


Relationship Between Halitosis and Mouth Breathing Among Pediatric Population: Exploring the Contributing Factors

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Purpose: In the pediatric population, mouth breathing can cause obstruction, congestion and other upper-respiratory tract diseases. The aim of this study is to assess the relationship between halitosis and mouth breathing in the pediatric population.

Methods: A cross-sectional study was carried out from February to April 2023. It included 232 children aged between 2–6 years from specialized clinics of pediatric dentistry in Saudi Arabia. The study sample was categorized in two groups such as nasal and mouth breathers. Breathing patterns were identified using clinical examination, mirror testing and water-in-mouth test under the supervision of an otolaryngologist. Breath Alert™ device and Halimeter were used for the assessment of Halitosis. Data were analyzed using Chi-square and binary logistic regression, as effect size measures, with p-values (<0.05) considered as statistically significant.

Results: Out of 232 participants, 115 were males (49.6%) and 117 (50.4%) were females. In terms of breathing patterns, 111 (47.8%) individuals were classified as mouth breathers, whereas 121 (52.2%) primarily used nasal breathing. Findings revealed no significant relationship between gender and breathing pattern ($p = 0.191$) nor between gender and halitosis in mouth breathers ($\chi^2 = 0.035$, $p = 0.852$) or nasal breathers ($\chi^2 = 0.001$, $p = 0.972$). However, breathing patterns and halitosis were found to be significantly related ($\chi^2 = 10.466$, $p = 0.001$). The results showed that ($n = 62$) 59.6% of the participants who were mouth breathers experienced halitosis, in contrast to ($n = 42$) 40.4% of nasal breathers. Further, the effect size confirmed that mouth breathers were more likely to experience halitosis than nasal breathers (OR = 2.37, 95% CI: 1.395–4.039, $p = 0.001$).

Conclusion: Mouth breathers are more prone to develop halitosis as compared to the nasal breathers.

Keywords: halitosis, mouth breathing, pediatric, nasal breathers, gender, oral health

Introduction

Mouth breathing (inhaling and exhaling via mouth) occurs in an estimated 5% to 75% of the pediatric population.¹ Increased frequency of mouth breathing can lead to several issues in children. For example, the air does not get filtered or warmed when air is inhaled via mouth. It bypasses the paranasal sinuses and nasal passages, unlike nasal breathing. Previous research has demonstrated a significant association between mouth breathing and conditions like obstruction, congestion and other upper-respiratory tract diseases in the pediatric population.^{2–5} Halitosis is a condition characterized by unpleasant breathing that affects not only the individual but also those around them during social interactions.⁶ It is commonly noted that patients often report halitosis following dental caries or periodontal disease.⁷

Halitosis can be categorized into two types: primary halitosis originating from exhalation through the lungs and secondary halitosis arising from exhalation through the mouth or upper airways. This condition arises when volatile sulfur compounds are produced, which are generated by the breakdown of epithelial cell debris located on the surface of the tongue. Mucin precipitation promotes this breakdown, leading to water imbalance, decreased saliva production, increased alkalinity, and microbial activity. This environment encourages proteolytic bacteria's growth that yields volatile

sulfur compounds. The primary sulfur-containing compounds are responsible for halitosis, which includes methyl mercaptan, hydrogen sulfide, and dimethyl sulfide.^{7,8}

Halitosis or oral malodor is a widespread oral health problem and is known to cause notable psychological and social impact. Studies have reported the negative impact of oral malodor on the overall well-being and self-esteem. This results in reduced social interaction thus, impacting the Quality of life of the individuals.^{8,9} Additionally, Alharbi et al⁹ indicated that factors like active periodontal disease, dry mouth, and tongue coating contribute to an increased occurrence of halitosis. Researchers faced difficulty in estimating the halitosis's prevalence in pediatric population with most of the children being unaware of their foul-smelling breath. Earlier research regarding the prevalence of halitosis has been inconsistent due to differences in data collection and study methods.^{10,11} Several studies have directly examined the relationship between breathing mode and halitosis in pediatric populations. One of the studies reported a 37.6% prevalence of halitosis among the pediatric population with a mean age of 12 years.¹² In the general population, halitosis is considered as an underestimated oral problem because majority of the affected individuals are either not aware of the condition or feel embarrassed in discussing their situation with others.⁷

Likewise, a study conducted by Villa et al¹² found that poor oral hygiene contributes to development of halitosis among pediatric population. It also indicated that halitosis is more prevalent among females and older children. The main cause that leads to halitosis is related to the conditions of the oral cavity, however, there might be other underlying pathological or physiological causes.¹³ Another study by Alqutami et al¹⁴ investigated the effect of gingival health status, halitosis and mouth breathing on dental caries in children. The findings denoted that mouth breathing did not affect the occurrence of dental caries or gingivitis after examining the lower left and upper right central incisors. In contrast, mouth breathers exhibited increased prevalence of halitosis in comparison to nasal breathers. The study also pointed out that mouth breathing was more common among males than females.

Some of the essential roles are performed by saliva, such as antimicrobial action, protection of oral tissues, taste potentiation, and carbon removal.¹⁵ Saliva is composed of 98% of water and plays a vital role in reducing bad breath because it renders protein utilized by the bacteria. Saliva also supplies oxygen to bacteria. A reduced amount of saliva leads to a negative impact on the mouth's self-cleaning ability, which ultimately leads to the production of odoriferous volatile compounds.¹⁶ Various clinical conditions alter salivary patterns. For instance, transitioning to mouth breathing from nasal breathing leads to adaptive modifications in dental arches and surrounding tissues. One of these adaptive changes is the surface drying and anatomic alteration of the mucosal palate.

It has been suggested that halitosis is significantly related to surface drying of mucosa in the pediatric population, which is a common complaint of individuals who breathe through the mouth. The individuals also suffer from facial rictus while swallowing, audible breathing, hypernasality, enlarged nostrils, hypotonic lower lips, protrusion of anterior teeth, restless sleep, reduced hearing capability, and drooping shoulders.⁸ The enzyme activation that accelerates the decomposition of amino acids is hindered when the salivary pH becomes slightly acidic (pH < 6.5). This suppresses the proliferation and growth of anaerobic and gram-negative bacteria. Insufficient putrefaction of amino acids results in bad breath since they contain Sulphur in reduced form.¹⁷

Mouth breathing may contribute to alteration in teeth positioning and dental arches due to the adjustment of the entire facial musculature, resulting in structural alteration in face, tongue, mandibles, lips, and palate. It happens because all these structures try to adapt to the new breathing patterns. The study by Motta et al⁸ examined the relationship between halitosis and mouth breathing in the pediatric population and found a significant correlation between them. Despite these established findings, limited research has explored this association in preschoolers aged 2–6 years, as most of the studies have focused on adults and older children. This age group is of considerable importance due to active craniofacial development, changing breathing patterns and limited awareness of oral health. Therefore, the aim of the current study is to investigate the relationship between halitosis and mouth breathing in children aged 2–6 years. Understanding this relationship at an initial developmental stage (2–6 years) is important as early detection and intervention approaches can help to protect oral health and guide healthcare providers. Through exploration of potential risk factors, particularly in this age group, the study contributes to the development of early measures to improve oral care in pediatric population.

Materials and Methods

Study Design

A cross-sectional study design was employed to determine the relation of halitosis with breathing patterns among the pediatric population. The study was conducted for three months from February to April 2023.

Study Population and Setting

The study population included children registered in the specialized clinics of pediatric dentistry for restorative treatments. The participants were Saudi and non-Saudi children aged between 2–6 years. The inclusion criteria included participants without any respiratory illnesses or health conditions with an informed parental consent. Patients with serious health conditions such as severe asthmatic patients or patients with other respiratory diseases were excluded from the study.

The sample size was determined using OpenEpi (Version 3, SSPropor calculator). Based on a prevalence of 10.1% for mouth breathers reported by Alqutami et al,¹⁴ a minimum sample size of 140 was calculated at a confidence level of 95%. However, the study included a total of 232 children to strengthen its reliability.

Ethical Review Statement

The study received approval from the Taibah University, College of Dentistry Research Ethics Committee Study Reference Number: TUCDREC/2008202/Sbahammam and was conducted in accordance with the principles of Declaration of Helsinki. A written consent form was given to the parents of the participants before the commencement of the study. Also, the study's aim and focus were explained clearly to the participants and their parents.

Sampling Method

Participants were recruited through a convenience sampling technique. They were categorized into two groups on the basis of their breathing patterns namely: nasal breathers and mouth breathers to evaluate the prevalence of halitosis.

Breathing Pattern Assessment

Clinical assessments and specific tests (mirror test and water-in-mouth test) were conducted to identify the breathing patterns of the participating children. Clinical evaluation was based on the absence and presence of the following variables: dropping eyes, dry lips, inverted lower lip, high arched palate, anterior open bite, long face, thin upper lip, hypotonic lips, narrow nostrils, and inadequate lip seal. On the other hand, the mirror test was conducted by positioning a two-sided mirror beneath the nostrils to observe vapour formation on mirror's upper and lower part to detect mouth and nasal breathing, respectively. Similarly, each child was asked to hold water in the mouth with closed lips for three minutes without swallowing while performing the water-in-mouth test. Parental assistance was provided to younger children who might encounter difficulty in performing this test. All these tests were performed under the supervision of an otolaryngologist, which increases the validity of the data collected through clinical evaluation. The signs of effort were observed concerning the lip commissure. Children showing an inability to hold closed lips for three minutes were considered mouth breathers.¹⁸

Study Variables and Halitosis Assessment

Halitosis was considered as the dependent variable and was categorized as present or absent on the basis of objective measurements. The primary independent variable was breathing pattern (nasal/mouth) which was evaluated as a potential risk factor for halitosis along with other contributing factors such as gender.

Oral heliometry was performed using a portable Breath Alertt™ device (Tanita Corporation, Japan) and Halimeter (Interscan Corporation, Chatsworth, CA, USA) to quantify halitus and differentiate various sources of odor. The Breath-Alertt device has showed a sensitivity of 80.76% and specificity of 98.38% for diagnosing halitosis, when compared with the organoleptic test, which is considered as the gold standard.¹⁹ Manufacturer's instructions were followed when using the portable sulfite monitor. The instructions included resetting the device by shaking it for 4 to 5 minutes to eliminate the

residual odors. Afterwards, the LCD button was pressed twice, and the participant was asked to blow the air. A similar procedure has been reported by Motta et al.⁸ The breath odor was rated on a scale from 1 to 4 according to the number appearing after the third beep. The different breathing levels are stated below:

1. No odor (considered normal)
2. Mild odor (considered normal)
3. Moderate odor (considered bad breath)
4. Strong odor (considered bad breath)

The procedure was repeated if no reading appeared after the third beep.

Data Analysis

Data was analysed using the Statistical Package for Social Sciences (SPSS) version 22.0. Descriptive statistical analysis was conducted for each group, while comparisons between the nasal and mouth breathing groups were made using the chi-square test. A significance level of 5% and a 95% confidence interval were established. Additionally, binary logistic regression analysis was employed to predict the likelihood of halitosis based on breathing patterns and gender.

Results

The study demographics are presented in [Table 1](#). According to [Table 1](#) the sample consisted of 115 (49.6%) males and 117 (50.4%) females. When examined for their breathing pattern, 121 (52.2%) of the participants were pre-dominantly nose breathers, whereas 111 (47.8%) had mouth breathing patterns. Further, the occurrence of halitosis was seen in 104 (44.8%) participants, while 128 (55.2%) participants showed no symptoms of Halitosis.

Regarding the evaluation of halitosis, the severity was assessed using the four-point organoleptic scale as displayed in [Figure 1](#). Results revealed that 71 (30.6%) of the children had a score of 1 (no odor), 57 (24.6%) had a score of 2 (mild odor), 56 (24.1%) had a score of 3 (moderate odor), whereas 48 (20.7%) children had a score of 4 (strong odor).

Likewise, [Table 2](#) showed the association between gender and breathing pattern. Findings demonstrated that 45.9% females were mouth breathers and 54.5% females breathed from nose. Among males, 54.1% were mouth breathers and 45.5% were nasal breathers. Results exhibited no significant association between gender and breathing pattern ($\chi^2 = 1.713$, $p = 0.191$).

Similarly, [Table 3](#) explored the influence of gender on the presence of Halitosis among the participants. Results reported no significant association between gender and halitosis ($\chi^2 = 0.146$, $p = 0.702$) neither in mouth breathers nor in nose breathers.

Furthermore, the relation between breathing pattern and halitosis was investigated in [Table 4](#). Upon analysis, the findings showed that among mouth breathers, 59.6% of the participants reported the occurrence of halitosis whereas the remaining 38.3% exhibited no signs of it. Conversely, 40.4% of the nasal breathers exhibited halitosis and 61.7% of the

Table 1 Demographic Characteristics

Demographic Characteristics		n (%)
Gender	Female	117 (50.4%)
	Male	115 (49.6%)
Breath	Mouth	111 (47.8%)
	Nasal	121 (52.2%)
Halitosis	No	128 (55.2%)
	Yes	104 (44.8%)

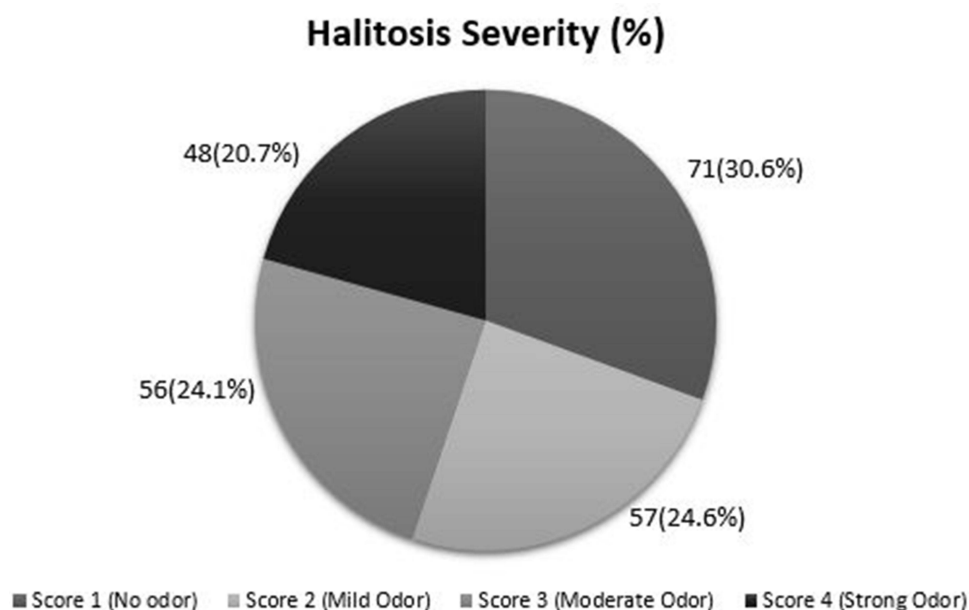


Figure 1 Overall Halitosis severity among Study Participants (N = 232).

participants demonstrated normal breath. Results indicated a statistically significant association between breathing pattern and the presence of halitosis ($\chi^2 = 10.466$, $p = 0.001$).

A logistic regression analysis was conducted to evaluate the impact of gender and breathing patterns on the likelihood of participants having halitosis. The regression model was statistically significant, $\chi^2 = 10.548$, $df = (2)$, $p = 0.005$ as illustrated in [Table 5](#). This model accounted for 5.9% of the variance in halitosis (Nagelkerke R^2) and accurately classified 60.8% of the cases. The analysis demonstrated that mouth breathers were more likely to contract halitosis than

Table 2 Association Between Gender and Breathing Pattern

Gender	Mouth Breathers n (%)	Nasal Breathers n (%)	Total n (%)	χ^2	p-value
Female	51 (45.9)	66 (54.5)	117 (50.4)	1.713	0.191
Male	60 (54.1)	55 (45.5)	115 (49.6)		
Total	111 (100.0)	121 (100.0)	232 (100.0)		

Table 3 Association Between Gender and Halitosis Among Study Participants (N = 232)

Gender	Halitosis		Total n (%)	χ^2	p-value
	No n (%)	Yes n (%)			
Female	66 (51.6)	51 (49.0)	117 (50.4)	0.146	0.702
Male	62 (48.4)	53 (51.0)	115 (49.6)		
Total	128 (100.0)	104 (100.0)	232 (100.0)		

Table 4 Association Between Breathing Pattern and Halitosis Among Study Participants (N = 232)

Breathing Pattern	Halitosis		Total n (%)	χ^2	p-value
	No n (%)	Yes n (%)			
Mouth breathers	49 (38.3)	62 (59.6)	111 (47.8)	10.466	0.001
Nasal breathers	79 (61.7)	42 (40.4)	121 (52.2)		
Total	128 (100.0)	104 (100.0)	232 (100.0)		

Table 5 Binary Logistic Regression Analysis of Factors Associated with Halitosis

Patient Characteristics	B	df	Sig.	OR	95% CI for OR (Lower–Upper)
Breathing pattern					
Mouth breathers	0.865	1	0.001	2.374	1.395–4.039
Nasal breathers	1 (Reference)				
Gender					
Female	−0.029	1	0.915	0.971	0.571–1.653
Male*	1 (Reference)				
Constant	−0.616	1	0.011	0.540	–

Notes: *Indicates reference group. Omnibus χ^2 (df = 2) = 10.548, p = 0.005, Nagelkerke R^2 = 0.059, Hosmer–Lemeshow χ^2 = 0.025, p = 0.988, Overall correct classification = 60.8%.

nasal breathers (OR = 2.37, p = 0.001). This denotes that mouth breathers were 2.37 times more likely to experience halitosis than nasal breathers. Also, gender was not significantly associated with the occurrence of halitosis (p = 0.915).

Discussion

The present study examined the relationship between halitosis and mouth breathing among the pediatric population along with exploring the additional factor of gender in its prevalence. Results reported that breathing pattern was not associated with gender, representing an equal distribution of breathing pattern regardless of the gender. Likewise, no significant relationship was observed between gender and halitosis which suggests that halitosis is equally prevalent in both males and females. Moreover, the study revealed a significant association between breathing patterns and halitosis, which denotes that mouth breathers tend to have higher risk of halitosis as compared to nose breathers. Logistic regression confirmed that mouth breathers exhibited a twofold increase in the likelihood of halitosis than nasal breathers.

De Menezes et al²⁰ posited that age and socioeconomic factors have no relationship with breathing patterns, but males were more prone to oral breathing. These findings are contrary to our study as no correlation was found between breathing patterns and gender. Similarly, the study conducted by Villa et al¹² assessed the likelihood of halitosis among the pediatric population and found that females were more prone to it. The findings of our study are consistent with previous research which showed that children who breathed from mouth tend to have bad breath. These findings are supported by the study of Motta et al⁸ which identified that the occurrence of halitosis is significantly greater in mouth breathers as they exhibited moderate to strong odor on the scale in comparison to the nasal breathers.

The association between halitosis and mouth breathing has been reported in various studies conducted on children. There was an increased prevalence of halitosis in mouth breathers than in nasal breathers.⁸ This point towards the significant role of oral airflow which contributes to the development of halitosis. However, these two studies were performed among children older than six. Moreover, Motta et al⁸ explains the physiology of the process for having

halitosis in mouth breathers as the mouth remains open during breathing which causes evaporation of saliva thus leading to oral dryness which results in halitosis development. Simultaneously, Pedersen et al¹⁶ reported that saliva plays an important role in reducing bad odor because it renders protein that is used by the bacteria. Reduced amount of saliva has negative impact on the self-cleaning ability of the mouth that ultimately leads to the production of odoriferous volatile compounds. These findings align with the results of our study which determines that halitosis is significantly influenced by breathing pattern with no significant association observed for gender.

Interestingly, this study did not identify age as a significant factor which aligns with previous studies that found no relation of age between halitosis and mouth breathers.^{14,20} According to Nadanovsky et al²¹ and Samnieng et al,²² age does not impact the presence of halitosis in individuals who are mouth breathers. Furthermore, Nadanovsky et al²¹ found males at higher risk of having persistent oral malodor than females. Contrastingly, Ademovski,²³ in his dissertation, showed significant differences between age and halitosis. These findings may be attributed due to differences in study population, assessment methods and age groups considered.

The study demonstrated notable strengths which include the use of objective halitosis assessment tools and the evaluations were conducted under the direct supervision of an otolaryngologist. Moreover, the large sample size and randomization enabled meaningful evaluation of the relation between halitosis and mouth breathing. Despite the strengths, there are several limitations that need to be addressed. The study did not consider other confounders for analysis such as socioeconomic status and scoring criteria to assess the oral health of patients. Participants were selected from dental clinics in a single region which limits the generalizability of the findings. Also, the study followed a cross-sectional design which misses out on the cause and effect relationship.

Future studies should focus on longitudinal designs to determine the impact of nasal breathing restoring treatments in reducing halitosis. Studies should include additional factors like oral hygiene, tongue coating and sleep related issues. Large and more diverse groups will help to strengthen the findings and explore the impact of environmental and cultural factors. The use of objective tools with questionnaires from parents and children will help in understanding the clinical setting for comprehensive evaluation.

Conclusion

The study findings lead to the conclusion that mouth breathers have higher chances of getting halitosis than nasal breathers in children aged 2 to 6 years. Similarly, there is no role of gender in the outcome of the breathing pattern. Also, gender does not impact the prevalence of halitosis among pediatric children. These results emphasize the need for pediatricians and clinicians to screen breathing patterns when assessing pediatric halitosis. It is recommended to further examine this age group to find an association between the socio-economic status of the parents, oral hygiene and respiratory illnesses with the outcome of halitosis. This will help in building further understanding of the factors leading to halitosis in children aged less than 6 years.

Abbreviations

IRB, Institutional Review Board; SPSS, Statistical Package for the Social Sciences; CI, Confidence Interval; Df, Degrees of Freedom; X^2 , Chi-Square; p, Probability Value; R^2 , Coefficient of Determination (Nagelkerke R^2); TM, Trademark; USA, United States of America.

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Disclosure

The author reports no conflicts of interest in this work.

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