into school health programs.** Mandatory supervised fluoride toothbrushing; oral health in the national curriculum; annual dental screenings with referral pathways; teachers trained as oral-health promoters. *Stakeholders:* Ministry of Education, Ministry of Health and Family Welfare. *Timeline:* phased over 3 years.
2. **Regulate sugar-sweetened beverages in schools.** Ban vending-machine sales; front-of-pack warning labels; tax sugar-sweetened beverages; subsidize healthy canteen alternatives. *Stakeholders:* Bangladesh Food Safety Authority, National Board of Revenue. *Timeline:* policy within 12 months, enforcement within 18.
3. **Promote physical activity through school infrastructure.** 60 minutes of daily activity; invest in playgrounds and safe active-transport routes; train PE teachers. *Stakeholders:* Ministry of Youth and Sports, Ministry of Education. *Timeline:* audits within 6 months, programs within 2 years.
4. **Address socioeconomic inequality in oral health.** Subsidized fluoride toothpaste for low-income families; school-based fluoride-varnish programs; free check-ups at community health centers. *Stakeholders:* Ministry of Social Welfare, NGOs. *Timeline:* pilots within 1 year, scale-up within 3.
5. **Build surveillance systems for adolescent health.** Integrate BMI and DMFT into routine school assessments; biennial national surveys. *Stakeholders:* Bangladesh Bureau of Statistics, icddr,b. *Timeline:* system design within 12 months.

4.3 Recommendations for NGOs and Civil Society

6. **Implement community-based oral health promotion.** Community health worker training; mobile dental camps; free fluoride toothpaste distribution. *Stakeholders:* BRAC, Save the Children, CHRSD Foundation. *Timeline:* 18 months to 20 communities.

7. Foster multi-sectoral collaboration. National adolescent-health coalition; knowledge-exchange platforms; advocacy for school-health budget. *Stakeholders:* CHRSD Foundation, Bangladesh Dental Society. *Timeline:* coalition within 6 months.

4.4 Recommendations for Health Practitioners

8. Adopt integrated care. Screen for obesity and caries together at routine visits; refer accordingly. *Stakeholders:* Bangladesh Pediatric and Dental Associations. *Timeline:* guidelines within 9 months.

9. Build oral-health literacy among families. Bengali-language materials; SMS/social-media messaging; nurse and midwife training. *Stakeholders:* Health Promotion Bureau, UNICEF. *Timeline:* materials within 6 months.

4.5 Research and Monitoring Priorities

10. Invest in longitudinal and interventional research, prioritizing longitudinal cohorts, mechanistic studies of salivary/microbiome pathways, intervention trials, cost-effectiveness analysis, and qualitative research on behavioral barriers. *Stakeholders:* universities, icddr,b, Bangladesh Medical Research Council. *Timeline:* research agenda within 6 months.

5. CONCLUSION

This analysis of BMI and dental caries among adolescents in Rangpur, Bangladesh, surfaces a counterintuitive, statistically significant result: obese adolescents were more likely, not less, to be caries-free than their normal-weight peers. The finding complicates conventional assumptions about the obesity–caries relationship and underlines the limits of BMI as a stand-alone caries-risk indicator.

At the same time, a 54.1% caries prevalence and 32% overweight/obesity rate in this urban school population signal an urgent need for integrated intervention against shared risk factors — sugar-sweetened beverage consumption, physical inactivity, and inadequate oral hygiene chief among them.

Key takeaways:

1. Obesity and dental caries call for coordinated, not siloed, intervention.
2. Schools are the most efficient, equitable platform for adolescent health promotion.
3. Policy must prioritize low-income communities to narrow health disparities.
4. Localized, longitudinal, and interventional research is needed to refine strategy.
5. Sustained collaboration across government, NGOs, academia, and communities is a precondition for impact.

Limitations and generalizability: The cross-sectional design precludes causal inference, and purposive sampling from a single school limits generalizability. BMI’s known limitations as an adiposity measure may obscure the true relationship under study. The sex-composition inconsistency in the original source data (Section 3, editorial note) should be resolved against the raw dataset before this figure is used in policy contexts. Future work should use probability sampling, longitudinal design, and direct adiposity measures (e.g., DXA, bioelectrical impedance).

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Editorial Notes: Data-Completeness Checklist

1. **Sex composition of the sample** — the source text states “all males” but every results table reports boys and girls separately (confirmed against the original published article, Hossain & Mustafiz, 2026). Verify against the authors’ raw dataset before this figure is cited in policy contexts.
2. Full confidence intervals for all regression rows in Tables 3.4–3.5.
3. Survey response rate against the calculated minimum sample of 384.

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