

Etiology, clinical manifestations and concurrent findings in mouth-breathing children

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Abstract

Objective: To investigate the etiology, main clinical manifestations and other concurrent findings in mouth-breathing children aged 3 to 9 years and resident in the urban area of Abaeté (MG), Brazil.

Methods: This study was based on a representative random sample of the town population, of 23,596 inhabitants. Clinical diagnosis of mouth-breathing was defined as a combination of snoring, sleeping with mouth open, drooling on the pillow and frequent or intermittent nasal obstruction. Children with a clinical diagnosis of mouth-breathing underwent nasal endoscopy, allergy skin tests and X ray of the rhinopharynx, full blood tests, eosinophil counts, total IgE assay and fecal parasitology. Data were analyzed using SPSS® version 10.5.

Results: The main causes of mouth-breathing were: allergic rhinitis (81.4%), enlarged adenoids (79.2%), enlarged tonsils (12.6%), and obstructive deviation of the nasal septum (1.0%). The main clinical manifestations of mouth breathers were: sleeping with mouth open (86%), snoring (79%), itchy nose (77%), drooling on the pillow (62%), nocturnal sleep problems or agitated sleep (62%), nasal obstruction (49%), and irritability during the day (43%).

Conclusion: Certain clinical manifestations are very common among mouth-breathing children. These manifestations must be recognized and considered in the clinical diagnosis of mouth-breathing.

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Introduction

A population study carried out in the urban area of Abaeté (MG), Brazil, found a 55% prevalence of mouth-breathing among children aged 3 to 9 years.¹ The mouth-breathing (MB) syndrome occurs when nasal breathing is substituted by a breathing pattern in which the nose is supplemented by oral respiration.² It may be related to genetic factors, incorrect oral habits or nasal obstruction of variable severity and duration. Children who are chronic mouth breathers may develop speech disorders, facial deformities and abnormal body posture and inadequate positioning of the teeth.³⁻⁶

Obstructive cases are related to irreducible hypertrophy of the adenoids and/or tonsils, deviated nasal septum and rhinitis, which may be manifest in isolation or in combination.⁷ All immunologically healthy children have adenoids from birth, which reach peak growth between four and 5 years of age and then undergo a process of atrophy, which is complete at around 10 years of age.⁸ In some cases the adenoids may increase in size to the extent that they partially or totally obstruct nasal respiration.^{9,10} Similarly, the tonsils may increase in size to the point at which they invade the nasopharynx or extend downwards into the region of the hypopharynx.^{9,10} Irreducible hypertrophy of the adenoids (HA) and/or

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tonsils is involved in the pathophysiology of obstructive forms of mouth-breathing, otitis media, sinusitis and nasopharyngitis and is considered the primary cause of sleep-related respiratory disorders and compromises children's physical and cognitive development.³

Among the different forms of rhinitis, allergic rhinitis (AR) has been identified as one of the most important causes of chronic MB in growing children and does not only affect normal development of the facial skeleton but also significantly interferes with overall health, asthma control and quality of life.^{4,10} It is defined as an inflammatory process of the nasal mucosa sufficient to provoke unilateral or bilateral nasal obstruction with intermittent or persistent obstruction resulting from hypertrophy of the inferior, middle or superior nasal conchae.¹¹ It is nowadays a global public health problem in the general population with a major impact on children's quality of life.^{12,13} Diagnosis is eminently clinical and treatment can be carried out by primary care providers.¹⁰

Deviated nasal septum (DNS) is a common condition which originates in the prenatal period, delivery or during growth. However, respiratory disorders only occur when there is obstruction. The condition may be symptomatic (with nasal obstruction) or asymptomatic (without nasal obstruction).⁷

This study investigated the prevalence of predisposing factors, clinical manifestations and concurrent findings in mouth-breathing children from the town of Abaeté (MG), Brazil. The results of this research may make a significant contribution to public health, making it possible to identify and correctly manage clinically controllable obstructive conditions, thereby reducing unnecessary referrals to secondary care providers, which currently have excessive demand in this specialty.

Methods

This population study was approved by the Pediatrics Department and the Research Ethics Committee of the Universidade Federal de Minas Gerais (UFMG). The municipality has a population of 23,596 inhabitants, 20,073 (85.07%) of whom live in the urban area and 3,523 (14.93%) of whom live in the rural area. The population of children aged 3 to 9 years totals 2,927 individuals, of whom 2,490 (85.07%) live in the urban area while 427 (14.93%) live in the rural area. The target population of this study is the 2,490 children living in the rural area, who account for 10.55% of the entire population.¹⁴

The age range of 3 to 9 years was chosen because peak HA incidence is observed in the middle of this range. It was therefore possible to identify both mouth-breathing children in the initial phases and also children with the craniofacial deformities characteristic of untreated later stage cases.

Two interviewers, students on the Nursing course at the Universidade Presidente Antônio Carlos (UNIPAC), in Bom Despacho (MG), Brazil, were trained to select the population

to be investigated and to administer the socioeconomic questionnaire. The interviewers visited a total of 1,538 households, grouped into 106 blocks. Inhabited blocks were numbered from 1 to 416 and a random number table used to choose an initial lot of 90 blocks. Extra blocks were chosen by the same method until sufficient blocks had been chosen to locate a sample of 370 children. The blocks chosen were then grouped into the 10 neighborhoods of the town, which were numbered from one to 10 and chosen by lots to define the order of fieldwork.^{15,16}

The 370 children included 193 (52.2 %) boys and 177 (47.8 %) girls and had a mean age of 5.93 years (with a standard deviation of 1.94/year). They were assessed at the Municipal Health Department's pediatric clinic by the pediatrician and researcher who identified the signs and/or symptoms of MB. This assessment was made in conformity with the social and political precepts of the SUS (Brazilian National Health Service), and with due authorization from those responsible for the children. In 16 cases permission was not given; this fact was noted for the purposes of statistical analysis and was not considered as a loss to the sample. With the objective of increasing representativeness, only one child from each household was enrolled.

Children were excluded from the study if they had heart diseases, pneumonia, or other comorbidities that could interfere with the results of the research, or if the free and informed consent form was not signed or if they were less than 3 or more than 9 years old.

Two protocols for clinical diagnosis of mouth-breathing were developed specifically for this study, the first for patient history (Table 1) and the second for clinical examination findings (Table 2). No instruments could be found in the literature that were validated and appropriate for the purpose. Since diagnosis was based on clinical criteria, all children were symptomatic at the time of the medical examination.

In order to investigate etiologic factors complications of the MB cases, the children underwent clinical examination, endoscopy, radiology, laboratory tests and allergy skin tests.

The pediatrician carried out physical examinations of the nasal cavities after prior training at a specialist clinic. Examinations were performed with indirect lighting via a mirror using a rhinoscope. Findings recorded were: coloration of nasal mucosa (normal, pale or inflamed), the size of inferior and/or middle conchae (normal, hypertrophic or atrophied) and the presence or absence of secretions.

The oral cavity examination was carried out with adequate and even lighting and with tongue depressed at its middle third to avoid provoking the gag reflex.

Nasal endoscopy was carried out at the Hospital São Vicente de Paulo, in Abaeté, by a otorhinolaryngology specialist using a Machida[®] ENT-30 P III 3.2 mm nasal-laryngeal fibroscope and the examination was recorded on videotape. The

Table 1 - Patient history protocol with clinical criteria for identifying mouth-breathing children*

Variables	Yes	No
Major signs		
Snores		
Sleeps with mouth open		
Drools on pillow		
Complains of a blocked nose every day		
Minor signs		
Itchy nose		
Complains of a blocked nose sporadically		
Nighttime breathing difficulties or agitated sleep		
Sleepy during the day		
Irritable during the day		
Difficulty or slow swallowing food		
More than three episodes of ear nose or throat infection (confirmed by a doctor) during previous 12 months		
Problems at school or failed years		

* Children were considered mouth breathers if they had two major signs or one major sign associated with two or more minor signs at the time of the pediatric consultation.

examiner made her diagnosis based on her endoscopic observations with no knowledge of any other patient information. Before examination patients were informed of the possibility of discomfort and a topical vasoconstrictor was applied. It was decided not to use topical anesthetic. All of the children tolerated the examination well and all examinations were without incident. Patients who did not attend and those who had acute upper airway infections or AR were examined at a later date after clinical improvement and by prior appointment.

Endoscopic diagnosis was based on color of nasal mucosa, size of inferior and middle conchae, the position of the septum within the nasal cavity and the size of adenoids. Inferior and/or middle conchae whether unilaterally or bilaterally, were defined as hypertrophic if their volume remained excessive even after vasoconstriction. Hypertrophy was classified as grade I (inferior and/or middle nasal conchae occupying 25% of the nasal fossa), grade II (inferior and/or middle nasal conchae occupying 50% of the nasal fossa) and grade III (inferior and/or middle nasal conchae occupying 75% or more of the nasal fossa).¹⁷ Conchae were defined as hypertrophic if they occupied more than 50% of the nasal fossa.

Septal deformities were classified by area according to the topography of the nasal cavity involved: area 1 (vestibular

area), where septal deviation affect nasal respiration very little; area 2 (nasal valve area), where deviations result in very significant obstruction; area 3 (attical area), where there may be obstruction below the cartilaginous framework and nasal bones, resulting in permanent nasal obstruction and sinus involvement; area 4 (anterior turbinate area); and area 5 (posterior turbinate area), where deviations cause facial pain, nasal obstruction and postnasal secretions and also compromise the auditory tube.¹⁸ Deviations were defined as obstructive if they were manifest bilaterally in areas 2, 3, 4 or 5.

Adenoids were defined as hypertrophic if they occupied an area greater than or equal to 70% of the rhinopharynx on endoscopy.¹⁹

A VMI Compacto 500 conventional X ray machine was used for radiological assessment of the rhinopharynx. The tests were carried out by a technician trained at a specialist clinic and were interpreted by a physician specialized in radiology.

The allergy skin tests (AST) were performed using allergenic extracts provided by FDA Allergenic Ltda. Tests were carried out by a nurse trained at a specialist clinic under supervision by the pediatrician responsible for this research.

Table 2 - Physical examination protocol for identification of mouth-breathing children*

Variables	Yes	No
Major signs		
Craniofacial abnormalities (adenoid facies)		
High arched palate		
Open bite (with no history of thumb sucking or pacifier use)		
Hypertrophy of nasal conchae		
Deviated nasal septum		
Tonsils increased in size to grade III or IV		
Cleft lip (protruding lower lip)		
Minor signs		
Abnormal chest		
Abnormal posture		
Involvement of tympanic membranes (opaque appearance, hyperemia, perforation and/or thickening)		
Nasal voice		
Speech disorders (tongue thrust, mixing up letters and/or sigmatism)		

* Children were considered mouth breathers if they had two major signs or one major sign associated with two or more minor signs at the time of the pediatric consultation.

All laboratory tests were carried out on the same day by a laboratory accredited by the Municipal Health Department of Abaeté.

Clinical diagnosis of AR was based on nasal obstruction and/or coryza; rapid-fire sneezing; nasal itching; inferior and/or middle nasal conchae visibly enlarged, with unilateral or bilateral hypertrophy being considered abnormal irrespective of the presence of secretions; allergy test results and total IgE assay results. Since this was a prevalence study there was no way of differentiating transitory hypertrophy from permanent hypertrophy.

Enlarged tonsils were defined as grade I when up to 25% of the oropharynx was obstructed, grade II, when there was 25-50% obstruction; grade III where obstruction was > 50% and < 75%; and grade IV, where over > 75% of the oropharynx cross section was obstructed. Tonsils were classed as hypertrophic at grade III or IV.²⁰

For this study, adenoids were classed as hypertrophic when enlarged by $\geq 50\%$ and were classed as obstructive of nose breathing when enlarged by $\geq 70\%$,²¹ both on the endoscopic examination and the X ray of the rhinopharynx.

Statistical analysis was carried out using SPSS® version 10.5 to calculate odds ratios with confidence intervals and to

apply the chi-square test, with results considered significant at $p < 0.05$.

Results

From the initial sample of 370 children, 204 (55%) were diagnosed clinically as mouth breathers. From this subset of 204 children, 11 (5.4%) did not complete the study due to dropping out or moving town and 18 (8.8%) did not present for all of the tests. The final sample therefore included 193 children, 175 (90.67%) for whom all test results were available and 18 (9.32%) with incomplete results. The patient history results showed that the most common clinical manifestations of mouth-breathing were: sleeping with the mouth open (86%), snoring (79%), itching nose (77%) and drooling on the pillow (62%). Table 3 contains the results of statistical analysis of the clinical manifestations on the patient history protocol and Table 4 contains the results of the statistical analysis of the clinical examination findings.

A total of 81.4% of the patients had a positive AST result, with 19.6% of the sample having a positive test for a single item and 61.8% for two or more items. Dust mites (59%) and fungi (37%) were the most common allergens, followed by pyrethrins (28%) and animal hair (27%).

Table 3 - Main clinical manifestations in mouth-breathing children's patient histories

Variables	p*	OR	Confidence interval of OR
Snores	0.001	45.3	23.4-87.8
Sleeps with mouth open	0.001	40.2	22.1-73.7
Drools on pillow	0.001	32.7	15.1-69.9
Blocked nose daily	0.001	78.4	10.7-72.4
Itchy nose	0.001	8.9	5.5-14.4

OR = odds ratio.

* Significant at $p < 0.05$.**Table 4** - Main findings of clinical examinations of mouth-breathing children

Variables	p*	OR	Confidence interval of OR
Craniofacial abnormalities	0.001	265.5	90.9-775.1
High arched palate	0.001	205.4	84.6-498.7
Hypertrophic conchae	0.001	138.6	48.6-395.3
Cleft lip	0.001	241.5	90.0-647.7
Thoracic abnormalities	0.001	289.8	39.7-2,113.1

OR = odds ratio.

* Significant at $p < 0.05$.

Total IgE was elevated in 87.9% of the patients, taking 60 UI/ml as the cutoff. The eosinophil count cutoff was set at < 4% of the total white blood count, identifying 32.1% of the patients as having eosinophilia. It is known that eosinophil counts are not a good indicator of allergy, since they are influenced by many factors, the most important of which is intestinal parasitosis. In this study, the overall prevalence of intestinal parasitosis was 9.5% and there was no association between eosinophilia and intestinal parasitosis ($p = 0.239$).

On the basis of the nasal endoscopy examination, 23.7% of the children had hypertrophic adenoids enlarged by 50 to 75% and 13.9% by more than 75%, i.e., according to this direct visual examination, 37.6% of the children assessed had hypertrophic adenoids.

The rhinopharynx X ray indicated that 55.6% of the children had an airway reduced by 50 to 75% and 23.6% by more than 75%, i.e., according to this radiology imaging exam, 79.2% of the children assessed had hypertrophic adenoids.

Nasal endoscopy indicated that 179 children (72.1%) had some type of nasal septum deviation. Of these, 107 (59.8%) were unilateral deviations and 20 (11.2%) were bilateral, in

area 1 on one side and area 2, 3, 4 or 5 in the contralateral nasal cavity. Only two children (1.0%) had deviations considered obstructive (bilateral in areas 2, 3, 4 or 5).

A 12.6% prevalence rate of enlarged tonsils was observed, breaking down to 7.4% with grade III hypertrophy and 5.1% with grade IV.

Discussion

Diagnosis of MB is clinical, and the pediatrician, who generally has the first contact with mouth breathing children, should take a detailed patient history and give due weight to information on clinical manifestations, ensuring early diagnosis and appropriate intervention. A large proportion of parents or guardians will not spontaneously volunteer information on disorders such as snoring, sleeping with the mouth open, drooling on the pillow or an itchy nose, because they believe they are unimportant or normal.

A recent study conducted at the pediatric otorhinolaryngology service run by the public health system of Belo Horizonte (MG), Brazil, indicated that AR (35.3%) was the most often diagnosed etiology for MB cases referred by primary care

providers,¹⁰ followed by hypertrophic adenoids (19.1%) and hypertrophic tonsils (2.4%). In our study, the main causes of MB were: AR (81.4%), hypertrophic adenoids (79.2%), hypertrophic tonsils (12.6%) and obstructive deviated nasal septum (1.0%).

The increase in prevalence of rhinopathies has been confirmed by several different studies, and AR is the most common type.^{10,22} Domestic dust, dermatophagoides, mold and animal hair are the most often identified allergens, which was also true of the results of this study, where 81.4 % of the sample had positive AST results, with 61.8% of cases being positive for two or more items. Furthermore, dust mites were the most common allergen with 59.0% positivity. Allergy testing is important in differential diagnosis for nasal conditions and for determining sensitization profiles, which in turn make it possible to reduce exposure. These tests are simple, easy to carry out, of low-cost and offer high sensitivity; the result is immediate and there is no need for expensive laboratory tests and they also have great educational value since the patient can clearly see the allergic response.²³ this study found that 54.6% of the children suffered from itchy noses and 65.9% hypertrophic nasal conchae, which are characteristic of AR.

Specific IgE assays are the most important "in vitro" method for diagnosing IgE-mediated hypersensitivity and correlate significantly with AST. Total IgE assays are influenced by several specific individual factors and situations and do not therefore have a significant correlation with AST.²⁴

According to some authors, hyperplasia of adenoids and tonsils are important causes of upper airway obstructions in children.^{4,25} The present study is in agreement with those authors, finding that 29.5% of cases involved hypertrophic adenoids, being the second most frequent cause; hypertrophy of the tonsils was the third most frequent cause of MB and was diagnosed in 12.6% of the sample.

According to some authors, there are strong positive correlations between rhinopharynx supplementary tests, such as X ray findings, and clinical and surgical parameters. X rays are of low cost, simple and widely available and this has become the method of choice for initial assessment of hypertrophic adenoids. Although it is routine practice to provide radiological findings together with subjective opinions, many authors call attention to their limitations and recommend objective assessments, with the adenoid-nasopharynx ratio being the most reliable in routine radiological practice.²⁶ In this study, radiological findings were based on subjective assessment and we believe that this is what caused the discrepancy between the results obtained from the two types of examination, where endoscopy findings defined 37.6% of patients as having hypertrophic adenoids while rhinopharynx X rays classed 79.2% as having the same condition.

For other authors, nasal endoscopy is a more trustworthy test than X ray of the rhinopharynx for assessing hypertrophic adenoids, it is well-tolerated and can be carried out away from the hospital environment, which could increase its routine applications.^{27,28}

One possible cause of nasal obstruction is deviations or deformities of the nasal septum. In a study carried out in Curitiba, PR, 534 volunteers without any prior diagnosis of respiratory disorder were assessed and a prevalence of 60.3% of DSN was detected.²⁹ This result is very close to what was found in this study, where 72.1% of the patients exhibited some degree of DSN, although this result does not agree with the claims of causality made for nasal obstruction, since only 1.03% of cases in this study exhibited an obstructive deviated nasal septum.

With relation to hypertrophic tonsils, a study carried out in Turkey³⁰ with a sample of 1,211 children aged 6 to 13 years found an overall prevalence of 11%, which is very similar to the figure observed here (12.6%).

Possible limitations of this study include the fact that the follow-up tests were not carried out for children who were not diagnosed as mouth breathers according to clinical criteria, thereby preventing identification of false-negatives; the use of subjective X ray findings; and the fact that financial considerations made it impossible to perform specific IgE assays for all of the antigens assessed by the AST.

Approximately two thirds of the patients in this study who were diagnosed with MB also had RA. This is a condition that pediatricians are capable of managing as long as they have received theoretical and practical training to deal with this important public health problem. Only difficult to control cases of RA should be referred to specialist centers for assessment, after weighing up possible comorbidities. Correct management of these cases reduces overload caused by unnecessary use of specialized services, in addition to reducing additional inconvenience to patients and their families and cost to the public health service.

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