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# The Effects of Mouth Breathing on Maxillofacial Growth in Children and Adolescents with Adenoid Hypertrophy: A Scoping Review

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## ABSTRACT

**Introduction:** Mouth breathing is a mode of breathing that replaces normal breathing through the nose, which is usually caused by an obstruction of the respiratory tract. The habit of breathing through the mouth can cause changes in maxillofacial morphology.
**Methods:** Article searches were done on PubMed, EBSCO Essentials, and Google Scholar electronic databases. Inclusion criteria included study subjects aged 3-18 years old who had a habit of breathing through their mouths due to adenoid hypertrophy. Articles that were reviewed were published from 2017 to October 2022.
**Results:** With a total of 1107 articles, 2 articles were identified through PubMed, 663 articles were identified through EBSCO Essentials, 424 articles were identified through Google Scholar, and 18 articles were identified through handsearching. After the selection process using the PRISMA-ScR flow diagram, 13 articles were taken for review. extract gel in experimental animals.
**Conclusion:** Children and adolescents with adenoid hypertrophy experience several changes in the maxillofacial structure due to the habit of mouth breathing. Children and adolescents with adenoid hypertrophy experience several changes in the maxillofacial structure due to the habit of mouth breathing.

***Keywords:*** Adenoid hypertrophy, airway obstruction, maxillofacial growth, mouth breathing

## INTRODUCTION

Mouth breathing is a mode of breathing that replaces normal breathing through the nose.[1] Mouth breathing has a complex and multifactorial etiology. Multifactorially, mouth breathing is commonly caused by nasal obstruction due to adenoid hypertrophy, tonsil hypertrophy, nasal septum deviation, turbinate hypertrophy, nasal polyps, sinusitis, or allergic rhinitis.[1–3] According to Moss's Functional Matrix Theory, normal respiratory function is necessary for a proper and balanced growth of the head and facial structures.[4] The theory is based on the principle of interaction between the functions of respiration, mastication, and swallowing which can affect the direction and amount of growth.[5] In general, the growth and development of maxillofacial, as part of craniofacial, is predominantly influenced by internal factors in the form of genetic factors, as well as external factors such as masticatory function.[6] Abnormalities of head and facial growth internally result from certain combinations of genes inherited from one or both parents, or due to changes in genes during pregnancy.[7] Genetic influences predominantly affect anterior facial height, maxillary and mandibular prominence, face/nose width, nasal root shape, nasolabial angle, allometry, and centroid size.[8] Environmental factors that affect head and facial growth can originate from the

mother's habits and lifestyle during pregnancy, such as smoking, drinking alcohol, consuming drugs, and allergens.

The most common congenital abnormalities are cleft lip with or without cleft palate and cleft palate, and nonsyndromic/syndromic craniosynostosis.[9,10]

Mouth breathing, low tongue posture, and high elongation of the lower anterior face may begin to be seen by age 3, but are usually detected after the age of 5. The poor influences of the habit of mouth breathing on the face stop after entering puberty.[11,12] Characteristics of growth spurt of the maxilla and mandible affect changes in facial profile, determining the diagnosis of jawbone disharmony, appropriate treatment time, and stability of treatment results. Research by Li shows that there is an effect of breathing through the mouth on the maxillofacial area. The study states that the most dominant influence on the maxilla and mandibular ramus occurs in the early stages of growth and development, while on the lips it occurs at all stages of growth and development.[13] Changes in maxillofacial morphology occur due to the habit of mouth breathing, which results in adaptive changes to the lips, tongue, and mandible, and subsequently results in skeletal changes by neuromuscular responses.[14]

Individuals who have a habit of mouth breathing often have a distinctive facial characteristic called "adenoid facies".[15] This face has the characteristics of open lip posture, muscle hypotonia, narrowing of the nose shape, proclination of the maxillary incisors, proclined lower lip, increased lower anterior facial height, maxillary constriction, high palate, high mandibular plane, anterior position of the tongue, mandibular retrognathism, and blank facial expression.[16] The results of Harari's study showed that the group of subjects who breathed through their mouth experienced downward and backward rotation of the mandible, increased overjet, increased palatal plane, and narrowed maxillary and mandibular dental arches.[2] Muñoz in his study reported that his mouth breathing subjects had class II malocclusion, crossbite, increased palatal height and overjet, and a dominantly vertical mandibular growth.[17]

The process of mouth breathing can cause a variety of functional changes, including the balance between the oral, perioral, and facial expression muscles which play a role in opening the mouth for air to enter.[4,18] When breathing through the mouth, the buccinator muscles tighten the cheeks, thereby pressing the maxillary teeth which causes the palate and maxillary dental arch to narrow.[18]

The orbicularis oris muscle shortens when the mouth is not closed, thus making the facial morphology become unbalanced, while the mentalis muscle experiences hypertrophy due to excessive effort to close the mouth.[19] These muscles, which continue to compress the jaw during mouth breathing, exert pressure on the jaw backwards, hindering its growth.[18–20]

The habit of mouth breathing and its effect on maxillofacial structures is still a controversial topic.[1] There are studies that have found no causal relationship between mouth breathing and vertical growth patterns of the head and face. However, children with long faces are more likely to have a habit of breathing through their mouths.[3]

The purpose of this scoping review is to examine the results of the last 5 years of research regarding the effects of mouth breathing on maxillofacial growth and development. This study is expected to be a preventive material for clinicians to be more aware of the maxillofacial changes that can occur due to mouth breathing, and the importance of detecting this habit early in children.

## METHODS

**Table 1. Literature search strategy**

| Database | Search strategy | Articles found |
|---|---|---|
| PubMed | (mouth breathing) AND (maxillofacial) AND (growth) AND (children) Filters: Free full text, From 2017-2022 | 2 |
| EBSCO Essentials | (mouth breathing) AND (maxillofacial) AND (growth) AND (children) Filters: Free full text, From 2017-2022, articles in English | 663 |
| Google Scholar | Mouth breathing, maxillofacial, growth, children/adolescents, nasal obstruction. Filters: From 2017-2022 | 442 |

The research conducted was a literature study using the scoping review method. The articles reviewed are taken from the PubMed, EBSCO Essentials, and Google Scholar electronic databases, which were published from 2017 to October 2022. Some of the keywords used were “mouth breathing”, “maxillofacial”, “growth”, “children/adolescents”, and "nasal obstruction". The inclusion criteria include research subjects of children aged 3-18 years old who had a habit of breathing through their mouths due to airway obstruction caused by adenoid hypertrophy. The articles included are those that are available in full-text and are in both English and Indonesian. Articles that discuss maxillofacial growth disorders that are not caused by mouth breathing and articles in the form of literature reviews are excluded.

Article searches in the PubMed, EBSCO Essentials, and Google Scholar databases are performed using the AND and OR operator Boolean features if available, so that the search results are more relevant to the sought topic. The search is carried out by entering a combination of predefined keywords (Table 1). Furthermore, the selection of article was carried out with the help of the PRISMA-ScR flowchart.

## RESULTS

The article selection process is shown in the PRISMA-ScR (Preferred Reporting Items for Systematic Reviews and Meta-Analyses Extension for Scoping Review) flowchart (**Figure 1**). A total of 1107 articles were identified, 2 of which were identified through PubMed, 663 articles identified through EBSCO Essentials, and a search through Google Scholar produced 424 articles. A search by hand searching identified 18 articles. The first elimination stage was identifying duplicate articles, and 99 articles were excluded. The next stage of selection is done by screening the title and abstract. A total of 978 articles were excluded because they did not match the topic of the problem and/or did not meet the inclusion

criteria. The next stage is selection by reading the contents of the entire text. Out of 30 articles, 13 were selected for further review, and the rest were excluded because they were irrelevant or did not meet the inclusion criteria.

The search results in the database yielded 13 articles that had been selected and assessed to meet the inclusion criteria. The general data and research results from the selected articles regarding the effect of mouth breathing on maxillofacial growth are listed in **Table 2**.

A total of four articles examined the relationship between mouth breathing and craniofacial/maxillofacial/dentofacial.[3,13,21,22] Two articles looked at the effects of airway obstruction on dentofacial and craniomaxillofacial structures, and their relationship to malocclusion.[23,24] Meanwhile, three articles focused on adenoid hypertrophy as the type of obstruction and examined its effect on craniomaxillofacial development.[25–27] One article compared differences in craniofacial characteristics between individuals with habitual mouth breathers and those with obstructive sleep apnea.[28] One article assessed dental arch dimensions in individuals with adenoid hypertrophy,[29] while one article analyzed the relationship of mouth breathing to palatal dimensions.[30] One article conducted a study on the effects of mouth breathing on facial soft tissue.[31]

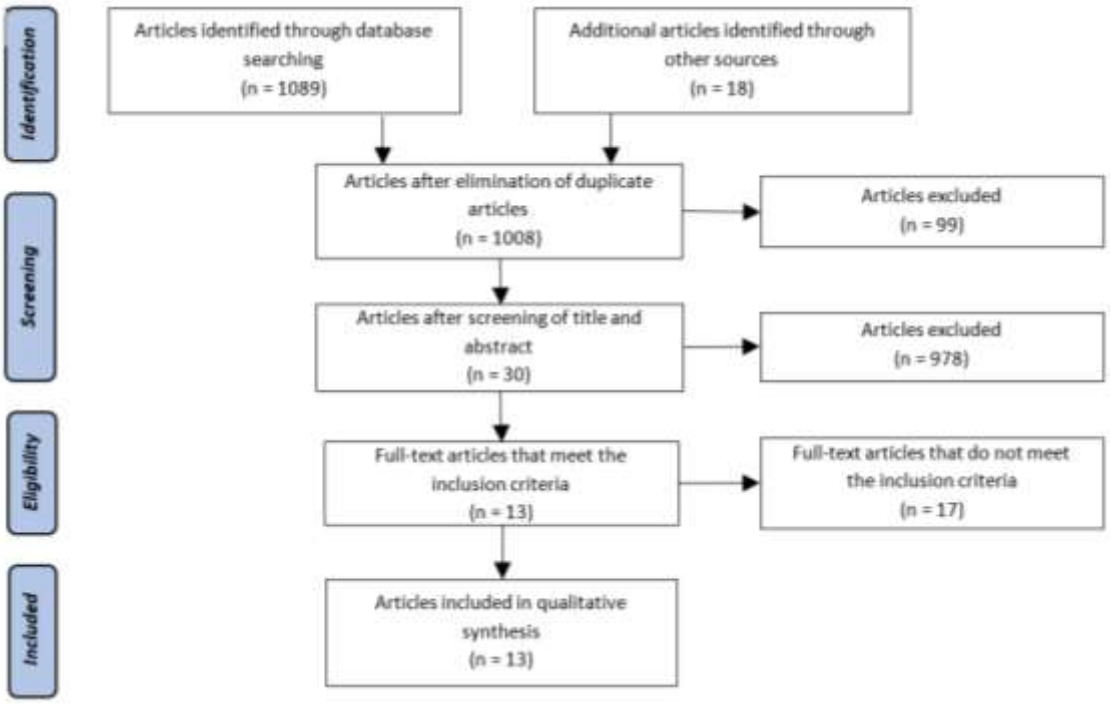


**Figure 1. Article selection using the PRISMA-ScR flowchart**

## DISCUSSION

A balance between normal functions of breathing, chewing and swallowing must be obtained in order for proper head and facial development to occur.[5] Therefore, mouth breathing that replaces nasal breathing is said to disturb this balance, causing changes in the structure of the head and face. Mouth breathing is often caused by obstruction of the respiratory tract in the form of adenoid hypertrophy, which reaches its maximum size at the age of 12 to 13 years.[32] Individuals who breathe through their mouths often have facial characteristics called adenoid facies.[15]

One of the most visible features is the posture of the lips that tend to open, as found in two research articles.[13,25] A research conducted using a questionnaire suggests a possible correlation between the open mouth posture and mouth breathing.[33] Two articles stated that the upper lip appeared protrusive in mouth breathing subjects.[13,31] A previous study showed that there were significant differences in upper and lower lip protrusion between the mouth breathing and nose breathing groups.[34] This may be due to a shortened lower lip in consequence of having to open continuously to allow air to enter. The condition of the lips that continue to open can cause the lips to experience hypotonia.[35] One article mentions that the nasal cavity becomes smaller due to mechanical obstruction of the adenoid tissue, which can cause obstruction and abnormalities in blood circulation of the nose.[27]

Four articles mention an increase in the height of the anterior lower face in individuals who breathe through their mouths,[3,22,26,31] resulting in faces that appear more oval compared to people who have normal breathing. The increase in the height of the anterior lower face occurs due to the vertical growth pattern being more dominant, which results in a leptoprosopic face type, also called the "long face syndrome",[36] and shows a dolichofacial facial shape.[37] The pattern of facial growth can be seen by taking measurements related to the direction of mandibular growth, so that facial growth can be determined whether it is balanced (mesofacial), has a dominant horizontal growth (brachyfacial), or a dominant vertical growth (dolicofacial).[38] A face that looks convex is mentioned in one article.[21]

**Table 2. General data and results of articles reviewed**

| Author, Publication Year | Location | Research Title | Number & Age of Subjects | Results |
|---|---|---|---|---|
| Angelescu, et al.[3] (2019) | Romania | Assessment of Craniofacial Morphology in Mouth Breathing Children | 80 subjects<br>Aged 6-13 yeard old | The Mouth Breathing group showed:<br>Large facial index<br>Larger ratio of lower facial height<br>Short upper lip (not significant) |
| Li, J., et al.[13] (2022) | China | Effects of mouth breathing on maxillofacial and airway development in children and adolescents with different cervical vertebral maturation stages: a cross-sectional study | 120 subjects<br>Aged 7-15 years old | Underdeveloped body of the mandible<br>Inferior-posterior mandibular rotation<br>Protruded upper lip<br>Shortened length of the upper and lower lips<br>Proclined maxillary incisors<br>Open lip posture |
| Vukićević, et al.[24] (2017) | Serbia | Radiographic cephalometry analysis of head posture and craniofacial morphology in oral breathing children | 60 subjects<br>Aged 8-14 years old | The Mouth Breathing group showed:<br>Mild maxillary retrognathia<br>Skeletal Class II malocclusion<br>Greater facial convexity |
| Chambi-Rocha, et al.[27] (2018) | Spain | Breathing mode influence on craniofacial development and head posture | 98 subjects<br>Aged 7-16 years old | The Mouth Breathing group showed:<br>Increase in lower anterior facial height (10-16 years old group)<br>Greater palate length (age group 10-16 years)<br>Large inclination of the mandibular plane |
| Acharya, et al.[21] (2018) | Nepal | Effect of Naso-respiratory Obstruction with Mouth Breathing on Dentofacial and Craniofacial Development | 90 subjects<br>Aged 10-14 years old | The Mouth Breathing group showed:<br>Increased overjet<br>Increased inferior-posterior mandibular rotation<br>Significant increase in mandibular plane angle<br>Higher palatal plane<br>Narrowing of the upper and lower arches in the canines and 1st molars<br>Class II malocclusion (three times more than class I)<br>Posterior crossbite<br>Abnormal lip seal |
| Anggraini, et al.[23] (2018) | Indonesia | Malocclusion in Mouth-Breathing Children Caused by Nasal Obstruction | 7 subjects<br>Aged 7-16 years old | Three subjects with the habit of mouth breathing for 1-2 years do not have malocclusion<br>One subject with the habit of mouth breathing for 2-3 years had an anterior open bite<br>Two subjects with the habit of mouth breathing for more than 3 years have class II division 1 malocclusion<br>One subject with the habit of mouth breathing for more than 3 years has a class II division 1 malocclusion with posterior crossbite |
| İnönü-Sakallı, et al.[22] (2021) | Türkiye | Comparative Evaluation of the Effects of Adenotonsillar Hypertrophy on Oral Health in Children | 120 subjects<br>Aged 3-14 years old | The Mouth Breathing group showed:<br>V-shaped narrowing of the maxillary arch (95%)<br>Adenoid facies (95%)<br>Open mouth posture (82.5%) |

| | | | | |
|---|---|---|---|---|
| | | | | Anterior/inferior tongue position (26%)<br>Mandibular retrognathia (92.5%)<br>Prognathic maxillary anterior teeth (37.5%)<br>Retrognathic mandibular anterior teeth (50%)<br>Class II division 1 malocclusion (64.3%)<br>Class I malocclusion (14.3%) |
| Zhang, L. & Liu, H.[25] (2022) | China | Influence of Adenoid Hypertrophy on Malocclusion and Maxillofacial Development in Children | 102 subjects<br>Aged 3-12 years old | The Adenoid Hypertrophy group showed:<br>Higher incidence of malocclusion<br>Posterior rotation of the mandible<br>Growth of the mandible in a posterior direction<br>Increased mandibular angle<br>Elongation of facial height<br>Developmental malformations of the face and jaw |
| Li, H., et al.[31] (2022) | China | Influences of Airway Obstruction Caused by Adenoid Hypertrophy on Growth and Development of Craniomaxillofacial Structure and Respiratory Function in Children | 98 subjects<br>Aged 4-12 years old | The Adenoid Hypertrophy group showed:<br>Mandibular retrognathia<br>Large angle of the mandibular plane<br>Narrowing of the nasal cavity |
| Feng, et al.[26] (2021) | China | Differences of Craniofacial Characteristics in Oral Breathing and Pediatric Obstructive Sleep Apnea | 317 subjects<br>Aged 5-16 years old | The Mouth Breathing group has a longer mandibular length than the Obstructive Sleep Apnea group<br>The growth direction of the mandible in the Mouth Breathing group is greater than in the Obstructive Sleep Apnea group |
| Osiatuma, et al.[28] (2017) | Nigeria | Dental Arch Dimensions of Nigerian Children with Hypertrophied Adenoids | 180 subjects<br>Aged 3-12 years old | The Adenoid Hypertrophy group showed:<br>Shorter maxillary arch dimensions<br>Shorter mandibular arch dimensions, except for the intermolar width<br>Shorter palate length<br>Increased palatal height in the canines, premolars, and molars<br>Reduced palate volume |
| Indiarti, et al.[29] (2017) | Indonesia | Changes in the palatal dimensions of mouth breathing children caused by nasal obstruction | 7 subjects<br>Aged 7-16 years old | 57% of the subjects have a high palate height (mouth breathing habit for more than 3 years)<br>14% of the subjects have a moderate palate height (mouth breathing habit for 2-3 years)<br>29% of the subjects have a low palate height (mouth breathing habit for 1-2 years) |
| Cheng, et al.[30] (2022) | China | A Study of the Facial Soft Tissue Morphology in Nasaland Mouth-Breathing Patients | 65 subjects<br>Aged 10-12 years old | The Mouth Breathing group exhibited a more protrusive upper lip and an increase in lower anterior facial height compared to the Nasal Breathing group<br>For male subjects, the lower lip was longer in the Mouth Breathing group than in the Nasal Breathing group<br>For female subjects, the Mouth Breathing group had a narrower mandibular width, a smaller ratio of mandibular width to facial height, and a greater ratio of lower lip height to lip width than the Nasal Breathing group |

Research by Milanesi showed that individuals who breathe through their mouths have the opportunity to have a convex facial profile 3.78 times higher than having a straight face profile.[39] Changes in facial profile that occur may be related to the length of time the habit of breathing through the mouth was started. One study found that subjects with convex facial profiles had the habit of mouth breathing for more than 3 years.[40]

Malocclusion is one of the impacts that often occurs due to mouth breathing. The most common occlusion relation found is skeletal class II malocclusion.[3,21,24,25] Acharya's research found that in the mouth breathing group, class II malocclusion was three times more than class I.[23] In addition, there was also an increase in overjet,[23] posterior crossbite,[23,24] and proclined maxillary anterior teeth.[13] Studies in two articles found a narrow V-shaped arch in both the maxilla and mandible.[23,25] The occurrence of narrowing of the maxillary arch is also known as maxillary constriction, which is a condition of reduced transverse dimensions of the maxilla.[41] Osiatuma found that subjects with adenoid hypertrophy had shorter dimensions of the maxillary and mandibular arches compared to subjects without adenoid hypertrophy.[29] The narrowing of the maxillary arch occurs due to the buccinator muscles which continue to apply lingual pressure to the maxillary teeth, especially to premolars and molars.[42] This pressure also causes the palate to become higher and deeper,[24,29,30] and its volume decreases.[29]

There are four articles that mention that the angle of the mandibular plane is greater in mouth breathing subjects compared to nasal breathing subjects.[22,23,26,27] Three articles found that the mandible was rotated in the posterior and inferior direction (clockwise rotation).[13,23,26] A study found a significant increase in the Articulare-Gonion-Menton angle in the mouth breathing group, which showed an increase in mandibular clockwise rotation. Mandibular clockwise rotation is characterized by an increase in lower anterior facial height and a decrease in posterior facial height.[43] Mandibular retrognathia is mentioned in two articles,[25,27] while one article mentions mild maxillary retrognathia and is not significant.[21] Zheng's research results indicate that individuals with the habit of mouth breathing has a greater tendency to experience mandibular and maxillary retrognathia compared to those who have normal nasal breathing.[4] Poor growth of the mandible can be caused by narrowing of the maxilla. Constriction of the maxilla limits the growth of the mandible laterally and anteriorly, thereby affecting its shape, posture and size.[44]

## CONCLUSION

The habit of mouth breathing, which often causes obstruction of the respiratory tract, can cause changes in the maxillofacial structure. Individuals who breathe through their mouths often show specific facial features, called “adenoid facies”. A review of several articles found several changes in the maxillofacial structures due to mouth breathing, including open lip posture, protrusive upper lip, decreased nasal cavity, increased lower anterior facial height, malocclusion, narrowing of the arch, high palate, large mandibular plane angle, clockwise rotation of the mandible, and retrognathic mandible.

### *Declaration by Authors*

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## REFERENCES

1. Zhao Z, Zheng L, Huang X, Li C, Liu J, Hu Y. Effects of mouth breathing on facial skeletal development in children: a systematic review and meta-analysis. BMC Oral Health [Internet] 2021;21(1):1–14. Available from: https://doi.org/10.1186/s12903-021-01458-7

2. Harari D, Redlich M, Miri S, Hamud T, Gross M. The effect of mouth breathing versus nasal breathing on dentofacial and craniofacial development in orthodontic patients. Laryngoscope 2010;120(10):2089–93.
3. Angelescu D, Angelescu T, Simu MR, Muntean A, Mesaros AS, Berbece S, et al. Assessment of Craniofacial Morphology in Mouth Breathing Children. 2019;3649–53.
4. Zheng W, Zhang X, Dong J, He J. Facial morphological characteristics of mouth breathers vs. nasal breathers: A systematic review and meta-analysis of lateral cephalometric data. Exp Ther Med 2020;3738–50.
5. Molina OF, Mendes AS, da Silveira IR, Collier KF, Santos ZC, Penoni VB, et al. Craniofacial, Oral and Dental Manifestations of Oral Breathing. Amazônia Science & Health 2018;6(1):34–42.
6. Hsu HY, Yamaguchi K. Decreased chewing activity during mouth breathing. J Oral Rehabil 2012;39(8):559–67.
7. Farhan TM, Al-Abdely BA, Abdullateef AN, Jubair AS. Craniofacial Anomaly Association with the Internal Malformations in the Pediatric Age Group in Al-Fallujah City-Iraq. Biomed Res Int 2020;
8. Richmond S, Howe LJ, Lewis S, Stergiakouli E, Zhurov A. Facial genetics: A brief overview. Front Genet 2018;9.
9. Pereira A V., Fradinho N, Carmo S, De Sousa JM, Rasteiro D, Duarte R, et al. Associated Malformations in Children with Orofacial Clefts in Portugal: A 31-Year Study. Plast Reconstr Surg Glob Open 2018;6(2):1–7.
10. Azoulay-Avinoam S, Bruun R, MacLaine J, Allareddy V, Resnick CM, Padwa BL. An Overview of Craniosynostosis Craniofacial Syndromes for Combined Orthodontic and Surgical Management. 2020;32(2):233–47.
11. Basheer B, Hegde KS, Bhat SS, Umar D, Baroudi K. Influence of mouth breathing on the dentofacial growth of children: a cephalometric study. J Int Oral Health 2014;6(6):50–5.
12. Malhotra S, Pandey RK, Nagar A, Agarwal SP, Gupta VK. The effect of mouth breathing on dentofacial morphology of growing child. Journal of Indian Society of Pedodontics and Preventive Dentistry 2012;30(1):27–31.
13. Li J, Zhao Z, Zheng L, Daraqel B, Liu J, Hu Y. Effects of mouth breathing on maxillofacial and airway development in children and adolescents with different cervical vertebral maturation stages: a cross-sectional study. BMC Oral Health [Internet] 2022;22(1):1–9. Available from: https://doi.org/10.1186/s12903-022-02234-x
14. Lin L, Zhao T, Qin D, Hua F, He H. The impact of mouth breathing on dentofacial development: A concise review. Front Public Health 2022;10(9).
15. Pawłowska-Seredyńska K, Umławska W, Resler K, Morawska-Kochman M, Pazdro-Zastawny K, Kręcicki T. Craniofacial proportions in children with adenoid or adenotonsillar hypertrophy are related to disease duration and nasopharyngeal obstruction. Int J Pediatr Otorhinolaryngol 2020;132.
16. Graber LW, Vanarsdall Jr. RL, Vig KWL, Huang GJ. Orthodontics: Current Principles and Techniques. 6th ed. St. Louis: Elsevier; 2016.
17. Muñoz ICL, Orta PB. Comparison of cephalometric patterns in mouth breathing and nose breathing children. Int J Pediatr Otorhinolaryngol [Internet] 2014;78(7):1167–72. Available from: http://dx.doi.org/10.1016/j.ijporl.2014.04.046
18. Grippaudo C, Paolantonio EG, Antonini G, Saulle R, La Torre G, Deli R. Association between oral habits, mouth breathing and malocclusion. Acta Otorhinolaryngologica Italica 2016;36(5):386–94.
19. Mattos FMGF, Bérzin F, Nagae MH. The impact of oronasal breathing on perioral musculature. Revista CEFAC 2017;19(6):801–11.
20. Manalip PH, Anindita PS, Tendean LEN. Gambaran Kebiasaan Bernapas Melalui Mulut dan Gigi Berjejal Anterior pada Siswa SD Negeri 46 Manado. e-GiGi 2020;8(1):22–7.
21. Acharya SS, Mali L, Sinha A, Nanda SB. Effect of Naso-respiratory Obstruction with

Mouth Breathing on Dentofacial and Craniofacial Development. Orthodontic Journal of Nepal 2018;8(1):22–7.
22. İnönü-Sakallı N, Sakallı C, Tosun Ö, Akşit-Biçak D. Comparative Evaluation of the Effects of Adenotonsillar Hypertrophy on Oral Health in Children. Biomed Res Int 2021;
23. Anggraini CM, Budiardjo SB, Setyanto DB, Indiarti IS. Malocclusion in Mouth-Breathing Children Caused by Nasal Obstruction. 2018;4(Idsm 2017):59–64.
24. Vukićević V, Pavlović J, Vujačić A, Martinović B, Kostić M, Staletović D. Radiographic cephalometry analysis of head posture and craniofacial morphology in oral breathing children. Vojnosanit Pregl 2017;74(11):1048–53.
25. Zhang L, Liu H. Influence of Adenoid Hypertrophy on Malocclusion and Maxillofacial Development in Children. Evidence-based Complementary and Alternative Medicine 2022;
26. Feng G, Gong X, Yu M, Huang X, Gao X. Differences of Craniofacial Characteristics in Oral Breathing and Pediatric Obstructive Sleep Apnea. Journal of Craniofacial Surgery 2021;32(2):564–8.
27. Chambi-Rocha A, Cabrera-Domínguez ME, Domínguez-Reyes A. Breathing mode influence on craniofacial development and head posture. J Pediatr (Rio J) [Internet] 2017;94(2):123–30. Available from: http://dx.doi.org/10.1016/j.jped.2017.05.007
28. Osiatuma VI, Otuyemi OD, Kolawole KA, Amusa YB, Ogunbanjo BO. Dental Arch Dimensions of Nigerian Children with Hypertrophied Adenoids. Turk J Orthod 2017;30(2):42–9.
29. Indiarti IS, Setyanto DB, Kusumaningrum A, Budiardjo SB. Changes in the palatal dimensions of mouth breathing children caused by nasal obstruction. J Phys Conf Ser 2017;884(1).
30. Cheng B, Mohamed AS, Habumugisha J, Guo Y, Zou R, Wang F. A Study of the Facial Soft Tissue Morphology in Nasal- and Mouth-Breathing Patients. Int Dent J [Internet] 2022;1–7. Available from: https://doi.org/10.1016/j.identj.2022.09.002
31. Li H, Wang H, Hao H, An H, Geng H. Influences of Airway Obstruction Caused by Adenoid Hypertrophy on Growth and Development of Craniomaxillofacial Structure and Respiratory Function in Children. Comput Math Methods Med 2022;
32. Wang J, Zhao Y, Yang W, Shen T, Xue P, Yan X, et al. Correlations between obstructive sleep apnea and adenotonsillar hypertrophy in children of different weight status. Sci Rep [Internet] 2019;9(1):1–7. Available from: http://dx.doi.org/10.1038/s41598-019-47596-5
33. Nogami Y, Saitoh I, Inada E, Murakami D, Iwase Y, Kubota N, et al. Prevalence of an incompetent lip seal during growth periods throughout Japan : a study. Environ Health Prev Med 2021;26(11):1–9.
34. Guimarães LC, Lima LV, Costa JG, Saramago ADAC, Mattos CT, Vilella BDS, et al. Is mouth-breathing related to alterations in facial soft tissues? Rio de Janeiro Dental Journal (Revista Científica do CRO-RJ) 2019;4(3):10–6.
35. Kalaskar R, Bhaje P, Kalaskar A, Faye A. Sleep difficulties and symptoms of attention-deficit hyperactivity disorder in children with mouth breathing. Int J Clin Pediatr Dent 2021;14(5):604–9.
36. Husain S, Kumar N, Rengalakshmi S. Correlation between hard and soft tissue lower anterior facial height of different skeletal pattern on South Indian population. Indian Journal of Forensic Medicine and Toxicology 2020;14(4):5027–35.
37. Occasi F, Perri L, Saccucci M, Di Carlo G, Ierardo G, Luzzi V, et al. Malocclusion and rhinitis in children: An easy-going relationship or a yet to be resolved paradox? A systematic literature revision. Ital J Pediatr 2018;44(1):1–10.
38. Flores-Blancas AP, Carruitero MJ, Flores-Mir C. Comparison of airway dimensions in skeletal class I malocclusion subjects with different vertical facial patterns. Dental Press J Orthod 2017;22(6):35–42.
39. Milanesi J de M, Berwig LC, Marquezan M, Schuch LH, de Moraes AB, da Silva AMT, et al. Variables associated with mouth breathing diagnosis in children based on a

multidisciplinary assessment. Codas 2018;30(4).
40. Calvin J, Budiardjo SB, Setyanto DB, Indiarti IS. Head posture and facial profile of mouth breathing children caused by nasal obstruction. Journal of International Dental and Medical Research 2017;10(Specialissue):594–9.
41. Calvo-Henriquez C, Megias-Barrera J, Chiesa-Estomba C, Lechien JR, Maldonado Alvarado B, Ibrahim B, et al. The Impact of Maxillary Expansion on Adults' Nasal Breathing: A Systematic Review and Meta-Analysis. Am J Rhinol Allergy 2021;35(6):923–34.
42. del Carmen BAR, Terreros MA. Impact of the Habit of Mouth Breathing on the Development of the Stomatognathic System- Literature Review. Journal of Dental Science Research Reviews & Reports 2022;4(2):1–8.
43. Lysy J, Karkazi F, Stanko P, Novak B. The influence of mouth breathing on skeletal and dental features of splanchnocranium. Bratislava Medical Journal 2021;122(3):196–9.
44. Zhang X, He J, Zheng W. Comparison of rapid maxillary expansion and pre-fabricated myofunctional appliance for the management of mouth breathers with Class II malocclusion. Eur Rev Med Pharmacol Sci 2021;25(1):16–23.

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