

Mouth Breathing in Pediatric Population: A Literature Review

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ABSTRACT

Introduction: Breathing is a vital function of the human body, usually carried out through the nose. Breathing through the mouth instead of through the nose is considered an abnormal breathing habit. Mouth breathing refers to the state of inhaling and exhaling through the mouth. Mouth breathing is also an etiological factor for respiratory distress during childhood sleep. Both habit and obstruction can lead to facial muscle imbalance and craniofacial changes. **Objective:** This article aims to review the basics of mouth breathing. **Method:** The search was carried out using online databases from Google Scholar and Pubmed. Articles included were articles published from 2014 to 2021. The keywords and terms used for the search for the article were as follows: mouth breathing”, “mouth breathing syndrome”, “mouth breathing in children”, “Children”, “Pediatrics”. **Results:** There were 19 articles that discussed matters related to the introduction of mouth breathing in children. **Conclusion:** Mouth breathing can be categorized into 3 types based on the etiology. The etiology and risk factors for mouth breathing are nasal obstruction, adenoids, and children who are not exclusively breastfed. Mouth breathing is characterized by many symptoms, some of which are class II relations, maxillary incisor protrusion, long face and others. This habit is diagnosed through a comprehensive history and several tests. The management generally includes the use of oral screens and may also be surgical to correct the cause of the obstruction.

Keywords: *Mouth breathing*, Children, Breathe through the mouth

INTRODUCTION

Bad habits related to the oral cavity are most often seen during infancy because they are a normal part of development. Usually, this habit disappears with time. If not, it is a problem to watch out for as it can cause serious dentoalveolar changes. This bad habit is usually associated with several psychological and physiological / anatomical etiologies that should be of concern. Therefore, if the patient complains of bad habits, it is important for dentists to understand the psychology and management of these habits. (1) Bad habits related to the oral cavity are frequent and constant habits due to the high frequency of repetitions. There are many types of oral habits, one of the most common habits in children is breathing through the mouth or mouth breathing. (2)

Breathing is a vital function of the human body, usually carried out through the nose. Breathing through the mouth instead of through the nose is considered an abnormal

breathing habit.(2)Mouth breathing refers to the state of inhaling and exhaling through the mouth.(3)Mouth breathing due to acute diseases, such as influenza, is not a condition to worry about. However, chronic mouth breathing conditions that completely depend on the mouth to breathe or in children with medical conditions such as sleep apnea become mouth breathing are conditions that need attention. This indicates that the child needs additional medical intervention or retraining to breathe easily through the nose.(2)

Due to the large number of comorbid conditions, mouth breathing (MB) has become a condition that needs to be considered by health care professionals in various fields. Mouth breathing is also an etiological factor for sleep-induced respiratory distress (SDB) during childhood. Both habit and obstruction can lead to facial muscle imbalance and craniofacial changes.(4)Mouth breathing has been shown to have an adverse effect on facial skeletal growth and occlusion due to displacement of lateral, buccal, and lingual muscle strength from normal conditions. Some pediatric patients may appear to be breathing through the mouth because of the shape of their lower jaw or have a lip incompetent. Children 3 to 6 years of age generally have a slight lip incompetent.(5)Children who are breathing through the mouth should also be suspected of having nasal airway obstruction. If nasal breathing is disturbed by hypertrophy of adenoids and tonsils, rhinitis, deviations of the nasal septum, there is a possibility that the child will experience mouth breathing.(5,6)

Public dentists and pediatric dentists may be in the best position to screen and treat patients with upper airway obstruction / mouth breathing. Dentists usually see patients regularly every six months, and inflamed tonsils can easily be detected by using a mirror to see the back of the patient's throat. All patients - children, adolescents, and adults - should be screened for upper airway obstruction. Mouth breathing is best treated using a multidisciplinary approach involving pediatricians, doctors, dentists, and otolaryngologists (ENT).(3,7)

METHOD

Search Strategy

The search was carried out using online databases from Google Scholar and Pubmed. Articles included were articles published from 2014 to 2021. The keywords and terms used for the search for the article are as follows: “mouth breathing”, “mouth breathing syndrome”, “mouth breathing in children”, “Children ”, " Pediatrics. In each article found according to keywords, the title and abstract of each article were checked and articles that met the criteria were downloaded.

The flow chart in figure 1 identifies the articles included and excluded at each stage. A total of 300 articles were found using the above keywords, after deleting the duplicates 270 articles were found. A total of 270 articles were screened, and 251 articles were excluded, 19 full-text articles were examined for their eligibility and 19 full-text articles were included as articles to be reviewed.

Inclusion and Exclusion Criteria

1. Inclusion Criteria

- a. Articles published in the last 7 years (2014-2021)
- b. Articles in English
- c. Articles that focus on the definition, prevalence, classification, etiology, signs and symptoms, effects, and management of mouth breathing in children.

2. Exclusion criteria

- a. Articles that only consist of abstracts written in English
- b. Full-text articles are not open access
- c. The article does not focus on the mouth breathing in children, it only touches a little about the mouth breathing in children.

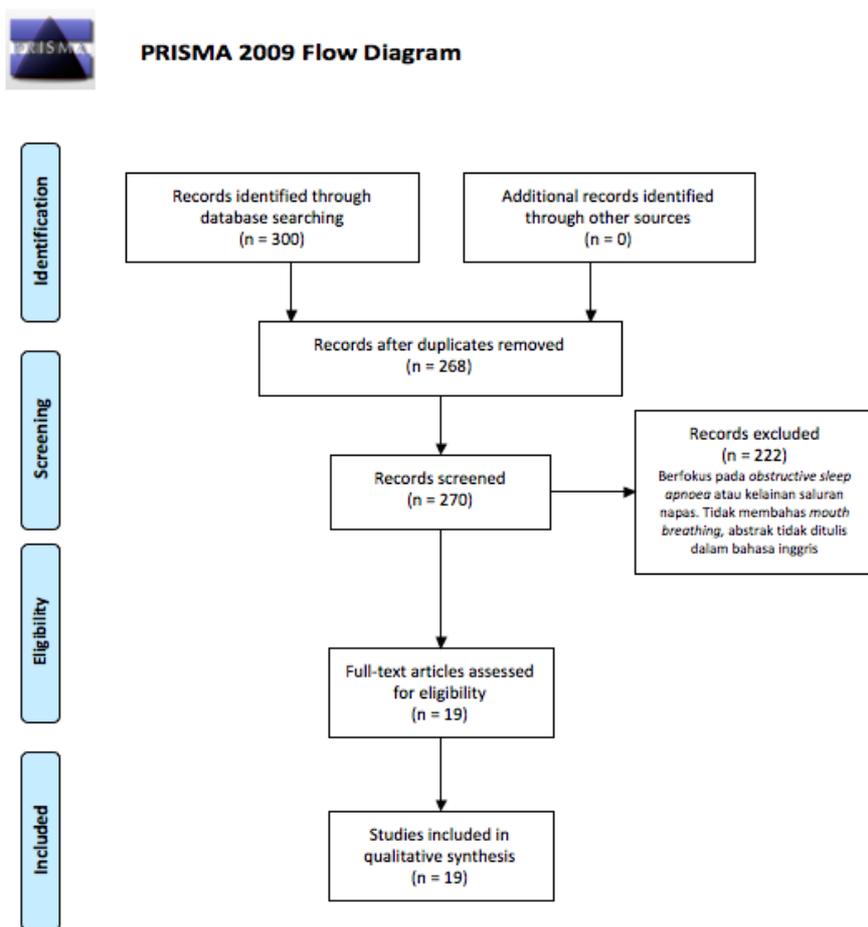


Figure1. Flow chart that explains the methodology of search and the total of articles included/ excluded in each stage

RESULTS

Of the articles found, 34 articles were analyzed and included in this systematic review. Information regarding the article can be found in table 1.

No.	Writer	Year	Title	Conclusion
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1.	Pancheo MCT, Casagrande CF, Teixeira LP, Finck NS, Araújo TM(8)	2015	Guidelines proposal for clinical recognition of mouth breathing children	In order to clinically recognize mouth breathing (MB), it is important for orthodontists to integrate results obtained from visual assessments, questions, and at least two types of breathing tests. It is important to ask questions that help identify predisposing factors for respiratory distress during sleep in children. The proposed guidelines may support clinical recognition of MB in children, help differentiate between habitual or obstruction-induced MB, guide clinicians to select the most appropriate treatment modality, and prevent adaptive facial changes that exacerbate MB patterns.
2.	Ali AA, Richmond S, Pospat H, Playle R, Pickles T, Zhurov A I, Marshall D, Rosin PL, Henderson J, Bonuck(9)	2015	The influence of snoring, mouth breathing and apnoea on facial morphology in late childhood: a three-dimensional study	Consistent evidence was provided using binary logistic regression and three-dimensional mean face superimposition to confirm the hypothesis that SDB (snoring, apnea and mouth breathing) among a cohort of children aged 15 years was associated with (1) increased facial height; (2) reduced nasal prominence; (3) decrease in nose width; and (4) retrognathic mandible. However, there is no statistical evidence to determine whether the prevalence and severity of SDB is associated with an increase or decrease in maxillary angle. However, the evidence was found to suggest an association between increased BMI and prevalence

				<p>of SDB symptoms. Because SDB has serious consequences for long-term health and quality of life, early diagnosis of SDB is essential. Health care professionals can play an important role in early diagnosis of SDB, recognizing different facial morphologies of long faces, decreasing nasal protrusions and retrognathic mandibles and referring these children to specialists for further assessment of clinical symptoms of SDB.</p>
3.	Basheer B, Hegde K S, Bhat SS, Umar D, Baroudi K(7)	2014	Influence of Mouth Breathing on the Dentofacial Growth of Children: A Cephalometric Study	<p>This study concluded that all subjects with the habit of mouth breathing showed a significant mandibular incisor proclination, lip incompetence and a convex facial profile. The presence of adenoids accentuates facial convexity and depth of the mentolabial sulcus. Multidisciplinary teams must work together to obtain early diagnosis and appropriate treatment, preventing the resulting chronic mouth breathing disorders. Because upper airway obstruction is an obstacle to normal dentofacial development, children with a habit of mouth breathing need immediate attention before growth continues permanently. Early recognition of such facial patterns can be used to identify individuals with respiratory distress who are likely to develop such types of</p>

				malocclusions. Therefore, concerted efforts by pediatric dentists, orthodontists, otorinolaryngologists and pediatricians are needed to reduce the continuing detrimental effects of respiratory distress on facial characteristics.
4.	Morais-Almeida M, Wandalsen GF, Solé D(10)	2018	Growth and mouth breathers	Mouth breathing should be considered a potential cause of growth retardation in children; pediatricians should assess these patients extensively.
5.	BEG, Ali AH, León IBG(11)	2016	Mouth breathing and its relationship to some oral and medical conditions: physio pathological mechanisms involved	In conclusion, we believe that this procedure offers the possibility of providing new ways to address the pain management challenges posed by chronic, inflammatory, immune, and degenerative diseases. Although the results of this clinical case report are positive and encouraging, further studies are needed in a large number of MCS patients before certifying that this procedure can be used widely. Therefore, we hope that further studies will be carried out along this research line.

6.	Veron HL, Antunes AG, Milanesi JM, Corrêa ECR(12)	2016	Implications of mouth breathing on the pulmonary function and respiratory muscles	When analyzing this study from a methodological point of view, many differences remained regarding not only the diagnosis of mouth breathing, but also variables related to the respiratory mechanism. When discussing mouth breathing, it is desirable to use a uniform classification, including the same terminology and the same laboratory tests. Further research is needed with more detailed methods, including objective and reproducible parameters in the evaluation of respiratory muscles.
7.	Yamaguchi H, Tada S, Nakanishi Y, Kawaminami S, Shin T, Tabata R, Yuasa S, Shimizu N, Kohno M, Tsuchiya A, Tani K(13)	2015	Association between mouth breathing and atopic dermatitis in Japanese children 2-6 old: A population based cross-sectional study	Mouth breathing was significantly associated with atopic dermatitis in Japanese preschool children aged 2-6 years. Additional case-control and cohort studies are needed to confirm this association. Furthermore, research targeting school children and adults will also help clarify this relationship
8.	Zhao Z, Zheng L, Huang X, Li C, Liu J, Hu Y.(14)	2021	Effects of mouth breathing on facial skeletal development in children: a systematic review and meta-anaylis	The results showed that the lower and upper jaw rotated posteriorly and inferiorly, and the occlusal plane was also steep in children with habitual mouth breathing. In addition, children with habitual mouth breathing showed a tendency towards labial inclination of the upper anterior teeth. Airway stenosis is common in children who breathe through the

				<p>mouth. In contrast to children with OSAS, there was no significant trend of decreasing rotation of the maxilla in children whose habitual mouth breathing was accompanied by adenoid / tonsillar hypertrophy conditions. At the same time, the palatal plane in children with adenoid hypertrophy develops a downward posterior rotation, which is not found in children with OSAS.</p>
9.	Inada E, Saitoh I, Kaihara Y, Yamasaki Y(15)	2021	Factors related to mouth-breathing syndrome and the influence of an incompetent lip seal on facial soft tissue form in children	<p>Our results demonstrate the importance of early diagnosis and treatment of MBS, and that early treatment of MBS can prevent possible dental and physical problems in the future. We think that proper treatment based on the greatest possible cause is needed to improve the condition of MBS.</p> <p>Since the mental and physical development of children greatly affects their health and future personal development, it is very important to clarify the SBM that occurs in children during development. In the future, our study group plans to increase the number of survey participants to clarify the functional and morphological characteristics of MBS, and to verify the results of dental therapeutic interventions. We also hope that this study will enable the identification of individual causes of MBS and facilitate the accurate selection of effective therapeutic</p>

				interventions.
10	Elmomani BR, Tarawneh AM, Rashdan HAR, Shuqran KK(16)	2015	Orthodontic alterations associated with mouth breathing habit	There is a strong correlation between nasopharyngeal airway obstruction (habitual mouth breathing) which causes changes in muscle function, and dental orthodontic abnormalities. Patients / parents need to be made aware on the importance of the correct breathing pattern in a growing child to achieve a normal dentoskeletal growth pattern.
11	Indiarti IS, Setyanto DB, Kusumaningrum A, Budiarjo SB(17)	2017	Changes in the palatal dimensions of mouth breathing children caused by nasal obstruction	It can be concluded that the mode of breathing can affect the vertical and transverse dimensions of the hard palate. Children who breathe through the mouth tend to have a narrow V-shaped arch and deep palate. In our study, we found a 57% frequency of deep palate in children who had the habit of mouth breathing. And the common etiology of this habit in this study was allergic rhinitis.
12	Sreshtaa VS, Geetha RV(18)	2019	Knowledge and awareness in association of malocclusion and mouth breathing in children	From the results of the study, it can be concluded that parents are very aware on the impact of MB on tooth arrangement. This indicates that the population in which the survey was conducted had a good knowledge orientation about the consequences. Based on the research and comparison articles, it was found that MB had a very pronounced effect on tooth alignment.

13	Valentina F, Cristina H, Daniela M, Barraza A(19)	2020	Prevalence and clinical characterization of mouth breathing patients in Viña Del Mar dan Quilpué Chile	Most of the population examined had a habit of mouth breathing. Early intervention from a pediatrician is essential for the diagnosis, reduction, and treatment of this syndrome in order to limit future complications.
14	Rangeeth BN, Rangeeth P(20)	2019	Mouth breathing “a habit or anomaly” – a review	MB is a compensatory mechanism that results from obstruction of the proper airways. The effects range from dentofacial to upper respiratory tract changes including their effects on muscles involved with breathing as well as psychological and posture changes. Therefore, the depiction of MB has a habit of further debate. This habit is difficult to break because of the neural traces and automaticity of this activity and sometimes it can never fulfill the goals that a person sets for himself whereas MB is never a goal set by the person himself but rather as a compensation mechanism therefore we suggest that MB is considered an anomaly and a multi-specialized approach to MB management was put into practice. Therefore, there is a need to discuss and treat MB as a disorder given the complexity of its effects on both the general health and dentofacial systems.
15	Lima ACD, Cunha DA, Albuquerque RC, Costa RNA, Silca HJ(21)	2019	Sensory changes in mouth breathers: systematic review based on prisma	In this review, most studies show changes in the sensory system in children who breathe through the mouth. Despite this

			method	<p>confirmation, there is greater concern in the evaluation of sensory receptors, and not in information processing. In addition, most of the studies evaluated the sensory system in a non-standard procedure, which may have led to inaccurate results in the population studied.</p> <p>The study in question indicates a need to acquire more knowledge, to define and standardize evaluation instruments for sensory systems, as this study observed a lack of standardization of these instruments and large variations in methodology, thereby reducing the reliability of results.</p> <p>Achieving the specificity of this evaluation will lead to more reliable diagnosis, and therapeutic planning based on scientific and reliable evidence, taking into account the relevance of the sensory system for the performance of daily activities, and, consequently, for the quality of life.</p>
16	Molina OF, Mendez AS, Silveira IR, Collier KF, Santos ZC, Penoni VB, Gama KR(22)	2018	Craniofacial, oral and dental manifestations of oral breathing	<p>The clinical manifestations of mouth breathing associated with craniofacial changes in children include dental changes, craniofacial changes, postural abnormalities, musculoskeletal disorders, anatomical changes, occlusal, oral and neuromuscular disorders. The mechanism of mouth breathing causes</p>

				pathological disorders in children including obstructive, postural, reduction of vertical effects on muscles, anterior tongue anatomical thrusting, interference with muscle forces exerted by the tongue, increased energy expenditure during sleep, smaller oral cavity, upper and lower jaw. which is pulled back and increased nasal airway resistance.
17	Damayanti Y, Soewondo W, Primarti RS(23)	2014	Frequency distribution of mouth breathing in children based on age and gender	Based on research that has been conducted on children aged 6-12 at the pediatric dentistry installation at the Padjadjaran University Dental and Oral Hospital in Bandung, it can be concluded that the percentage of mouth breathing habits in children aged 6-12 years in the pediatric dentistry installation in Padjadjaran University Bandung Dental and Oral Hospital is low, with the number of girls who have a habit of mouth breathing higher than boys.
18	Soares JP, Klein D, Ximenes M, Pereira CS, Antunes EC, Dias L, Borgatto A, Cardoso M, Bolan M(24)	2018	Mouth breathing and prevalence of sleep bruxism among preschoolers aged 2 to 5 years	The prevalence of bruxism found is low. The presence of bruxism and mouth breathing are not correlated. It was observed that children between the ages of 4 and 5 years had a higher prevalence of bruxism, because the male was more exposed to this condition.
19	Rossi RC, Rossi NJ, Rossi NJC, Yamashita HK, Pignatari SN(25)	2015	Dentofacial characteristics of oral breathers in different ages: a	This study shows that dental and bone factors are associated with OB in children, and it appears to be more severe into

			retrospective case-control study	adolescence. But adults did not show an association between OB and skeletal factors, only on the dental variable, this indicates that there was no causal relationship between dental and skeletal factors and OB. Treatment of patients who have breathed by mouth should still be multidisciplinary, because OB will continue even if dental and skeletal factors are reduced.
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DISCUSSION

Definition

Mouth breathing is a respiratory disorder that affects children, adolescents, and even adults in a high percentage of the general population and is also responsible for causing both local and systemic pathological effects in the short and long term.(22)Mouth breathing is defined as a habit that has a bad influence and can be defined as a bad habit related to the oral cavity if there are no factors and anatomical barriers to breathing through the mouth. Sassouni stated that mouth breathing is the habit of breathing through the mouth instead of the nose. Some time later, Merle suggested the term oronasal breathing to replace oral or mouth breathing because she felt that this term was more correct and appropriate.(3)Mouth breathing in children is a manifestation of oral function that is not well developed and has a negative effect not only on the oral cavity and kraofacial morphology, but also on general conditions. In this context, mouth breathing syndrome is defined as a series of signs and symptoms, all or some of which are found in an individual, which for various reasons displaces the correct nasal breathing pattern into an oral or mixed pattern of breathing.(15,26)Currently, the accepted view is that individuals who are said to be mouth breathing are individuals who breathe through their mouths even when they are resting. Such people should be distinguished from nasal breather (people who breathe through the nose) who only breathe through the mouth when exerting / receiving intense physical load but breathe through the nose when they rest.(3)

Prevalance

Mouth breathing is a respiratory dysfunction that affects approximately 10-15% of the pediatric population.(27)The prevalence of children with the habit of breathing through the mouth has shown mixed results across the existing literature. A study by Cuc et al showed a prevalence of mouth breathing of 14% in children with maxillary and dental abnormalities, in this study women and children living in urban areas were more affected.(28). A study in Brazil in 2010 analyzed 419 school children aged 6-11

years and showed that the prevalence of mouth breathing in the sample was 56.8% of the sample studied.(29)Another study in Cuba conducted in 2009 also found the percentage of mouth breathing was 24.7% and the majority was dominated by children aged 6-11 years.(19)A more recent similar study conducted by Kukwa et al. found a mouth breathing prevalence of 18.7%, but in this study it was found that mouth breathing was more common in boys (6,5% vs 5,4%).(30)A study on the prevalence of mouth breathing was also conducted at the Padjadjaran University Dental Hospital in 2011 and the prevalence of mouth breathing from patients who came to the pediatric dentistry installation at the Universitas Padjadjaran Hospital was 10.9% and it was more commonly found in girls.(23)

Classification

In 1987 Sim and Finn classified mouth breathing into three categories based on their etiology:(3,31)

1. Obstructive: Children with increased resistance or total obstruction of normal airflow through the nasal passages. Seen in ectomorphic individuals with a long and narrow face and nasopharyngeal canal
2. Habitual: Children who continuously breathe through the mouth out of habit, even though the obstruction has been cleared
3. Anatomical: Short upper lip that does not allow complete closure of the mouth without excessive effort.
 - a. Complete obstruction: The nasal passages are completely closed
 - b. Partial blockage

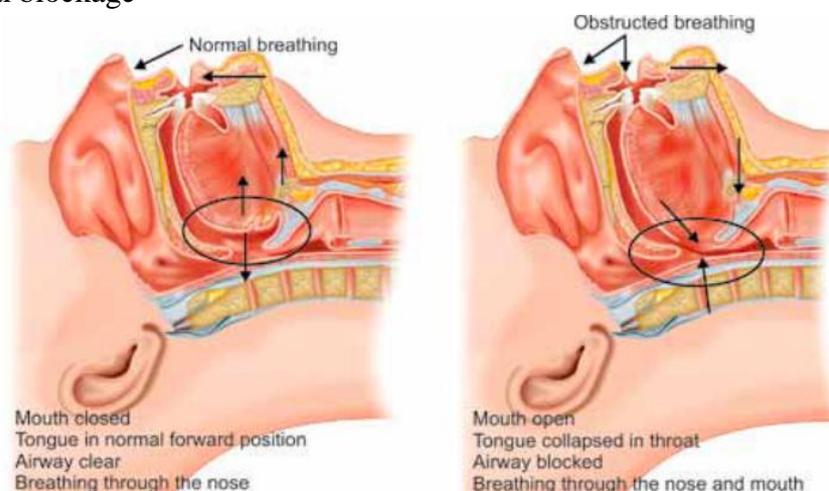


Figure2. The difference between normal and obstructed breathing

Etiology and Risk Factors

1. Nasal obstruction
 - a. *Turbinate Enlargement*

This enlargement can occur due to allergy, chronic infections of the mucous membranes, rhinitis, hot and dry climatic conditions, and in areas with air pollution. Nasopharyngeal obstruction is the most common cause of mouth breathing due to

increased nasal resistance. The most common form of obstruction is congenital laryngomalacia.(2,3,5)

b. Adenoids

The most common cause of nasal obstruction in children is hypertrophy of the adenoids, which are the nasopharyngeal cushions of lymphoid tissue. Children and adolescents usually experience what is known as "Adenoid Facies". The characteristics of "Adenoid facies" are as follows: 1. The nostrils are pinched, the upper lip is short; 2. Open mouth and elongated face; 3. The lower angle of the mandible becomes steeper; 4. Retrognathic mandible, face without expression; 5. Protrusion maxillary teeth, narrow maxillary alveolus, hypoplastic maxilla, anterior tongue position, retroclinated mandibular incisors.(22,32)It has long been known that enlarged adenoids cause obstruction-induced mouth breathing. However, some children continued to breathe through the mouth even after surgical removal of the adenoids. This could be due to being accustomed to breathing through the mouth and laziness in using the nose despite having an adequate nasal airway. It could be that in many children there are some mechanical obstacles besides the adenoids that prevent the children from breathing through the nose. In fact, it seems that a combination of the anatomical disorders of the upper airway and nose are more likely to cause a shift in breathing from nose to mouth. Mechanical obstructions that can cause obstruction of the nasal airways and cause the child to shift to the oral breathing pattern include the anatomical variations present in the nasal cavity and paranasal areas during development in the turbinate and concha bullosa areas, as well as sinus inflammation and nasal changes such as recurrent chronic sinusitis and hypertrophy of the concha inferior nose.

c. Intranasal defects

Intranasal defects can include nasal septal deviation, septal subluxation, septal thickness, bony spurs, and polyps.. (2,3,5)

d. Allergic rhinitis

Allergic rhinitis may play a key role in mouth breathing because of the high prevalence of this condition. Infections and bacterial toxins that occur in the nasal cavity can cause tissue irritation resulting in an allergic reaction. (5,11,33)

2. Etiology in children with developmental disorders

Children with developmental disabilities often experience breathing problems. Mouth breathing is common in this group of individuals and is independently associated with sex and use of drugs acting on the central nervous system. Regarding the use of drugs acting on the central nervous system in patients with developmental disorders, several studies have evaluated the effect of these drugs on mouth breathing.(34)Benzodiazepines are one of the most commonly administered drugs to patients with cerebral palsy. Benzodiazepines can be associated with respiratory depression, hypoventilation, hypoxia, and obstructive sleep apnea. The mechanisms that cause these respiratory changes, particularly during sleep, may come from elimination by chemical drugs and respiratory nerve control or by reducing wakefulness by

changing the duration of sleep stages or by reducing the amount of REM (Rapid Eye Movement).(35)Thus, mouth breathing becomes an alternative to increased oxygen uptake by these people as their nasal breathing will be obstructed.(34)

3. Non-breastfeeding child

A study conducted by Savian et al in 2021 showed the prevalence of mouth breathing was 44% (95% CI: 38-49) (total N = 1182). Exclusive breastfeeding is a protective factor against the development of mouth breathing (OR = 0.62; 95% CI: 0.41-0.93). The likelihood of developing mouth breathing were 41% and 34% lower among children who were breastfed for more than 12 months and more than 24 months, respectively.(36)The mechanism of breastfeeding in newborns is very complex, and requires the central nervous system to coordinate procedures for sucking, breathing, and swallowing.(37,38)Children who were exclusively breastfed (EBF) during the first months of life showed a physiological sucking pattern with more sucking movements, and were more coordinated when compared to those who were artificially bottle-fed; This phenomenon occurs because the orofacial muscles are less trained in infants who are fed formula milk, therefore the muscles are more flaccid and hypotonic.(39)Breastfeeding helps nasal breathing because the physiology of this activity prevents air from entering through the mouth during breastfeeding thereby forcing air through the nose and stimulating all the orofacial muscles.(40)In addition, the nutritional and immunological protection provided by breast milk prevents or reduces the risk of respiratory tract infections, which can result in inhalation through the mouth due to nasal congestion.(39)

Signs and Symptoms

The examination included a clinical evaluation of the following intra and extraoral characteristics: Dark circles under the eyes (bilateral discoloration of the lower eyelid and periorbital socket, ranging from purple to dark brown in color), dry lips (dry and chapped lips), head posture forward (distance from the cervical spine more than 6 cm from the vertical tangent to the thoracic spine), Tonsil hypertrophy, Pale (abnormal loss of skin color), Cleft between the lips (distance from the lowest part of the upper lip to the very top of the lower lip), Eversion of the lower lip (thick and outward directed lower lip), exposed incisors (measured from the lowest point of the upper lip to the incisal edges of the maxillary teeth > 2mm at rest), compression of the maxilla (deep or narrow palate), palate deep (high domed or ogival-shaped palate), Interposition of the tongue in the phoneme (usually pushing the tongue forward when speaking), protrusion of the maxillary incisors (incisors in the vestibular position), gingivitis, oral biofilm (mixed heterogeneous microbial community -aerobic and anaerobic-surrounded by an intercellular matrix of salivary polymers or microbes adhering to the tooth surface), nasal permeability, anterior open bite, posterior cross bite, long face, maxilla and mandible retrognathic.(3,5,19)

Pathophysiology

A reduced incidence of competent lip on the upper lip in children is associated with high nasal resistance, therefore, an open mouth posture allows adequate intake of air by mouth. Perhaps because the muscles around the nose are not used physiologically, some atrophy also occurs in the upper lip, causing lip hypotonus. Mouth breathing usually develops as a consequence of nasal resistance. In one study, nasal obstruction was induced in experimental animals. Obstruction results in mouth breathing, narrowing of the maxilla, increased lower face height, malocclusion and dental abnormalities. The maxilla and mandible are retracted in patients with mouth breathing and obstructive sleep apnea, resulting in reduced oral area, reduced functional space for the tongue, which in turn takes a more posterior position, thus supporting, upper airway obstruction during sleep. Lymphoid tissue hypertrophy plays an important role in the pathophysiology of mouth breathing and sleep apnea in children. Maintaining nasal breathing during childhood is important for preventing skeletal disorders. The habit of breathing through the mouth is often accompanied by a habitual posture of the anterior tongue instead of covering the lips to create the anterior seal needed to initiate physiological deglutition.(22)

Diagnosis

Early diagnosis is very important for the correction of mouth breathing and to avoid associated conditions. Correctly diagnosing habitual oral breathing may require a detailed history, clinical examination, and diagnostic tests. In the history, there are several points that need to be asked whether the patient snores, sleeps with his mouth open, drools' during sleep, complains of nasal congestion every day, keeps his mouth open even when not focused, is very drowsy during the day, has headaches when he wakes up, is easily tired, often have allergic reactions, have trouble at school, have trouble concentrating. A clinical examination is then performed to check for the signs and symptoms described above. Patients with the habit of breathing through the mouth need to be fully diagnosed through the various clinical trials available. The mirror test and water retention test are the most cited breathing tests in the literature. The lip seal test is the most frequently used, followed by the mirror test and water retention test. (6,41)

Mirror test: Mirror test is also called fog test. A double-sided mirror is installed between the nose and mouth. The generation of steam on the side of the nose from the mirror indicates exhalation through the nose if steam is formed in the mirror area above the mouth, then the patient is breathing through the mouth. If the steam diameter reaches 30mm then the nasal breath flow is low, if it is 30-60mm then average and if it is above 60mm high.(3,41)

Massler's water retention test: The patient was asked to hold back approximately 15ml of water. Patients with the habit of breathing through the mouth cannot hold water for too long.(3,41)

Massler butterfly test and zwemer / cotton test: A butterfly-shaped strand of cotton is placed over the upper lip under the nostrils. On exhalation if the fibers vibrate downward, the patient breathes through the nose and if the fibers vibrate upward, the patient breathes through the mouth.(3)

Cephalometry: Can be used to calculate the number of nasopharyngeal spaces, the size of the adenoid glands and to find out the patient's skeletal pattern by taking various angles of cephalometry.(3)

The widely used Friedman score on a global scale is used for the assessment of the stage of obstruction at the level of the mesopharynx in the tongue. This is a modification of the Mallampati classification where the tongue is in the oral cavity during examination.(42)

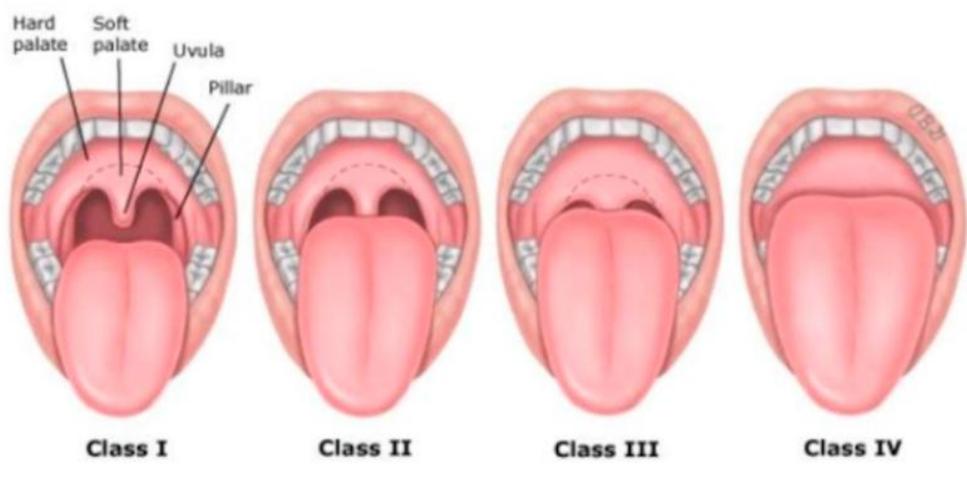


Figure 3. Representative image for the Mallampati score; Class I: When the tongue is in the oral cavity, the tonsils, lateral column and entire uvula are easy to examine; B: Class II — The entire soft palate and uvula are visible, excluding the palatal tonsils; C: Class III - part of the soft palate is visible but not the entire uvula; Class IV: only the soft palate is visible

Effects of Mouth Breathing

1. Disruption of skeletal and dentofacial development and the occurrence of malocclusion

While the craniofacial structures grow, they adapt to different breathing patterns during mouth breathing. Changes in the facial muscles affect dental arches and tooth position, associated with structural disorders of the lips, tongue, palate and mandible with subsequent facial deformities. In addition, mouth breathing decreases masticatory activity, reducing the vertical effect on the posterior teeth, which can negatively affect their vertical position, leading to malocclusion. These changes are characterized by: a long face with an increase in the height of the lower anterior face, a narrowed arch of the maxilla, an increase in palatal height with a reduction in the area and volume of the palatal surface, crowded teeth, narrowed nasal airways, and enlarged nostrils. The lower jaw continues to retract in growth with increasing mandibular plane angles and genial angles, resulting in a small chin, dental malocclusion (Class II), hypotonic upper lip,

hypertonic lower lip, protrusion of the anterior teeth and prominent nose, with an unfavorable profile. In addition, it has been hypothesized that the reduction in mandibular growth in children with adenoid faces is due to abnormal secretion of nocturnal growth hormone and its mediators. Hormone secretion normalized after adenotonsillectomy and rehabilitation of mouth breathing, with accelerated growth of the mandible and changes in its growth direction. This can be explained by more intensive endochondral bone formation in the condylar cartilage and / or by growth of appositional bone at the lower border of the mandible, after restoration of normal nasal breathing and hormonal status.(7,9,11,14,18)

2. Lung function and respiratory muscles

The upper airways are the structures most responsible for increasing resistance with increased airflow, therefore factors that change the diameter of the airways (the same as nasal obstruction) can change the resistance of the structure. Failure in filtration, humidification and heating of the inhaled air stimulates an increase in the presence of leukocytes in the blood, increases pulmonary hypersensitivity and decreases their volume and capacity. In addition, there is evidence that upper airway or nasal obstruction determines disruption of the afferent nerves with a profound effect on respiration and pulmonary airway caliber, negatively affecting chest expansion and alveolo-pulmonary ventilation. The prominent inspiratory movement of the upper chest affects the thoracoabdominal mechanism by changing the position of the diaphragm muscle and its zone of aposis due to a decrease in intra-abdominal pressure. This fact can lead to the development of chest deformities, such as an elevation of the last ribs, displacement of the upper part of the chest cage and an increase in lumbar lordosis. Nasal obstruction can cause decreased olfactory stimulation, increased lung hyperresponsiveness and nasal congestion. Therefore, upper airway obstruction can cause mouth breathing, impaired ventilation and chest expansion, which in turn result in impaired development of the chest cavity. Changing breathing patterns with mouth breathing also implies the need for postural adaptation.(12)

3. Dimensions of the palate

Several factors influence craniofacial growth and development, including genetic and environmental factors. Breathing through the nose is a stimulus for harmonious craniofacial growth and development. The existence of mouth breathing in children can cause changes in the facial frame and morphology of the hard palate. Children with mouth breathing have a significantly higher mean depth of the hard palate in the molar region. It can be concluded that the mode of breathing affects the dimensions of the palate. Mouth breathing causes morphological changes in the hard palate because the absence of negative pressure on the nasal cavity prevents the palate from descending and the action of the bones and other facial muscles that help compress the outer arch of the maxilla, thus the growth is more prominent vertically.(17)

4. Sensory changes

Hearing sensory shows a strong association with mouth breathing, due to the prevalence of chronic otitis as a result of poor auditory tube function. Therefore, these changes can

interfere with the perceptual capacity of speech sounds, determine a lack of attention and concentration, leading to developmental delays. There is also a close relationship between smell and taste, because the taste receptors ecstasy are caused by smell, and the possibility of a sensory decrease in taste perception due to mouth breathing.(21)

5. Posture Changes

The head posture that is closer to the anterior is a strategy adopted by children who breathe through the mouth to facilitate airflow. The more anterior position of the head is a combination of extension of the upper cervical spine, flexion of the cervical spine and chest leading to increased cervical lordosis. Prolonged anterior posture of the head causes increased tension in the extensor muscles of the head and stretches of the infrahyoid muscles creating inferior and posterior traction of the hyoid bone. As a result, the mandible retracts and becomes depressed.(43)

6. Poor physical and learning abilities

Lack of oxygen and hormonal factors make children who breathe through the mouth tend to be obese, tire easily, and not doing well in school. They are not physically athletic. Also mouth breathing shows cognitive impairment as well as attention deficit hyperactivity disorder (memory, concentration, attention, learning disabilities, low perception and sensorimotor integration); while surgical treatments that restore nasal breathing also benefit learning abilities. This may be related to sleep disturbances because it has been shown that children with excessive daytime sleepiness appear to have an almost 10-fold risk of developing learning difficulties. It has also been suggested that breathing through the mouth and not through the nose can negatively affect brain function. It has been thought that oral breathing associated changes in the central nervous system can be caused by changes in acid-base balance, with the resultant respiratory acidosis. This affects the activity of potassium channels that are sensitive to ATP, which plays an important role in central nervous system function.(11)

7. Atopy

Atopic dermatitis is a chronic skin disorder characterized by pruritus and inflammation that mostly develops during childhood and is strongly associated with the patient and relative's allergic history.(13,44)Filaggrin, which is encoded by the FLG gene, is a protein essential for skin barrier function.(13,45)children with the abnormal FLG gene were 3.12–4.78 times more likely to have atopic dermatitis than normal subjects.(13)It is possible that periodontal disease and / or tonsillitis may mediate the mechanisms underlying any association between mouth breathing and dermatitis atopic.(13,46)

8. Increase asthma morbidity

In an assessment of the respiratory patterns of children with asthma, a cohort study of asthmatic children between the ages of 3 and 6 years revealed that mouth breathing was more common in children with asthma. Therefore, people with asthma have a higher tendency to breathe through the mouth, and mouth breathing can predispose to the evolution of more severe craniofacial changes, such as increased overjet and opening, abnormal swallowing and speaking, and a long facial profile. Mouth breathing can

increase asthma morbidity, possibly through increased sensitivity to inhaled allergens, highlighting the risk of mouth bypass breathing in the 'one airway, one disease' concept'. (47,48)

Management

There are several things that need to be considered in treating pediatric patients with the habit of mouth breathing:

1. Age of children: Mouth breathing in most cases is self-correcting after puberty. This can be attributed to the development of the nasal passages as the child grows, thereby reducing the obstruction caused by adenoid enlargement.
2. ENT examination: An otorhinolaryngologist examination may be recommended to determine whether a condition requiring treatment is in the tonsils, adenoids or nasal septum. If the habit continues after the cause is removed, this condition is habitual.
3. Prevention and interception: mouth breathing can be prevented by using an oral screen(5).

The use of oral screens has been seen as the standard management protocol for mouth breathing. Knowledge of the effects of adjunct therapy should be noted in order to better understand the pathogenesis as well as limit the progression of the condition. Oral screens have become suitable tools for lip training which act to stretch the lip muscles, exert a force to push out the proclinated incisors, and also strengthen the lips at the same time. Surgical management alone does not convert a child with oral breathing to nasal breathing without any other intervention.(49)Speech therapy combined with beclomethasonedipropionate inhalation has more effective clinical and functional control for asthma, allergic rhinitis, and mouth breathing.(50)The use of porous oral patch which is a porous skin pad consisting of three layers: silicone sheet, polyurethane foam, and polyurethane film, used for the management of obstructive sleep apnea and obstructive mouth breathing during sleep has shown benefits.(51)As for the surgical approach, studies have demonstrated the benefit of adenotonsillectomy for 18 children with adenotonsillar hypertrophy to allow return of nasal breathing, benefits for dental occlusion, support for adequate facial morphofunctional development.(52)Another article analyzed the effects of rapid maxillary expansion surgery on 29 children and found that this procedure, by itself, is not justified in inducing a nasal breathing pattern in children with habitual mouth breathing.(53), (54), (55), (56), (57).

CONCLUSION

Mouth breathing is defined as a series of signs and symptoms, all or part of which are present in an individual, which for various reasons displaces the correct nasal breathing pattern into an oral or mixed pattern of breathing. Mouth breathing can be categorized into 3 types based on the etiology, namely obstructive, habitual, and anatomical. The etiology and risk factors for mouth breathing are nasal obstruction, adenoids, and children who are not exclusively breastfed. Mouth breathing is characterized by many symptoms, some of which are class II relations, maxillary incisor protrusion, anterior open bite, long face and others. This habit is diagnosed through a comprehensive history as well as tests such as the mirror test, water retention test and lip seal test. Management

generally includes the use of oral screens and may also be through surgery to correct the cause of the obstruction but still must be accompanied by other measures to correct the habit if it occurs habitually.

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