

# Mouth Breathing in Schoolchildren in Ankawa District: Symptoms, Risk Factors, and Orthodontic Implications in a Cross-Sectional Study with Home-Based Test Validation

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## ABSTRACT

**Background and Objective:** Mouth breathing is common in children and has been associated with a range of clinical concerns. Early recognition may help orthodontists and other healthcare professionals identify and manage this condition.

This study aimed to determine the prevalence of mouth breathing among school-aged children in the Ankawa district and to examine its associations with demographic factors, sleep-related symptoms, general well-being, and parent-reported school functioning.

**Methods:** A cross-sectional school-based study was conducted among 270 primary schoolchildren using multi-stage stratified cluster sampling. Data were collected using a parent-completed questionnaire and a home-based water retention screening test. Students were trained during school visits, and parents completed the questionnaire at home after providing written informed consent.

**Results:** Based on the water retention screening test, 48% of the sample screened positive for mouth breathing. Children who retained water in their mouths for more than 3 minutes were classified as nasal breathers. Only 15.9% were reported to habitually breathe through the mouth during the day, while 18.1% were reported to do so during sleep. No statistically significant differences were found by age or sex ( $p > 0.05$ ). However, a significant difference was observed between public and private school students ( $p < 0.05$ ). A significant association was also found between positive screening test results and parent-reported teacher concern about the child's attention ( $p < 0.001$ ).

**Conclusion:** Mouth breathing was common in this sample of school-aged children. Early recognition and increased awareness may help support timely assessment and management of potential health, behavioral, and academic consequences.

**Keywords:** Sleep Apnea Syndromes; Mouth Breathing; Malocclusion/etiology; Orthodontics, Interceptive; Mass Screening

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## INTRODUCTION

Understanding the prevalence of mouth breathing goes beyond mere definition, requiring exploration of its underlying causes and broader implications. Recent studies have indicated that many students exhibit oral breathing patterns, with higher rates observed in public school settings.<sup>1</sup> This finding suggests a potential association between socioeconomic factors and respiratory health, indicating that vulnerable populations may warrant particular attention in assessment and follow-up.<sup>2</sup> Chronic mouth breathing is associated with significant long-term consequences, including alterations in facial structure, dental malocclusions, and impaired quality of life. Therefore, early recognition and multidisciplinary management strategies are crucial components of care for children with this condition.<sup>3,4</sup>

Mouth breathing is associated with considerable alterations in craniofacial morphology, encompassing Class II malocclusion, anterior open bite, and posterior crossbite.<sup>4,5</sup> It increases facial height and the mandibular plane angle, in addition to modifications in cranial alignment.<sup>4,6</sup> These changes may exacerbate respiratory problems and are associated with further complications, highlighting the need for comprehensive evaluation and intervention strategies that involve orthodontists, otolaryngologists, and other healthcare professionals.<sup>7</sup> Children with mouth breathing frequently present with obstructive sleep apnea, a condition that is known to aggravate systemic health complications and influence overall wellness.<sup>8</sup> Sleep disorders are among the most commonly reported manifestations associated with mouth breathing, emphasizing the imperative for interdisciplinary intervention.<sup>9,10</sup>

Effective management of mouth breathing requires collaboration among various healthcare professionals, including dentists, orthodontists, and ENT specialists, to ensure comprehensive patient care.<sup>9</sup> This collaborative approach addresses the immediate symptoms and targets the underlying causes, ensuring a holistic treatment plan that promotes long-term health and well-being for affected individuals.

Timely identification and intervention are considered important components of care for children with mouth breathing and may support harmonious facial development and oral health.<sup>5</sup>

The adverse consequences of mouth breathing are

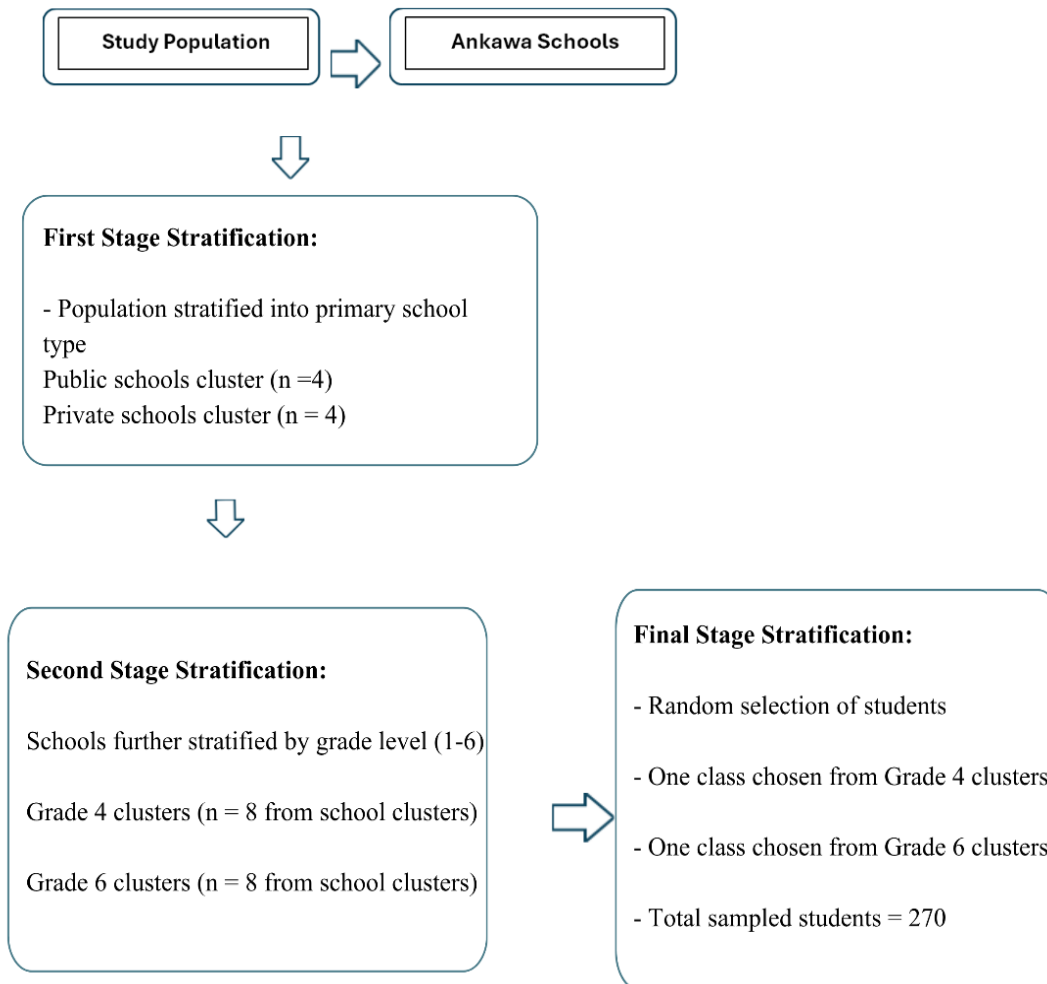
well documented, though doubts remain about whether it is a primary etiological factor or a secondary adaptation to preexisting craniofacial abnormalities.<sup>4</sup> This controversy highlights the complexity of the condition and underscores the need for further research and interdisciplinary collaboration to comprehend and address its multifaceted aspects.

Despite its clinical relevance, there is a paucity of research from Erbil City, Iraq, evaluating the prevalence of mouth breathing and its associated risk factors. Global investigations suggest that approximately 10%-40% of children engage in mouth breathing. Environmental exposures, allergies, and anatomical anomalies such as enlarged adenoids or a deviated septum are considered risk factors.<sup>1,10</sup>

In the Kurdistan Region of northern Iraq, environmental and social determinants, including air pollution, may be associated with a higher prevalence of mouth breathing; however, local data remain limited.<sup>11</sup> This study aimed to determine the prevalence of mouth breathing among school-aged children in the Ankawa district and to examine its association with demographic factors, sleep quality, general well-being, and overall school performance.

## METHODS

This cross-sectional school-based study was conducted from early to late March 2025 in the Ankawa district, north of Erbil City, in the Kurdistan Region of Iraq. A questionnaire was used to collect data from school-aged children attending primary schools in the Ankawa district. The sampling method employed was multistage stratified cluster sampling. The target population was divided into two primary strata: public and private primary schools. Four schools were randomly selected from each stratum, creating clusters of public and private schools. The selected schools were then stratified by grade level, and grades 4 and 6 were chosen because they represent an important developmental stage, and students were considered able to complete the questionnaire process reliably with parental support. In the final stage, one class from each selected grade was randomly chosen, forming the final sampled clusters (Figure 1).



**Figure 1.** Flowchart showing the sampling method of the study

### Sample Size

A total of 270 completed questionnaires were included in the final analysis. The sample size was calculated using the StatCalc Module of Epi Info 7, with a population size of 100,000 and a 95% confidence level. The absolute precision was set at 5%, with an estimated prevalence rate of 24%, based on previous studies.<sup>11,12</sup> Given that the Ankawa district is part of Erbil city, it was assumed that the prevalence rate would be similar. The estimated sample size was approximately 280 participants after adjustment for finite population correction. The final sample size was set at 300 to account for an anticipated 5% non-response rate due to student absence on the day of administration. A total of 270 questionnaires were returned, resulting in a 90% response rate.

### Ethical Considerations

Before data collection, approval was obtained

from the district's Directorate of Primary Education. The study was also approved by the Orthodontic Department and the Scientific Research Ethics Committee at the College of Dentistry, Hawler Medical University, on March 9, 2025, with reference number 2425164. Written informed consent was obtained from the students' parents via an explanatory section at the end of the questionnaire, which required their signatures. Questionnaires without signed parental informed consent were excluded from the study.

### Questionnaire Design

After ethical approval was obtained, the questionnaire was developed in accordance with the 2015 guidelines for the clinical recognition of mouth breathing.<sup>13</sup> The questionnaires incorporated most of the questions suggested in the referenced paper, along with a water retention test. This test was used as a functional screening tool for assessing

breathing patterns.<sup>14</sup> Participants who could not retain water in their mouths for 3 minutes were classified as screening-positive for mouth breathing, whereas those who maintained water for more than 3 minutes without swallowing were classified as nasal breathers. The questionnaire was designed to be completed by parents, and the symptoms, habits, medical history, environmental exposure, and school-related variables analysed in this study were therefore parent-reported.<sup>1</sup>

Before the questionnaire was distributed, an orthodontist and a statistician carefully reviewed it to check that the questions were clear, relevant, and methodologically sound. Their input led to minor adjustments, making the questionnaire easier to understand and more effective at capturing the information needed for the study.

To improve the standardisation and consistency of the home-based water retention test, students were first thoroughly trained and supervised in class, where they practised measuring and accurately recording time. They then repeated the test at home, following the same standardised procedure, and recorded their results. This approach helped familiarise participants with the test protocol, minimising variability and enhancing the consistency and accuracy of the home-based measurements.

### Language and Sections

The questionnaire was developed in three languages (English, Kurdish, and Arabic) to accommodate the diverse population and linguistic demographics of school children in the Ankawa district. It aimed to assess the prevalence of mouth breathing, associated risk factors, and its impact on students' health and daily activities using parent-reported information together with the home-based water retention test. The questionnaire consisted of three main sections: demographic information (age, sex, and socioeconomic status); parent-reported symptoms and risk factors related to mouth breathing that could affect general and oral health, including sleep-related symptoms; and parent-reported school functioning. The last section included the water retention test to be performed at home, along with the written informed consent. In this study, mouth breathing status was determined primarily from the reported results of the water retention test, which was used as a screening tool. Participants who retained water for less than 3 minutes were classified as positive on the mouth breathing screening test.<sup>15,16</sup> Partici-

pants were instructed to complete the questionnaire at home with their parents, as many items relied on parental observation or parent-reported information known to them.

### Data Collection Process

Data collection involved visits to all schools included in the study, during which an explanatory presentation was provided to the selected students about the habit of mouth breathing, its symptoms, and potential complications to raise awareness of the issue. Students were also trained to perform the water-retention test at home to reduce errors from improper test execution. Following the presentation, paper-based questionnaires were distributed to students in their classrooms. Although the questionnaires were completed by participants and their parents, they were distributed under the supervision of the researcher and teachers to facilitate clarification and ensure uniform distribution and language selection. Data collection spanned three weeks, from the beginning to the end of March 2025.

### Exclusion Criteria

Questionnaires without signed parental informed consent, those with missing data, and those with inconsistent responses were excluded from the study.

### Data Analysis

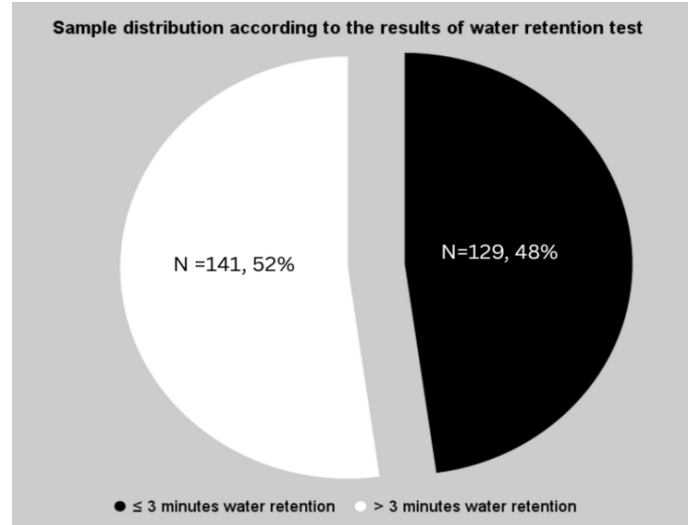
Descriptive statistics were used to analyse the demographic data and the prevalence of mouth breathing, including frequencies and percentages for variables such as age, Sex, grade, income, and school type (public vs private), using SPSS version 30 (IBM Corp., Armonk, NY, USA). Comparisons and associations between different variables were assessed using the chi-square test. The McNemar test was used to compare screening test results with parent-reported mouth breathing during the day and during sleep.

## RESULTS

The water retention test classified 129 of 270 participants (47.8%) as screening-positive for mouth breathing and 141 (52.2%) as negative (Figure 2, Table 1).

Mouth breathing in the sample was additionally assessed using parent-reported observations of the habit during the day and at night. We found that only 43 (15.9%) of the sample reported daytime mouth breathing, while 49 (18.1%) reported a habit during sleep. Among the 43 participants with parent-reported daytime mouth breathing, 23

(53.5%) screened positive on the water retention test. Among the 49 participants with parent-reported mouth breathing during sleep, 25 (51.0%) screened positive on the water retention test. The results of the water retention test were compared with parent-reported responses regarding whether the habit was observed during the day or during sleep. A statistically significant difference was found between the screening test results and parents' observations ( $p < 0.001$ ) (Table 1). Cohen's Kappa ( $\kappa$ ) was 0.031 for the parent-reported habitual mouth breathing in the daytime and 0.017 for the habit while sleeping, which both fall into the slight agreement range based on Landis & Koch's scale. These findings indicate slight agreement between the screening test results and parent-reported observations of the habit.



**Figure 2.** Prevalence of mouth breathing among participants based on the 3-minute water retention test

**Table 1.** Distribution of Participants According to Water Retention Screening Test Results and Parent-Reported Mouth-Breathing Habits

	Screening-positive for mouth breathing (according to the water retention test)		Screening-Negative for mouth breathing (according to the water retention test)		McNemar test p-value *
		Count N (% within the test)	Count N (% within the test)	Total count N (% within the sample)	
Parent-reported mouth breathing during the day	Yes	23 (17.8%)	20 (14.2%)	43 (15.9%)	< 0.001
	No	106 (82.2)	121 (85.8%)	227 (84.1%)	
	Total sample %	129 (47.8%)	141 (52.2%)	270 (100%)	
Parent-reported mouth breathing during sleep	Yes	25 (19.4%)	24 (17%)	49 (18.1%)	<0.001
	No	104 (80.6%)	117 (83%)	221 (81.9%)	
	Total sample %	129 (47.8%)	141 (52.2%)	270 (100%)	

\* Statistical significance was assessed using the McNemar test. Cohen's Kappa ( $\kappa$ ) was used to test agreement between test and parent-reported habit;  $\kappa = 0.031$  for daytime observation and 0.017 for sleeping observation.

Participants ranged in age from 9 to 12 years; 113 (41.9%) were aged 9-10 years and 157 (58.1%) were aged 11-12 years. Further demographic details are presented in Table 2. The difference between them was not statistically significant in the mouth breathing test results ( $p > 0.05$ ). A greater proportion of participants attended public schools (168, 62.2%), while private school participants comprised only 102 (37.8%) of the sample. A statistically significant difference was found between school type and water retention screening test results ( $p < 0.001$ ), with a higher percentage of mouth breathing among public school students (55.95%) than among private school students

(34.32%). The sex distribution was approximately even, with a slightly greater percentage of males (144, 53.3%) than females (126, 46.7%). There was no statistically significant difference between males and females in the water retention screening test results. Based on socioeconomic status, 57.0% of participants in the low socioeconomic group ( $n = 35$ , 13.0%) were classified as positive mouth breathers, followed by 53.5% in the high socioeconomic group ( $n = 43$ , 15.9%) and 44.8% in the fair socioeconomic group ( $n = 192$ , 71.1%). The differences in water retention screening test results across socioeconomic levels were not statistically significant ( $p > 0.05$ ).

**Table 2.** Sample Distribution and Water Retention Screening test Results According to Demographic Characteristics

Demographic characteristic		Sample distribution		Water retention screening test results		p-value	Pearson Chi-square value
		Frequency (N)	Percent (%)	Screening - positive (%)	Screening-negative (%)		
Age category	<10 (9-10)	113	41.9	53.1%	46.9%	0.138*	2.204a
	>10 (11-12)	157	58.1	43.9%	56.1%		
	Total	270	100				
School type	Private	102	37.8	34.31%	65.69%	<0.001*	27.000a
	Public	168	62.2	55.95%	44.05%		
	Total	270	100				
Sex	Male	144	53.3	45.8%	54.2%	0.5*	.468a
	Female	126	46.7	50.0%	50.0%		
	Total	270	100.0				
Grade	4	129	47.8	53.5%	46.5%	0.07*	3.229a
	6	141	52.2	42.6%	57.4%		
	Total	270	100.0				
Socioeconomic level	Fair	192	71.1	44.8%	55.2%	0.29*	2.478a
	Low	35	13.0	57.1%	42.9%		
	High	43	15.9	53.5%	46.5%		
	Total	270	100.0				

\* Pearson's chi-square test was used. A p-value  $\leq 0.05$  was considered statistically significant

**Table 3.** Associations Between Water Retention Screening Test Results and Parent-Reported Symptoms and Related Factors

Symptoms and factors related to mouth breathing (parent feedback)			Mouth breathing test results		p-value*, Pearson's chi-square
		n (% of sample)	Positive %	Negative %	
Allergy history	Yes	37 (13.7)	18.9%	81.1%	<0.001, 14.312a
	No	233 (86.3)	52.4%	47.6%	
Difficulty in school performance	Yes	38 (14.1)	36.8%	63.2%	0.145, 2.120a
	No	232 (85.9)	49.6%	50.4%	
Parent-reported teacher concern about the child's attention	Yes	27 (10)	81.5%	18.5%	<0.001, 13.658a
	No	243 (90)	44%	56%	
Parent-reported facial changes with possible orthodontic implications (e.g., long face or narrow jaw)	Yes	12 (4.5)	50%	50%	0.875, .025a
	No	258 (95.5)	47.7%	52.3%	
Sleep-disordered breathing	Yes	21 (7.7)	57.1%	42.9%	0.37, .800a
	No	249 (92.3)	47%	53%	
Frequent colds or respiratory infections	Yes	41 (15)	53.7%	46.3%	0.4, .670a
	No	229 (85)	46.7%	53.3%	
Exposure to smoking	Yes	38 (14.1)	52.6%	47.4%	0.5, .418a
	No	232 (85.9)	47%	53%	
Exposure to mould	Yes	7 (2.6)	100%	0%	<0.01, 7.855a
	No	263 (97.4)	46.4%	53.6%	
Exposure to pet dander	Yes	19 (7.04)	52.6%	47.4%	0.66, .193a
	No	251 (92.96)	47.4%	52.6%	
Continuous runny or stuffed nose	Yes	15 (5.55)	26.7%	73.3%	0.092, 2.837a
	No	255 (94.45)	49%	51%	
History of tonsillectomy or adenoidectomy	Yes	21 (7.77)	33.3%	66.7%	0.168, 1.904a
	No	249 (92.23)	49%	51%	
Deviated nasal septum or nasal obstruction	Yes	27 (10)	59.3%	40.7%	0.208, 1.585a
	No	243 (90)	46.5%	53.5%	
Tonsillitis or adenoid enlargement	Yes	31 (11)	61.3%	38.7%	0.1, 2.563a
	No	239 (89)	46%	54%	
Snoring during sleep	Yes	30 (11.1)	33.3%	66.7%	0.09, 4.810
	No	240 (88.9)	50%	50%	
Drooling	Yes	46 (17)	45.7%	54.3%	0.75, .100a
	No	224 (83)	48.2%	51.8%	
Dry mouth and/or chapped lips	Yes	32 (11.9)	50%	50%	0.785, .072a
	No	238 (88.1)	47.5%	52.5%	
Orthodontic consultation	Yes	24 (8.9)	29.2%	70.8%	0.05, 3.657a
	No	246 (91.1)	49.6%	50.4%	

\* Statistical significance was tested using Chi-square test; a p-value ≤ 0.05 was considered statistically significant

As shown in Table 3, 37 participants (13.7%) had a parent-reported history of allergy, of whom 81.1% were classified as negative on the water retention screening test. Allergy history was significantly associated with the water retention screening test results ( $p < 0.001$ ). Multiple other environmental and health-related symptoms and factors potentially associated with mouth breathing were also analysed for statistical correlations, as detailed in Table 3. Water retention screening test results showed a significant association between reported environmental mould exposure and mouth breathing ( $p < 0.01$ ); however, this finding should be interpreted with caution given the very small exposed subgroup. In contrast, no significant associations were observed between mouth breathing and sleep quality or other symptoms related to sleep-disordered breathing. Parent-reported teacher concern about the child's classroom attention showed a strong, statistically significant association with positive mouth breathing results ( $p < 0.001$ ). Parent-reported facial changes, however, were not significantly associated with the test results ( $p > 0.05$ ).

"N" and "% within sample" indicate the number and proportion of participants reporting each symptom or factor. "Positive %" and "Negative %" represent the proportion of participants within each category classified as positive (water retention time  $\leq 3$  minutes) or negative ( $> 3$  minutes) for mouth breathing.

## DISCUSSION

Mouth breathing is common in children, especially those seeking orthodontic treatment. It can lead to various health problems beyond facial changes, such as sleep disturbances and compromised oral health. Some studies have also reported school performance problems.<sup>11,17-18</sup>

Understanding the prevalence of this condition in children may help inform further research and support earlier recognition and management. Moreover, gaining insight into the factors associated with mouth breathing, like demographic, environmental, and other health-related factors, is crucial.<sup>3,18-20</sup>

This study was questionnaire-based and incorporated a home-administered water retention test as a screening tool. Logistical barriers precluded direct clinical examination, similar to barriers reported in earlier research.<sup>21</sup> While the water retention test offers a practical, low-cost method for approximating breathing patterns in large school samples, it

remains a screening tool rather than a diagnostic gold standard. Its administration at home, reliance on cooperation between child and parent, and the absence of clinical verification introduce potential sources of misclassification that must be considered when interpreting the findings.

In this sample, the prevalence of mouth breathing was 48% based on water retention screening test results, slightly lower than that reported in other studies.<sup>21-23</sup> A local study, on the other hand, showed a lower prevalence of 24.4%.<sup>11</sup> These differences may reflect not only true variation in regional prevalence but also methodological factors, including variability in screening or diagnostic criteria, study settings, and population characteristics. We found a statistically significant difference between the water retention screening test results and parental feedback on breathing, with only slight agreement between the two. This discrepancy may be partially explained by insufficient parental awareness of the significance of breathing patterns and by inaccurate reporting of the child's habitual breathing, especially during sleep. However, it may also reflect limitations of the home-based screening test itself, such as inconsistent timing, suboptimal adherence to instructions, or difficulties for younger children in maintaining a sustained water hold regardless of their true breathing pattern. Taken together, these issues underline that both parental reports and the home-based test are imperfect proxies. Therefore, clinicians should complement subjective information and simple screening tools with more objective and standardised clinical assessments to detect mouth breathing more reliably.<sup>24</sup>

The screening test results did not show a significant association with several demographic factors, such as age category, sex and socioeconomic level. However, we found a highly significant difference between public and private schools in mouth breathing, with a greater prevalence among public school students. This finding aligns with a study conducted in Brazil.<sup>22</sup> One plausible explanation is that school-related and environmental factors, which may not be fully captured by broad demographic categories, contribute to the observed pattern. These results highlight the need to increase awareness of the importance of mouth breathing, encourage regular ENT checkups and orthodontic consultations, and explore contextual influences in public school environments, such as class size, ventilation, and allergen exposure. The larger

number of students in public schools, along with potential environmental differences, may also be related to the higher prevalence detected by the test. A previous study identified allergic rhinitis and inflamed adenoids as major causes of mouth breathing.<sup>23</sup> In contrast, our findings did not show the expected association. This divergence should be interpreted cautiously. Because the present study relied on parental reporting of medical history and symptoms, underlying conditions such as allergic rhinitis, adenoid hypertrophy, or chronic nasal obstruction may have been underdiagnosed or underreported. Limited access to specialised ENT services and infrequent visits could further reduce the likelihood that parents were aware of these conditions. Additionally, the screening nature of the water retention test and its lack of direct anatomic evaluation may have constrained its sensitivity to specific pathologies. These methodological constraints likely contributed to the absence of statistically significant associations with some well-established risk factors, rather than contradicting the standard medical literature.

The results revealed that most symptoms related to mouth breathing during sleep, such as snoring and drooling, were not statistically significant, which appears to contrast with much of the existing literature.<sup>25</sup> This apparent inconsistency is again likely influenced by the inherent limitations of the data sources used: parental observation during sleep is often incomplete, especially if the child sleeps in a separate room or if symptoms are intermittent. Furthermore, the cross-sectional design and reliance on broad yes/no questions may not capture the full spectrum and frequency of sleep-disordered breathing manifestations. These findings emphasise the need for improved parental education on nocturnal symptoms and support the implementation of awareness campaigns to enhance recognition of signs of mouth breathing at home.

A recent study concluded that mouth breathing can significantly impair an individual's cognitive functions and memory.<sup>26</sup> Our findings are broadly consistent with this evidence, as a high proportion of children whose parents reported that the class teacher had expressed concern about their attention were classified as mouth breathers according to the water retention test. Although the cross-sectional design precludes causal inference, this association suggests that even when identified through a simple screening tool, mouth breathing

may be linked to classroom inattention and, potentially, broader academic challenges. Longitudinal studies incorporating validated neurocognitive measures and objective respiratory assessments are needed to clarify the direction and magnitude of this relationship.

In summary, our study broadly aligns with the literature regarding the relatively high prevalence of mouth breathing in school-aged children and its potential behavioural implications. At the same time, some associations commonly reported in the medical literature, particularly with allergic and adenotonsillar conditions or specific sleep-related symptoms, were not confirmed in our sample. Rather than contradicting established evidence, these discrepancies likely reflect the methodological boundaries of a questionnaire-based, home test-validated cross-sectional study. The combined limitations of parental reporting and the water retention screening test may have attenuated or obscured some expected associations. Consequently, our findings should be seen as complementary to, rather than dismissive of, standard clinical research. Therefore, early recognition and management of mouth breathing remain important. Our results underscore the importance of early screening within schools, followed by appropriate referral pathways for clinical evaluation. Raising awareness among parents, teachers, and healthcare providers, alongside the use of more robust diagnostic approaches, may facilitate earlier recognition and management of mouth breathing and may reduce the risk of potential long-term consequences for children's health, craniofacial development, and learning outcomes.

### Limitations

This study relied on self-reported data obtained through a questionnaire, which may be subject to recall bias, reporting inaccuracies, and subjective symptom interpretation. Due to school restrictions and limited time, it was not possible to conduct direct clinical examinations to confirm mouth breathing or related findings, potentially reducing the precision of the assessment. Additionally, the home-based water retention test, while practical for large samples, has inherent limitations as a screening tool: it depends on correct execution by children and parents, does not directly assess nasal airway anatomy or function, and may misclassify some individuals. Consequently, the results should be interpreted with caution, particularly when they

diverge from findings based on comprehensive clinical evaluations. Future studies should incorporate objective clinical assessments, standardised diagnostic criteria, and, where feasible, instrumental evaluations of airway patency and sleep-disordered breathing to validate and refine these findings.

## CONCLUSION

This study found a high prevalence of mouth breathing (47.8%) among primary school-aged children in the Ankawa district, Erbil, as determined by the home-based water retention test, which was higher than previously reported local figures. The marked discrepancy between parental reports and test results underscores both the limitations of relying solely on subjective observations and the constraints of a single screening tool administered outside a clinical setting. The higher prevalence observed in public school students compared with their private school counterparts suggests potential environmental or behavioural influences that merit further investigation. Regarding environmental factors, the statistically significant association between reported environmental mould exposure and mouth breathing should be interpreted with caution. The 100% positive rate for mouth breathing among the small subgroup exposed to mould may reflect a localised cluster or issues such as reporting bias or questionnaire misinterpretation, rather than indicating mould as a definitive regional determinant. Larger studies with more detailed environmental assessments are needed before drawing firm conclusions about the broader role of mould exposure in this setting. The observed association between teacher concern about classroom attention and positive screening test results suggests potential academic and behavioural implications of unrecognised and untreated mouth breathing.

Given the lack of significant associations with age, sex or socioeconomic status, mouth breathing in this setting appears to be multifactorial and cannot be adequately explained by common demographic variables alone. These findings support consideration of early school-based screening using simple tools such as the water retention test, followed by confirmatory clinical assessment where indicated, rather than challenging the broader medical literature. Raising awareness among parents, teachers, and healthcare providers is essential to improve recognition and referral. Future research should

integrate comprehensive clinical examinations and standardised home- or school-based screening tools to validate these findings, explore causal pathways, and contribute to improved preventive and management strategies for mouth breathing in children.

## Conflict of Interest

The authors declare no conflicts of interest.

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## REFERENCES

1. Bokov, P., Dahan, J., Boujemla, I., Dudoignon, B., André, C. V., Bennaceur, S., Teissier, N., & Delclaux, C. Prevalence of mouth breathing, with or without nasal obstruction, in children with moderate to severe obstructive sleep apnea. *Sleep Medicine*. 2022; 98, 98–105. <https://doi.org/10.1016/J.SLEEP.2022.06.021>
2. Aparecida De Menezes, V., Leal, R. B., Moura, M. M., Flávia, A., & -Garcia, G. .Influência de fatores socioeconômicos e demográficos no padrão de respiração: um estudo piloto. *Revista Brasileira de Otorrinolaringologia*. 2007; 73(6), 826–834. <https://doi.org/10.1590/S0034-72992007000600014>
3. Lopes, D., Martins, L., Fontes, L., Lima, S. C., Demeda, V. F., Oliveira Da Silva, A. L., Santos De Oliveira, A. R., Melo De Oliveira, F., Beatriz, S., Lima, F., Soraya, V., Sales, F., & Lacerda, D. L. The Mouth Breathing Syndrome: Prevalence, causes, consequences and treatments. A Literature Review. *JOURNAL OF SURGICAL AND CLINICAL RESEARCH*. 2014; 5(1), 47–55. <https://doi.org/10.20398/JSCR.V5I1.5560>
4. Feștilă, D., Ciobotaru, C. D., Suci, T., Olteanu, C. D., & Ghergie, M. Oral Breathing Effects on Malocclusions and Mandibular Posture: Complex Consequences on Dentofacial Development in Pediatric Orthodontics. *Children* 2025; 12(1), 72. <https://doi.org/10.3390/CHILDREN12010072>
5. Macho, V. <https://athenaumpub.com/wp-content/uploads/Mouth-Breathing-and-ItsImplications-for-Dental-Malocclusion-A-Systematic-Review.pdf>. *Journal of Dental Health and Oral Research*. 2024; 1–12. <https://doi.org/10.46889/JDHOR.2024.5206>
6. Chowdhary K, Yadav G, Rai A, Saha S, Dhinsa K, Sharma A. Mouth Breathing Habit and Their Effects on Dentofacial Growth in Children in the Age Range of 6–14 Years: A Cephalometric Study. *Int J Clin Pediatr Dent*. 2024;17(5):545–51. <https://doi.org/10.5005/JIP-JOURNALS-10005-2864>
7. Jefferson Y. Mouth breathing: adverse effects on facial growth, health, academics, and behavior. *Gen Dent*. 2010 Jan-Feb;58(1):18-25; quiz 26-7, 79-80. PMID: 20129889.
8. Romero-Peralta S, Rubio C, Castillo-García M, Resano P, Alonso M, Solano-Pérez E, et al. Obstructive Sleep Apnea in Pediatrics and Adolescent Women: A Systematic Review of Sex-Based Differences Between Girls and Boys. *Children [Internet]*. 2024;11(11):1376. <https://doi.org/10.3390/CHILDREN11111376/S1>

9. Predescu IA, Kis AM, Pitic DE, Dinu S, Pacurar M, Bud E, et al. Mouth Breathing Syndrom-An Interdisciplinary Approach. *Romanian Journal of Oral Rehabilitation*. 2024;16(4):385–401. <https://doi.org/10.62610/RJOR.2024.4.16.38>
10. Emslie Rd, Massler M, Zwemer Jd. Mouth Breathing: I. Etiology and Effects (a Review). *The Journal of the American Dental Association*. 1952; 44(5):506–21. <https://doi.org/10.14219/JADA.ARCHIVE.1952.0099>
11. Mahdi Alawsi HR, Hassan BA, Jamil Al-Talabani SZ. Prevalence of Parafunctional Habits among Preschool Children and its Correlation to Parental Education Status. *Polytechnic Journal*. 2021;11(1):9. <https://doi.org/10.25156/ptj.v11n1y2021.pp42-45>
12. Paolantonio, E. G., Ludovici, N., Saccomanno, S., La Torre, G., & Grippaudo, C. Association between oral habits, mouth breathing and malocclusion in Italian preschoolers. *European Journal of Paediatric Dentistry*. 2019; 20(3), 204–8. <https://doi.org/10.23804/EJPD.2019.20.03.07>,
13. Pacheco MCT, Casagrande CF, Teixeira LP, Finck NS, de Araújo MTM: Guidelines proposal for clinical recognition of mouth breathing children. *Dental Press J Orthod*. 2015: 31:39.
14. Wasnik M, Kulkarni S, Gahlod N, Khekade S, Bhattad D, Shukla H. Mouth breathing habit: a review. *Int J Community Med Public Health*. 2020;8(1):495. <https://doi.org/10.18203/2394-6040.IJCMPh20205742>
15. Abdelghany AM, Elsamanody AN. A simple home test to differentiate habitual from pathological mouth breathing. *Int J Pediatr Otorhinolaryngol*. 2023 Nov 1;174. <https://doi.org/10.1016/J.IJPORL.2023.111719>
16. Zaghi S, Peterson C, Shamtoob S, Fung B, Kwok-keung Ng D, Jagomagi T, et al. Assessment of Nasal Breathing Using Lip Taping: A Simple and Effective Screening Tool. *Int J Otorhinolaryngol*. 2020;6(1):10. <https://doi.org/10.11648/J.IJO.20200601.13>
17. Ribeiro GCA, dos Santos ID, Santos ACN, Paranhos LR, César CPHAR. Influence of the breathing pattern on the learning process: a systematic review of literature. *Braz J Otorhinolaryngol*. 2016; 82(4):466–78. <https://doi.org/10.1016/J.BJORL.2015.08.026>
18. Inada E, Saitoh I, Kaihara Y, Yamasaki Y. Factors related to mouth-breathing syndrome and the influence of an incompetent lip seal on facial soft tissue form in children. *Pediatric Dental Journal*. 2021;31(1):1–10. <https://doi.org/10.1016/J.PDJ.2020.10.002>
19. De Menezes VA, Leal RB, Moura MM, Granville-Garcia AF. Influence of socio-economic and demographic factors in determining breathing patterns: a pilot study. *Braz J Otorhinolaryngol*. 2007;73(6):826–34. [https://doi.org/10.1016/S1808-8694\(15\)31179-4](https://doi.org/10.1016/S1808-8694(15)31179-4)
20. Soares ME da C, Ramos-Jorge J, Lima LJS, Moreira LV, Fernandes IB, Ramos-Jorge ML, et al. Mouth breathing is associated with a higher prevalence of anterior dental caries in preschool children. *Braz Oral Res*. 2024;38:e057. <https://doi.org/10.1590/1807-3107BOR-2024.VOL38.0057>
21. Felcar JM, Bueno IR, Massan ACS, Torezan RP, Cardoso JR. [Prevalence of mouth breathing in children from an elementary school]. *Ciencia & Saude Coletiva*. 2010;15(2):437–44. <https://doi.org/10.1590/S1413-81232010000200020>
22. De Menezes VA, Leal RB, Pessoa RS, Pontes RMES. Prevalence and factors related to mouth breathing in school children at the Santo Amaro project-Recife, 2005. *Brazilian Journal of Otorhinolaryngology (English Edition) [Internet]*. 2006;72(3):394–8. [https://doi.org/10.1016/S1808-8694\(15\)30975-7](https://doi.org/10.1016/S1808-8694(15)30975-7)
23. Abreu RR, Rocha RL, Lamounier JA, Francisca Â, Guerra M. Prevalence of mouth breathing among children. *J Pediatr (Rio J)*. 2008; 84(5):467–70. <https://doi.org/10.2223/JPED.1806>
24. Fujimoto S, Yamaguchi K, Gunjigake K. Clinical estimation of mouth breathing. *American Journal of Orthodontics and Dentofacial Orthopedics*. 2009 Nov 1;136(5):630.e1-630.e7. <https://doi.org/10.1016/J.AJODO.2009.03.034>
25. Izu SC, Itamoto CH, Pradella-Hallinan M, Pizarro GU, Tufik S, Pignatari S, et al. Obstructive sleep apnea syndrome (OSAS) in mouth breathing children. *Brazilian Journal of Otorhinolaryngology (English Edition)*. 2010; 76(5):552–6. <https://doi.org/10.1590/S1808-86942010000500003>
26. Jung JY, Kang CK. Investigation on the effect of oral breathing on cognitive activity using functional brain imaging. *Healthcare (Switzerland)*. 2021; 9(6):645. <https://doi.org/10.3390/HEALTHCARE9060645/S1>

**Appendix (questionnaire)**

**Table 4.** Parent Questionnaire: Mouth Breathing and Child Health in Ankawa District

Section	Question	Options/Response
1. Demographic Information	Child's age	Tick the option
	Sex	<input type="checkbox"/> Male <input type="checkbox"/> Female
	School's Name	<input type="checkbox"/> 1. Ankawa local primary school <input type="checkbox"/> 2. Private Meltho International School <input type="checkbox"/> 3. Private Marqardakh International School <input type="checkbox"/> 4. Private Maryamana Primary School <input type="checkbox"/> 5. Shlama local school <input type="checkbox"/> 6. Al-Bishara private school <input type="checkbox"/> 7. Yazdandokht Primary School <input type="checkbox"/> 8. Hidyab local school
	Grade level	<input type="checkbox"/> 1. Grade 4 <input type="checkbox"/> 2. Grade 6
	Household Income	<input type="checkbox"/> 1. Enough for daily needs <input type="checkbox"/> 2. Not enough for daily needs <input type="checkbox"/> 3. Exceeds daily needs
2. Health History	Known allergies	<input type="checkbox"/> Yes <input type="checkbox"/> No
	Asthma	<input type="checkbox"/> Yes <input type="checkbox"/> No
	Chronic Rhinitis	<input type="checkbox"/> Yes <input type="checkbox"/> No
	Sinusitis	<input type="checkbox"/> Yes <input type="checkbox"/> No
	Frequent colds or respiratory infections	<input type="checkbox"/> Yes <input type="checkbox"/> No
	Enlarged tonsils or adenoids	<input type="checkbox"/> Yes <input type="checkbox"/> No
	Other respiratory conditions (specify)	_____
	Breathing problems during sleep	<input type="checkbox"/> Yes <input type="checkbox"/> No
	Frequent snoring	<input type="checkbox"/> Yes <input type="checkbox"/> No

Section	Question	Options/Response
3. Environmental Factors	Smoking exposure at home	<input type="checkbox"/> Yes <input type="checkbox"/> No
	Pollen (seasonal allergies)	<input type="checkbox"/> Yes <input type="checkbox"/> No
	Mould	<input type="checkbox"/> Yes <input type="checkbox"/> No
	Pet dander	<input type="checkbox"/> Yes <input type="checkbox"/> No
	Other allergens (specify)	_____
4. Oral and Behavioral Habits	Mouth breathing during the day	<input type="checkbox"/> Yes <input type="checkbox"/> No
	Mouth breathing while sleeping	<input type="checkbox"/> Yes <input type="checkbox"/> No
	Drooling/mouth open while resting/asleep	<input type="checkbox"/> Yes <input type="checkbox"/> No
	Dry mouth or chapped lips	<input type="checkbox"/> Yes <input type="checkbox"/> No
5. Medical and Dental History	Deviated nasal septum / nasal obstruction	<input type="checkbox"/> Yes <input type="checkbox"/> No
	Surgeries (e.g., adenoidectomy, tonsillectomy)	<input type="checkbox"/> Yes <input type="checkbox"/> No — If yes, specify: _____
	Orthodontist consultation	<input type="checkbox"/> Yes <input type="checkbox"/> No
6. Impact on Daily School Life	Difficulty concentrating / performing in school	<input type="checkbox"/> Yes <input type="checkbox"/> No—If yes, describe: _____
	Teacher concerns about behavior/attention	<input type="checkbox"/> Yes <input type="checkbox"/> No
7. Parent's Observation	Changes in facial appearance	<input type="checkbox"/> Yes <input type="checkbox"/> No
	Steps taken to address mouth breathing	<input type="checkbox"/> Yes <input type="checkbox"/> No
	Additional information	_____ _____
Informed Consent	By completing this questionnaire, you consent to participation.	Parent signature: _____ Date: _____