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Prevalence of Mouth-Breathing Tendency Among 6–12-Year-Old Schoolchildren in Mumbai, Maharashtra: A Cross-Sectional School-Based Study

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Abstract

Background: Mouth breathing in children may reflect airway compromise or an established habit and has been linked with oral and dentofacial changes. Local school-based data from large Indian metropolitan settings remain limited.
Objectives: To estimate the frequency of mouth-breathing tendency using functional screening tests among 6–12-year-old schoolchildren in Mumbai, and to examine age- and gender-wise patterns along with selected associated clinical indicators.
Methods: A cross-sectional descriptive survey was conducted among schoolchildren aged 6–12 years in Mumbai. Children were screened using two chairside functional tests, mouth mirror (fog) test and Massler water-holding test, along with clinical assessment for lip incompetence, adenoid facies, and anterior open bite. Descriptive statistics were computed, and age- and gender-wise associations were tested using the chi-square test (two-sided; significance set at $p<0.05$).
Results: A total of 800 children were examined (male 53.75%, female 46.25%). Across age groups, mouth mirror test positivity ranged from 3.1% to 4.6% (overall $p=0.541$), and water-holding test positivity ranged from 1.4% to 2.8% (overall $p=0.468$). Concurrent positivity on both tests ranged from 4.6% to 5.3% (overall $p=0.903$). Clinical indicators were infrequent and showed no significant age-wise differences (lip incompetence $p=0.867$; adenoid facies $p=0.912$; anterior open bite $p=0.269$). Gender-wise, mouth mirror test positivity did not differ significantly ($p=0.243$), while water-holding test positivity was higher in females than males ($p=0.042$); other gender comparisons were not significant.
Conclusion: Functional screening indicators of mouth-breathing tendency were uncommon in this school-based Mumbai cohort and did not vary meaningfully by age. A small gender-related difference was observed for water-holding test positivity, while other screening outcomes and associated clinical indicators showed no clear demographic patterning.

Introduction

Nasal breathing is the physiological route of respiration and provides important protective functions such as filtration, humidification, and temperature regulation of inspired air. In contrast, mouth breathing in children commonly arises due to upper airway obstruction (e.g., adenoid/tonsillar hypertrophy, allergic rhinitis) or may persist as a habit even after obstruction resolves. Persistent oral breathing is clinically relevant because it can alter the oral environment (dryness, gingival inflammation), disturb orofacial muscle balance, and contribute to changes in dentofacial growth during active developmental years [1].

A growing body of evidence links mouth breathing with dentofacial and occlusal alterations. Cephalometric and clinical studies have reported associations with increased facial convexity, lip incompetence, and altered incisor inclination among mouth-breathing children, supporting the concept that chronic functional adaptation can influence craniofacial development [2]. From an orthodontic perspective, mouth breathing and other deleterious oral habits have also been shown to cluster with more severe malocclusion patterns and multiple occlusal traits, including altered overjet relationships and open bite tendencies [3]. Importantly, airway factors may interact with occlusion bidirectionally; for example, among mouth-breathing children assessed with structured ENT evaluation, tonsillar hypertrophy has been associated with malocclusion and increased overjet [4]. Beyond dentofacial effects, mouth breathing has also been reported as a clinical marker associated with sleep-related breathing problems in school-aged children, further reinforcing its relevance in pediatric health screening [5].

Reported prevalence of mouth breathing varies widely across regions and diagnostic approaches. High prevalence figures have been reported in some school-based cohorts in Brazil, while Indian epidemiological data have also documented lower prevalence in community samples, reflecting heterogeneity in populations and case definitions [6–8]. Despite this global literature, there remains limited contemporary evidence describing the burden of mouth breathing in large Indian metropolitan settings such as Mumbai, where environmental exposures, healthcare access, and respiratory morbidity profiles may differ across communities.

In this context, the present study aimed to estimate the prevalence of mouth-breathing tendency among 6–12-year-old schoolchildren in Mumbai, Maharashtra. The objectives of the study were to determine age-wise and gender-wise distribution of screening test positivity and to document the frequency of selected associated clinical indicators relevant to mouth breathing and dentofacial development.

Materials and Methods

This cross-sectional descriptive study was conducted across schools of Mumbai city over a period of 19 months between May 2024 and December 2025. All assessments were performed on-site in the participating schools under field conditions using a standardized examination sequence and recording format.

The study was conducted in accordance with the modified Declaration of Helsinki. Ethical approval was obtained from the Institutional Ethics Committee prior to the commencement of fieldwork . Administrative permission was obtained from the principals/authorities of the participating schools. Written informed consent was obtained from parents/guardians and assent was obtained from the children before examination. Participation was voluntary, with the option to withdraw at any stage without consequences. Confidentiality was maintained by assigning each participant a unique serial number; no personal identifiers were used for analysis or reporting.

Study population and eligibility criteria

The study population comprised schoolchildren aged 6–12 years enrolled in schools located within Mumbai city. Children were included if they were present on the day of examination and if parent/guardian consent and child assent were obtained. Children with special health care needs, known systemic disorders, those absent on the day of examination, or those without consent/assent were excluded.

Sample size estimation

Sample size was calculated for estimation of a single population proportion using the standard formula: $n = (Z^2 \times P \times (1 - P)) / d^2$, where Z = 1.96 for 95% confidence level, P = 0.35 (assumed prevalence), and d = 0.035 (absolute precision, set as 10% of P). The minimum required sample size was approximately 714. To improve precision and account for absenteeism and incomplete recordings, the final sample size was fixed at 800 children.

Sampling technique and participant selection

A probability-based simple random sampling method (lottery method) was used. After obtaining permissions, class registers for grades corresponding to the 6 to 12-year age group were obtained from each participating school. A sampling frame was prepared by listing all eligible children, and each child was assigned a unique serial number. Serial numbers were drawn randomly until the required sample size was achieved. If a selected child was absent on the day of examination or met any exclusion criterion, replacement was done by repeating the lottery method using the remaining eligible list.

Examiner training, calibration, and pilot study

All examinations and diagnostic tests were performed by a single investigator to eliminate inter-examiner variability. Prior to the main survey, calibration and standardization procedures were undertaken in the Department of Pediatric and Preventive Dentistry to ensure uniform interpretation and recording. A pilot study was conducted on approximately 10% of the planned sample (about 80 children) to assess feasibility of school-based screening, appropriateness of the checklist, and practicality of the diagnostic tests under field conditions. Based on pilot observations, the examination sequence and recording format were finalized and applied uniformly in the main study.

Infection control and examiner safety

Standard infection control precautions were followed during all examinations. Hand hygiene was performed before and after each examination using hand sanitizer. Disposable gloves and face masks were used and changed as per protocol. Instruments were cleaned and disinfected between participants in accordance with institutional infection control procedures. Biomedical waste was segregated and disposed of as per applicable biomedical waste management guidelines.

Materials and instruments

The armamentarium included disposable gloves, disposable face masks, and hand sanitizer. Clinical instruments included mouth mirrors for intraoral examination and a clean double-sided mirror used specifically for the mirror (fog) test.

Clinical examination and diagnostic procedures

Children were examined in an upright seated position with the head in a natural posture under adequate illumination. A calm environment was maintained to minimize altered breathing patterns due to anxiety, speaking, or recent physical activity. A focused extraoral and intraoral screening was performed to identify features commonly associated with mouth breathing.

Extraoral signs assessed included elongated facial appearance (long/narrow face), lip incompetence or lip gap at rest, hypotonic lips, everted lower lip, narrow nostrils, and facial appearance suggestive of adenoid facies when present. Intraoral signs assessed included anterior open bite.

Two standardized chairside tests were then performed for each participant (Figure 1). For the mirror (fog) test, a clean double-sided mirror was held vertically between the nose and mouth, close enough to capture exhaled airflow without touching the child. The child was instructed to sit quietly and breathe normally for approximately one minute without speaking. Fogging predominantly on the nasal side was interpreted as nasal breathing, fogging predominantly on the oral side as mouth breathing, and fogging on both sides as mixed breathing.

For the Massler water-holding test, the child was asked to take a mouthful of water and hold it for three minutes with the lips sealed, without swallowing, while attempting to breathe through the nose. The investigator timed the test. Inability to retain the water for the full three minutes due to lip opening, spillage, or early expulsion was considered suggestive of mouth-breathing habit, while successful completion indicated competent nasal breathing during the test.

Figure 1: a) Water holding test; b) Mirror test

The primary outcome was the prevalence of mouth-breathing habit. A child was categorized as a mouth breather when diagnostic testing supported mouth breathing based on the recorded mirror-test fogging pattern and/or inability to complete the three-minute water-holding test, together with supportive clinical features noted during examination. Children without supportive diagnostic findings were categorized as non–mouth breathers.

Statistical analysis

Completed data collection sheets were checked on the same day for completeness and legibility. Data were coded and entered into a computerized database using participant serial numbers and then imported into SPSS version 21 (SPSS Inc., Chicago, IL, USA) for analysis. Age was summarized using mean and standard deviation. Categorical variables (sex, clinical signs, test results, and mouth-breathing status) were summarized as frequencies and percentages. Prevalence was calculated as: (number of mouth breathers / total number examined) × 100, and reported with a 95% confidence interval. Associations between mouth-breathing status and categorical variables (e.g., age group, sex, and recorded clinical signs, where applicable) were evaluated using the Chi-square test. All tests were two-sided, with the confidence level set at 95% and statistical significance set at $p < 0.05$.

Results

A total of 800 schoolchildren aged 6–12 years were examined. The largest proportion belonged to the 8–9-year age group (43.5%), followed by 10–12 years (40.13%) and 6–7 years (16.38%). The sample included 430 males (53.75%) and 370 females (46.25%). Table 1 summarizes the demographic distribution.

Table 1. Participant characteristics (N=800)

Variable	**Category**	**n (%)**
Age group	6–7 years	131 (16.38)
	8–9 years	348 (43.50)
	10–12 years	321 (40.13)
Sex	Male	430 (53.75)
	Female	370 (46.25)

Age-wise distribution of functional screening test positivity is shown in Table 2. Mouth mirror test positivity ranged from 3.1% to 4.6% across age groups (p=0.541). Water-holding test positivity ranged from 1.4% to 2.8% (p=0.468). Positivity on both tests ranged from 4.6% to 5.3% (p=0.903).

Table 2. Functional screening test positivity across age groups

Age group (n)	**Mouth mirror test: Present n (%)**	**Water-holding test: Present n (%)**	**Both tests: Present n (%)**
6–7 years (131)	4 (3.1)	3 (2.3)	6 (4.6)
8–9 years (348)	16 (4.6)	5 (1.4)	16 (4.6)
10–12 years (321)	10 (3.1)	9 (2.8)	17 (5.3)

Overall comparison (χ^2, p): Mouth mirror 1.227, p=0.541; Water-holding 1.521, p=0.468; Both tests 0.205, p=0.903.

Age-wise frequencies of the recorded clinical findings are presented in Table 3. Lip incompetence ranged from 12.6% to 14.0% (p=0.867), adenoid facies from 3.7% to 4.4% (p=0.912) and anterior open bite from 2.3% to 5.6% (p=0.269) across the age groups.

Table 3. Clinical findings across age groups

Age group (n)	**Lip incompetence: Present n (%)**	**Adenoid facies: Present n (%)**	**Anterior open bite: Present n (%)**
6–7 years (131)	17 (13.0)	5 (3.8)	3 (2.3)
8–9 years (348)	44 (12.6)	13 (3.7)	14 (4.0)
10–12 years (321)	45 (14.0)	14 (4.4)	18 (5.6)

Overall comparison (χ^2, p): Lip incompetence 0.285, p=0.867; Adenoid facies 0.184, p=0.912; Anterior open bite 2.630, p=0.269.

Gender-wise comparisons are summarized in Table 4. Mouth mirror test positivity was 3.0% in males and 4.6% in females (, p=0.243). Water-holding test positivity was 1.2% in males and 3.2% in females, showing a statistically significant difference (p=0.042). Positivity on both tests was 4.2% in males and 5.7% in females (p=0.329). No statistically significant gender differences were observed for lip incompetence, adenoid facies,or anterior open bite (all p>0.05).

Table 4. Functional screening tests and clinical findings across gender groups

Parameter: Present n (%)	**Male (n=430)**	**Female (n=370)**	**χ^2**	**p value**

Mouth mirror test	13 (3.0)	17 (4.6)	1.360	0.243
Water-holding test	5 (1.2)	12 (3.2)	4.139	0.042*
Both tests positive	18 (4.2)	21 (5.7)	0.952	0.329
Lip incompetence	48 (11.2)	58 (15.7)	3.524	0.060
Adenoid facies	14 (3.3)	18 (4.9)	1.341	0.247
Anterior open bite	17 (4.0)	18 (4.9)	0.395	0.530

*p<0.05.

Discussion

Mouth breathing in childhood is clinically relevant because it can reflect impaired nasal airway function or an established habit, and over time it may contribute to changes in the oral environment and dentofacial development [1,9-15]. In the present Mumbai school sample, functional indicators of mouth-breathing tendency were uncommon, and positivity remained broadly stable across the 6–12-year age range. This age-wise stability is plausible because airway-related patterns and learned breathing habits, once established, often persist across adjacent school years unless a precipitating obstruction resolves or intervention occurs; therefore, large age gradients are not necessarily expected in cross-sectional school cohorts [10,11,15].

An important methodological insight from the findings is the internal pattern between the two screening tools. Mirror fogging captures a brief snapshot of airflow dominance during quiet breathing and can identify children who intermittently shift to oral or mixed breathing. In contrast, the Massler water-holding task is more stringent: it requires sustained lip seal and nasal breathing for a fixed duration, and therefore it is more likely to yield fewer positives [16,17]. Studies that used similar chairside testing in school settings demonstrate that prevalence estimates vary widely depending on how "mouth breathing" is operationalized and whether symptom-based screening is incorporated [6,18]. The relatively low positivity in the present cohort, therefore, may reflect a smaller pool of children with persistent functional deviation rather than a high burden of intermittent or symptom-driven oral breathing.

When compared with published prevalence work, the low proportions observed here are consistent with Indian epidemiologic data that report modest mouth-breathing prevalence in community school samples. Shetty and Munshi (1998), for example, reported mouth breathing as one of several oral habits in a large school population, with a prevalence of 4.6% [8]. In contrast, several Brazilian school-based studies have reported prevalence in the range of ~50–55% [6,7], highlighting substantial between-population heterogeneity even when the target age groups overlap. Differences in background airway morbidity, allergy burden, environmental exposures, and, critically, case definitions and diagnostic thresholds likely explain much of this spread, rather than any single "true" global prevalence [19].

The clinical indicators evaluated alongside the tests (lip incompetence, adenoid facies,and anterior open bite) were generally infrequent and did not vary meaningfully by age. This pattern suggests that, in this screened population, overt phenotypic markers associated with chronic mouth breathing and prolonged postural adaptation are not common. This contrasts with cephalometric and clinic-based studies where confirmed mouth breathers show clearer dentofacial differences, including increased interlabial gap and altered soft-tissue profile [2,21-23]. It also aligns with broader orthodontic epidemiology showing that mouth breathing tends to cluster with more severe malocclusion traits in higher-risk or referred samples [3,20]. From a practical standpoint, these findings support targeted identification: children who screen positive or show suggestive features can be prioritized for airway evaluation and early interceptive guidance, rather than assuming a high population-wide burden.

Gender-wise, the significant difference observed for the water-holding test should be interpreted cautiously because the absolute number of positives was small. A sustained lip-seal task can be influenced by transient nasal symptoms on the day of examination, anxiety, and compliance, so a statistically significant difference does not necessarily imply a stable biological sex predilection. Nonetheless, it highlights the need for clinical correlation for children who repeatedly fail functional nasal-breathing tasks because mouth breathing has also been associated with sleep-disordered breathing risk in school-aged cohorts [24-26].

This study has limitations. The cross-sectional design cannot establish temporality between breathing pattern and dentofacial features, and brief school-based screening may under-detect intermittent mouth breathing or over-capture transient congestion. No confirmatory ENT assessment or objective airway measures were included, which limits etiologic attribution. Future research should incorporate standardized symptom instruments (including sleep-related screening), ENT confirmation, and longitudinal follow-up to determine how functional screening positivity relates to evolving occlusal traits and whether early referral pathways reduce downstream dentofacial consequences.

Conclusion

Overall, mouth-breathing tendency identified through school-based functional screening appeared uncommon in this cohort and showed no meaningful variation across the examined age range. A small gender-related difference was observed for performance on the water-holding test, while other screening outcomes and associated clinical indicators did not demonstrate clear demographic patterning.

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