

# **Influence of mouth breathing on oral health in children: A population-based cross-sectional study in Nagpur city**

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## ***Abstract***

### ***Background/purpose***

*Previous studies have suggested that mouth breathing has harmful effects on oral health in children, but the evidence has been insufficient. To investigate the association of mouth breathing with oral health in school children aged 8–11 years from Nagpur city, India*

### ***Materials and methods***

*Cross-sectional data were obtained from March to April 2019. A questionnaire was used to investigate children's mouth breathing habits and personal/family histories related to allergic disease. Oral health status was determined through a clinical oral examination. Data were analyzed with multivariable logistic regression.*

### ***Results***

*In total, 1007 children were included. We observed no association between mouth breathing and dental caries in children. However mouth breathing was associated with child's tonsillitis and was identified as a possible risk factor for class II dental malocclusion.*

### ***Conclusion***

*We confirmed the positive association between mouth breathing (especially during sleep) and dental class II malocclusion. However the influence of mouth breathing on dental caries*

*remains uncertain. An intervention trial is required to evaluate whether the prevention of mouth breathing can reduce the risk of dental problems.*

**Keywords:** *Allergic rhinitis, Asthma, Atopic dermatitis, Dental caries, Mouth breathing*

## **Introduction**

Mouth Breathing can be considered a consequence of being unable to perform nasal breathing. However, if oral breath continues, complex problems can arise. Especially in animal experiments, such as those involving rat models, forced mouth breathing has been found to affect respiratory function.<sup>8</sup> Human infants are sometimes considered obligate nasal breathers,<sup>[1]</sup> but healthy humans can generally perform mouth breathing and nasal breathing simultaneously during functional activities such as eating, exercising, and blowing into an instrument.

Oral and nasal breathing have different quantitative and qualitative effects on the respiratory system.<sup>[2,3,4]</sup> If mouth breathing becomes chronic, the saliva will evaporate due to the change in humidity in the oral cavity. Thus, the saliva will not be able to maintain the homeostatic function of filtering foreign substances and controlling the humidity, temperature, and pH.<sup>[5,6]</sup>

In the mouth, saliva is essential for immune defense, food digestion and lubrication, taste, and remineralization of the teeth. In particular, antimicrobial agents such as secretory IgA and lysozyme are essential for protection. Furthermore, saliva is supersaturated by several ions that maintain the pH in the oral cavity between 6.2 and 7.4, which is vital for the prevention of dental caries. Patients with significantly reduced saliva due to Sjogren's syndrome or xerostomia are susceptible to infection due to changes in homeostasis and become vulnerable to allergic diseases and dental diseases such as dental caries and periodontitis.<sup>[6,7]</sup>

There is paucity in literature detailing the effect of mouth breathing on oral health of children . Therefore, we investigated the association of mouth breathing with oral health among schoolchildren. To the best of our knowledge, this is the first study to evaluate the effects of mouth breathing on the oral health in schoolchildren aged 8–11 years from Nagpur city

## **Material and methods**

### **Study approval**

This study was approved by the Swargiya Dadasaheb Kalmegh Smruti Dental College & Hospital Institutional Review Board .Informed consent was obtained from parents (or guardians), and permission was obtained from the children. Written consent forms were obtained for the same. The study design conformed to the Helsinki Declaration of Human Rights for human observation studies.

### **Study population, data collection, and examiner training and calibration**

Four elementary schools in Nagpur city were randomly selected and visited from March to April 2019. Questionnaires and oral examinations were conducted for 1031 elementary school students aged 8–11 years. Oral examinations were carried out by two trained team members (one dentist and one recorder). The questionnaire was distributed to each child's parents one week before the oral examination and was collected after the oral exam. The survey was completed by the parents

based on their observations of the child's condition. The questionnaire was only sent if the parents agreed that it could be used as part of a clinical study.

## Outcome measures

### Questionnaire items

- A questionnaire was used to investigate the children's mouth breathing habits, personal and family histories and basic information. The survey included three questions each to evaluate mouth breathing in the daytime (MBD) and mouth breathing during sleep (MBS). The inquiries related to MBD and MBS were given in Figure 1: The questionnaire item was modified through the methods described by Yamaguchi et al. (17). The MBD and MBS scores were the sum of three items, each with a minimum score of 3 and a maximum score of 11. The TMB score was defined as the sum of the MBD and MBS scores.

- Q.1 Does the child breathe through his mouth?
- Q.2 Is the child's mouth ordinarily open?
- Q.3 Does the child open his mouth when chewing?

#### **The questions related to MBS were as follows:**

- Q.1 Does the child snore?
- Q.2 Does the child open his mouth?
- Q.3 Is the child's mouth dry in the morning?

**Figure 1.MBD and MBS questionnaire**

### Oral examination items

All examinations were performed by two trained examiners (one dentist and one recorder). The examiner used a mirror and an air syringe under a light source, with an average time of one minute per exam. Three categories of oral examination items were used in this study: the caries experience index of deciduous teeth (dft) and permanent teeth (DMFT), Mallampati and Brodsky classifications, and the malocclusion index (MI).

To investigate the prevalence of dental caries, the dentist evaluated the dft and DMFT in terms of the decayed, missing, and filling status of each tooth. The dental caries index (DI) was defined as the sum of the dft and DMFT indices.

Mallampati classification (grades 1 to 4) and Brodsky classification (grades 1 to 5) were used to evaluate the size of the tongue and the palatine tonsil, respectively. These were assessed while the children were seated in a chair without phonation, with the tongue being maximally exposed, and were measured twice for reliability.

The tonsil size index (TSI) was defined as the sum of the Brodsky and Mallampati classifications. The MI was defined as the sum of the values of the occlusal relationship of the

first permanent molars, overjet of central incisors and overbite of incisors, midline deviation of permanent incisors, and presence of lip competency at rest. Occlusion was evaluated in the state of the centric occlusion. If the first molar or permanent incisors were missing or had not erupted, the subject was excluded from the survey. The overjet and overbite of incisors were classified into three categories (<0, 0–4, >4 mm) using Vernier calipers. The occlusal relationship of both first permanent molars was assessed by angle classification (class I/II/III). Midline deviation (yes, >1 mm) and lip competency were scored as binary parameters (1 = no, 0 = yes).

### Data analysis

The results from the questionnaires and oral examinations were analyzed with SAS (version 9.3, SAS Inc., Cary, NC, USA). Pearson's  $\chi^2$  test was used to investigate the relationships of the mouth breathing indices with continuous variables such as age, sex, BMI, and oral examination indices. An independent two-sample t-test was performed to compare the mean values of the mouth breathing indices with categorical variables, including personal and family histories. We also conducted a multivariable logistic regression analysis to determine the factors affecting each child's history as dependent variables. The stepwise selection was used by analyzing the factors affecting the history of the child, with correcting only the significant factors to determine the influence of mouth breathing. Bonferroni correction was used for posthoc analysis. All statistical analyses were performed with a *p*-value of 0.05.

### Results

The questionnaires were distributed to 1031 elementary school children aged 8–11 years, and 1007 surveys were collected, for a response rate of 92.3%. We excluded 24 questionnaires that were missing basic information such as height and weight. Thus, we included a total of 1007 questionnaires in this study.

The male to female ratio was 1:0.94. There were no significant differences in the mouth breathing indices according to age and BMI, but a significant difference according to gender was observed ( $p < 0.05$ ). We observed allergic rhinitis (47.5%) was the most common child's respiratory disease, followed by nasal congestion (32.7%) and otitis media (26.1%). Personal histories of all diseases except otitis media were significantly associated with TMB ( $p < 0.05$ ) and MBS ( $p < 0.05$ ), whereas only allergic rhinitis, AD, sinusitis, and otitis media were associated with MBD ( $p < 0.05$ ).

Allergic rhinitis, sinusitis, tonsillitis, and nasal congestion were associated with the most statistically significant differences in MBS ( $p < 0.001$ ). Regarding family history, allergic rhinitis, sinusitis, and nasal obstruction were associated with TMB ( $p < 0.05$ ) and MBS ( $p < 0.05$ ), while only tonsillitis was associated with MBD ( $p < 0.05$ ). In terms of the oral examination, only overjet and Brodsky classification were significantly associated with MBS ( $p < 0.01$ ).

When the relationships between MBD, MBS, and TMB scores were analyzed, statistically significant correlations were observed between each pair of variables ( $p < 0.001$ ) (Table 1). MBD and MBS exhibited a moderate correlation, with a correlation coefficient of  $r = 0.42$ .

**Table 1. Associations between MBD, MBS, and TMBI.**

	Mean $\pm$ SD	MBD		MBS		TMB	
		Pearson r	P value	Pearson r	P value	Pearson r	P value
<b>MBD</b>	5.01 $\pm$ 1.03			0.46	0.001	0.94	0.001
<b>MBS</b>	5.28 $\pm$ 1.66					0.86	0.001
<b>TMB</b>	10.89 $\pm$ 2.74						

*p* values were calculated using Pearson's  $\chi^2$  test. MBD: mouth breathing index in the daytime, MBS: mouth breathing index during sleep, TMBI: total mouth breathing index. \* $p < 0.05$ , \*\* $p < 0.01$ , \*\*\* $p < 0.001$ .

We did multivariable linear regression to identify factors influencing each child's mouth breathing pattern (the dependent variable) and observed a gender difference in MBS and TMB scores. Regarding MBD scores, only the child's history (allergic rhinitis, atopic dermatitis, sinusitis) showed a statistically significant difference. Concerning MBS scores, child's history (allergic rhinitis, tonsillitis), family history (allergic rhinitis, sinusitis), and tonsil size index showed a statistically significant difference. (Table 2)

Table 3. Multivariable linear regression analysis of factors associated with mouth breathing.

	Mouth breathing pattern					
	MBD score		MBS score		TMB score	
	B (SE)	<i>p</i> Value	B (SE)	<i>p</i> Value	B (SE)	<i>p</i> Value
<b>Gender (reference = male)</b>			-0.19(0.086)	0.016	-0.24 (0.145)	0.095
<b>Child History</b>	0.434 (0.109)	<0.001	0.561(0.092)	<0.001	1.08 (0.182)	<0.001
<b>Allergic rhinitis</b>						
<b>Atopic dermatitis</b>	0.274(0.154)	0.056	0.191 (0.17)	0.119	0.436 (0.229)	0.056
<b>Sinusitis</b>	0.351(0.181)	0.051	0.141 (0.162)	0.384	0.434(0.284)	0.134
<b>Tonsillitis</b>			0.374 (0.153)	0.017	0.271(0.267)	0.328
<b>Otitis media</b>	0.221(0.121)	0.071			0.501(0.194)	0.010
<b>Family History</b>						

<b>Allergic rhinitis</b>			0.221(0.100)	0.031	-0.05 (0.179)	0.801
<b>Sinusitis</b>			0.501 (0.185)	0.009	0.771 (0.341)	0.027
<b>Oral Examination</b>						
<b>Dental Caries</b>	0.985(0.06)	0.04	1.06 (0.01)	0.02	0.995(0.12)	0.00*
<b>Angles Malocclusion</b>	1.05(0.02)	0.02	0.89 (0.10)	0.04	1.23(0.17)	0.00*
<b>Brodsky Classification</b>			0.110 (0.04)	0.001	0.171(0.061)	0.003*

Each mouth breathing score were the dependent variable, and the following variables showing  $p < 0.05$  in each univariate analysis were included as independent variables; gender, child history (allergic rhinitis, atopic dermatitis, asthma, sinusitis, tonsillitis), family history (allergic rhinitis, sinusitis), and oral examination (Brodsky classification). MBD: mouth breathing in the daytime, MBS: mouth breathing during sleep, TMB: total mouth breathing, B: non-standardized coefficient, SE: standard error. \* $p < 0.05$ , \*\* $p < 0.01$ , \*\*\* $p < 0.001$ .

## Discussion

The mouth breathing indices exhibited significant correlations with the children's allergic disease histories. The MBS was more closely related to the children's allergic diseases than the MBD. Furthermore, among the oral examination indices, the Brodsky classification and overjet of maxillary central incisors were related to mouth breathing indices. However, neither personal nor family allergic disease history was associated with oral examination indices. Most items in the children's allergic disease histories had strong relationships with the family histories, but there were weak correlations among the oral examination indices (data not shown).

The results of this study suggest that there is a statistically significant relationship between MBD and MBS ( $p < 0.001$ ,  $r = 0.419$ ). Also, MBS was closely related to a child's medical history. MBS may be accompanied by reduced saliva secretion, resulting in further environmental changes in the oral cavity.[8,9] Therefore, MBS is expected to be more harmful to children than MBD.

Many studies have used various methods to diagnose mouth breathing. Nevertheless, there are not many accurate ways to assess the severity of mouth breathing. Determining whether the mirror is frozen under the nose is a widely used method of diagnosing anatomical mouth breathing. However, habitual mouth breathing without accompanying anatomical problems cannot be identified by this method. Therefore, questionnaires are the easiest and most widely used method of diagnosing mouth breathing. However, surveys have limitations, in that the results differ according to the researchers' standards for categorizing and analyzing categorical data. Therefore, in this study, we calculated the mouth breathing index as a continuous rather

than a categorical variable, since the clinical standpoint for diagnosing mouth breathing is an arbitrary criterion and so is not clear.

In this study, we employed the widely-used Brodsky and Mallampati classifications to measure the sizes of the tonsils and tongue, respectively. In general, the tonsils of a growing child are twice as large as those of an adult and decrease in size after puberty. Thus, some clinicians do not consider it necessary to cure tonsillar hypertrophy.[10] However, when the increase in tonsil size exceeds the average level, the inner diameter of the upper airway decreases, which can markedly increase the air resistance (compared to that in adults) and induce mouth breathing. Therefore, some studies have reported that the frequency of mouth breathing was reduced and the quality of sleep was improved by adenotonsillectomy. [11]

In modern society, pediatric dentists observe tonsillar hypertrophy frequently in clinical practice and are interested in its relationship with immune disease. This study also indicated that the size of the palatine tonsil was related to mouth breathing. However, we cannot conclude whether mouth breathing is the cause or effect of tonsillar hypertrophy because nasal septum deviation or lower turbinate hypertrophy can also cause significant nasal obstruction. In conclusion, this study demonstrated that mouth breathing is a risk factor for tonsillitis (tonsillar hypertrophy) and class II dental malocclusion. MBS is expected to be more harmful to children than MBD.

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