

## AIRWAY OBSTRUCTION AS A CAUSE OF MALOCCLUSION: A SYSTEMATIC REVIEW

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### ABSTRACT

Malocclusions can occur due to the airway obstruction and the developmental process that the obstruction limits. The purpose of this study is to uncover whether airway obstruction is a cause of malocclusion. The systematic review involved the identification of relevant articles on the Google Scholar, Cochrane Library, and PubMed databases. Studies published between 2011 and 2021 were obtained, screened, and assessed for eligibility using the PRISMA guidelines. The outcomes were summarized in a table. 14 studies were included for the systematic review, with the average number of participants they analyzed being seven to 9,098. The studies revealed the existence of an association between airway obstruction and dental malocclusion, majorly of Class II and III. They also indicated that some of the conditions that cause airway obstruction include rhinitis, asthma, tonsillitis, and sleep apnea, which are also associated with malocclusion. Mouth breathing, especially during childhood, affects the development of craniofacial patterns, which can cause malocclusion. There is a significant association between airway obstruction and malocclusion, implying that airway obstruction is one of the causes of Class I, II, and III malocclusions.

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### Introduction

Malocclusion is a dental and oral health problem that can result in fluorosis, decay of teeth, gingivitis, or other gum-related problems [1]. By definition, malocclusion is the lack of alignment between the teeth of the upper and lower dental arches, resulting in the lack of contact between the teeth when the jaws come together [2]. When it occurs in childhood, it has negative effects on the child's dental health and daily life, with the individual experiencing symptoms such as oral pain and difficulties in chewing. According to Reddy *et al.* [2], the child could also experience bullying from teasing by colleagues, skip school as a result of the teasing or pain, and avoid smiling. The condition does not normally require any treatment, but a correction of the occlusion challenge can go a long way in preventing tooth decay and reducing the pressure in the joint between the mandibles [2]. The long-term impacts of malocclusion on the quality of life, however, render it undesirable for the dental health of a child or an adult.

There are various causes of malocclusion that dentists and researchers have discovered. According to Reddy *et al.* [2], the condition can occur when the individual has extra teeth, has abnormally shaped teeth, or has teeth with abnormal sizes. Agarwal *et al.* [1], on the other hand, cite genetic and environmental factors as possible causes of malocclusion. The authors also mention local factors such as poor oral health or hygiene habits and the dental abnormalities to be causative of the condition [1]. The genetic, environmental, and dental factors can result in the poor development of the soft tissues, skeleton, and dental structures of the children, contributing to the lack of occlusion [3]. The mainstream studies of the etiology of malocclusion, however, do not focus on the contributions that the airway makes to the development of the dental structure.

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One of the potential causes of malocclusion that has received attention among scholars is airway obstruction. For instance, Rapeepattana *et al.* [3], when examining the etiology of malocclusion, included children who had abnormal breathing habits – abnormal mouth breathing – in the investigation of potential causes. Tinano *et al.* [4] adopted a similar approach by evaluating the relationship between oral breathing in children and the occurrence of malocclusion. The study focused on Angle class II malocclusion – characterized by the posterior positioning of the mandible to the maxilla [4]. The authors also investigated class I malocclusion – defined as the location of the maxillary mesiofacial cusp in the mesiofacial development groove of the first molar in the mandible – and class III malocclusion, which refers to the anterior positioning of the mandible to the maxilla [5].

In their investigation of the condition, Joshi *et al.* [5] noted the existence of reports detailing the causative effect of malocclusion on airway obstruction, sleep apnea, gastric disturbances, and developmental growth issues. The authors also discovered the prevalence of class II malocclusion among individuals having narrow upper pharyngeal airways [5]. Nguyen *et al.* [6] reported that the upper airway obstruction is strongly linked with both dental and skeletal malocclusions. The authors also state that the malocclusions that occur as a result of upper airway obstruction are correctible through various orthodontic techniques [6]. However, the studies do not sufficiently examine the causative effect of airway obstruction on malocclusions of all three classes. Consequently, the present study reports on a systematic review of existing literature to uncover whether airway obstruction is a cause of malocclusion.

## Materials and Methods

### *Search Strategy*

The process of identifying the articles that address the topic of study involved the conduction of an online search on the Google Scholar, Cochrane Library, and PubMed databases. The search was performed on June 25, 2021, using the following key terms: airway obstruction and malocclusion, airway obstruction as a cause of malocclusion, and causes of malocclusion. The researcher reviewed the titles of the articles and their abstracts for potential inclusion in the study. Only the articles whose titles and abstracts matched the purpose of the study were considered for the eligibility analysis. Further, the relevant studies that were cited by the authors of the considered articles were also analyzed for eligibility.

### *Study Eligibility*

From the literature search and identification of relevant articles based on the titles and abstracts, the researcher then conducted an eligibility analysis of the articles. These are the criteria used for the inclusion of articles:

- The study must be published in a peer-reviewed journal or a conference publication.
- The study must have been published between 2011 and 2021.
- The article must report on a primary study reporting on airway obstruction as a cause of malocclusion.

Using these criteria, the articles were screened for eligibility, and those that met the criteria were further analyzed and excluded if they met the following exclusion criteria:

- The article adopts a case report or case study design.
- The article is a letter or editorial on a journal or periodical.
- The study is a systematic review or literature review (secondary).

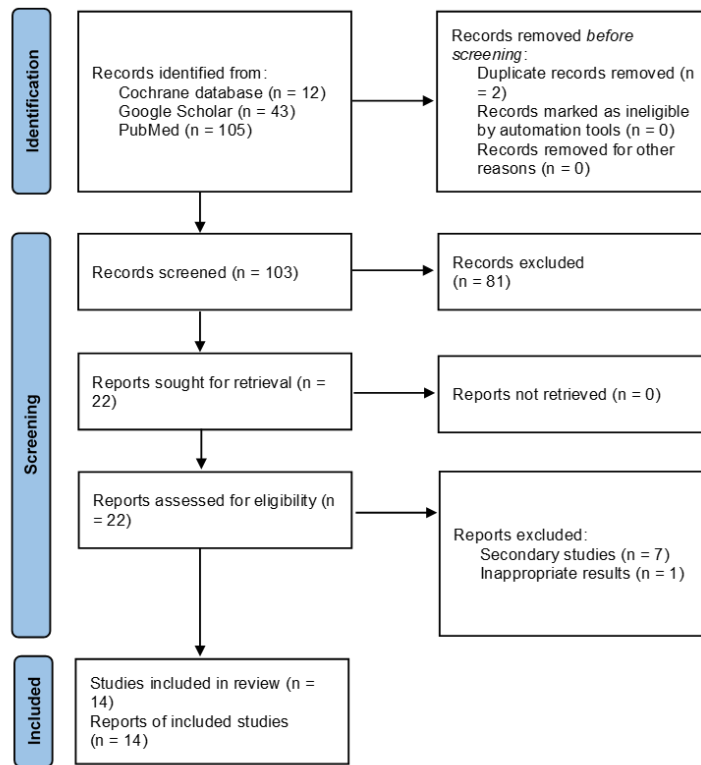
### *Data Extraction and Analysis*

After the eligibility analysis, the full manuscripts of the articles that met the inclusion criteria and did not meet the exclusion criteria were retrieved, with the researcher determining the final inclusion. The Cochrane Risk of Bias Tool was used to assess the extent to which design flaws, analysis and conduct procedures, and the reporting of the studies – especially the randomized clinical trials – resulted in the overestimation or underestimation of the impacts of the interventions used [7]. The final list of articles from the process was then used to extract data that provide evidence for conclusive findings on airway obstruction as a cause of malocclusion. The information was then summarized thematically based on the purpose of the study. The summary also included the risk of bias associated with the specific study.

## Results and Discussion

### *Study Selection*

From the search of the literature on the three databases, a total of 160 articles with titles that matched the keywords were identified (12 from Cochrane, 105 from PubMed, and 43 from Google Scholar). Two articles were identified to be duplicates from the collective search, meaning that 103 articles were considered for the screening process. The screening of the abstracts led to the exclusion of 81 articles based on the specified criteria. 22 articles were then assessed for eligibility, after which eight (8) were excluded for reasons including the study being secondary and having inappropriate results. **Figure 1** shows the PRISMA flowchart for the process.



**Figure 1.** PRISMA flow diagram for the records

*Study Characteristics*

Most of the included studies had participants whose ages ranged from three years to 25 years. The studies had varying sample sizes, with the least sample size being seven patients studied in cross-sectional descriptive analysis and the largest sample comprising 9,098 participants whose data were analyzed through a retrospective study. The second-largest analysis occurred through a cross-sectional study that was performed among 3,017 children to investigate the relationship between mouth breathing and malocclusions. The rest of the studies had between 54 and 1,007 participants. The subjects of the analysis had conditions causing airway obstruction such as mouth breathing, hyoid bone mispositioning, nasal obstruction, sleep-related breathing disorder, allergic rhinitis, obstructive tonsils/tonsilitis, asthma, and upper respiratory tract disorders. The malocclusions investigated in the studies were of classes I, II, and III, with the dental patterns investigated including chin angles, open bite, overjet, crossbite, facial convexity angles, and facial and dental development patterns.

*Study Findings*

**Table 1** details the included studies, the years they were published, the research designs that they adopted, the number of participants, the relevant findings, and the risk of bias based on the Cochrane Risk of Bias Tool.

**Table 1.** Results of systematic review

Study ID	Design and year	Participants	Findings	Risk of Bias
Grippaudo <i>et al.</i> [8]	Cross-sectional study, 2016	3017 children	An increase in the prevalence of mouth breathing and bad habits is associated with severe malocclusions. Mouth breathing has a close association with dental characteristics such as overjet, crossbite, open bite, and contact displacement.	Performance bias, because of no blinding of trial participants.  Risk of bias: moderate.
Shokri <i>et al.</i> [9]	ANOVA test on airway volume and malocclusion types, 2020	180 participants	The hyoid bone positioning has an association with airway dimensions. Smallest airway volumes (obstruction) associated with class II malocclusion. Class III cases had the largest airway volumes.	Selection bias from the identification of patients whose CBCT scans were analyzed.  Risk of bias: low.
Lopatiene <i>et al.</i> [10]	Experimental: Cephalometric analysis of clinical and radiology data, 2016	114 pre-orthodontic patients	Malocclusion Angle Class II patients more frequently had constricted airways. Constricted airways are also associated with decreased facial convexity angle, nasal, and lip-chin angles.	Selection bias from the identification of patients on whom to perform cephalometric analysis.  Risk of bias: low.
Iwasaki <i>et al.</i> [11]	Experimental: Computational	62 children with malocclusion	There is a possible relationship between nasal obstruction, pressure of the pharynx, and Class II	Performance bias from the lack of a suitable blinding strategy

	fluid dynamics (CFD), 2016.		malocclusion. The findings link airway obstruction to malocclusion, especially the Class II type.	for participants. Risk of bias: moderate.
Memon <i>et al.</i> [12]	A cross-sectional analytical study, 2012.	360 orthodontic patients	The relationship between narrow upper pharyngeal airway and the occurrence of skeletal malocclusion as compared to normodivergent and hypodivergent facial patterns is significant.	Selection bias from the identification of orthodontic patients whose cephalographs were assessed. Risk of bias: low.
Moré <i>et al.</i> [13]	A prospective randomized controlled trial study, 2011	60 children aged between 3 and 13 years	There are abnormalities in the development of facial and dental features among children with breathing disorders.	Detection bias from the authors' knowledge of allocated interventions by the outcome. Risk of bias: low.
Silva <i>et al.</i> [14]	Correlation study on lateral cephalograms, 2015	80 individuals aged between 10 and 17 years old	The sizes of the oropharynx and nasopharynx, the position of the mandibles, and the mandibular length were reduced among individuals with Class II malocclusion. Therefore, these individuals had diminished measurements of the upper airways.	Selection bias from the identification of patients whose cephalograms were assessed. Risk of bias: low.
Luzzi <i>et al.</i> [15]	Case-control study, 2013	275 Italian children aged 5-9 (125 with malocclusions and 150 healthy)	The children who had a history of allergic rhinitis were three times more at risk of developing dental and skeletal alterations than healthy children.	Detection bias from the authors' knowledge of allocated interventions by the outcome. Risk of bias: low.
Diouf <i>et al.</i> [16]	Cross-sectional study, 2015	Children aged between 6 to 12	Individuals with obstructive tonsils have a higher tendency to develop a convex facial profile and a skeletal class II than those without obstructive tonsils. They also have more mandibular retrusion and retroclined incisors.	Selection bias, with authors concealing the allocation of participants and their number. Risk of bias: high.
Tinano <i>et al.</i> [4]	Quantitative correlation study, 2017	1,002 oral breathing children	The association between oral breathing (airway obstruction resulting from enlarged tonsils, adenoids, or allergic rhinitis) and malocclusion is not significant. Findings imply that there is no significant association between Class II malocclusion and the type of nasal obstruction.	Performance bias, because of no blinding of trial participants and the knowledge of the interventions. Risk of bias: moderate.
Anggraini <i>et al.</i> [17]	Cross-sectional descriptive study, 2018	7 patients aged between 7 and 16	Mouth-breathing children showed several types of malocclusions. Airway obstruction that leads to habitual mouth breathing can, therefore, contribute to the development of malocclusion.	Selection bias due to inadequate generation of a random number of patients. Risk of bias: high.
Abe <i>et al.</i> [18]	Retrospective medical analysis, 2020	9098 students aged 17-19 years	The participants had a high awareness of the association between allergic rhinitis, asthma, and arrhythmia which are characterized by upper airway obstruction and malocclusions. There is a recommendation, however, for further studies to confirm the association between the obstruction-causing conditions and malocclusions.	Reporting bias due to potential selective reporting of the outcomes. Risk of bias: low.
Lin <i>et al.</i> [19]	Population-based case-control study, 2021	773 patients with malocclusions and 3865 patients with no malocclusions	The risk of developing malocclusion is high among pediatric patients having URIs malocclusion.	Performance bias, because of no blinding of trial participants and the knowledge of the interventions. Risk of bias: low.
Siddiqui <i>et al.</i> [20]	Analysis of pre-treatment records of cephalograms, 2020	54 orthodontic patients aged 15-25 years	The A point, nasion, B point (ANB) angle had a strong negative correlation with the upper pharyngeal space and a moderate negative correlation with the lower pharyngeal space. Thus, the higher the angle, the lower the pharyngeal space. Classes II and III malocclusion were, consequently, correlated with low pharyngeal spaces.	Selection bias from the identification of orthodontic patients whose cephalograms were assessed. Risk of bias: low.

This review of 14 articles addressing airway obstruction as a cause of malocclusion revealed that there is a high association between the obstruction and different classes of malocclusion. Airway obstruction occurs majorly at the nose and pharynx, through which individuals naturally breathe [8]. The obstruction is characterized by many symptoms. According to

Grippaudo *et al.* [8], the most common symptoms include sneezing, poor airflow through the nose, sleep apnea or obstructive sleep apnea, and other respiratory infections including sinusitis and ear infections. The major causes of the obstruction are the occurrence of conditions such as allergic rhinitis, tonsillitis, adenotonsillar hypertrophy, asthma, and other upper respiratory disorders [8, 18, 19].

The review revealed that the conditions that cause airway obstruction correlate with malocclusions. Luzzi *et al.* [19] explained that children having a history of allergic rhinitis have three times more risk of developing dental and skeletal alterations including malocclusion as compared to those who have no such history. The malocclusions that occur due to rhinitis include posterior crossbite and an increased overjet [15]. Similarly, the patients who have obstructive tonsils have a high likelihood of developing a convex facial profile and skeletal Class II malocclusion as compared to those without [16]. The skeletal class II patients have occlusions characterized by mandibular retrusion and a reclining of the incisors [16]. Upper respiratory tract disorders increase the risk of severe dental malocclusion [19]. Consequently, the dental abnormalities resulting from these conditions are directly caused by the obstruction of the upper airways that they produce.

The measurements of the upper airways also affect malocclusion. The review reveals that individuals with malocclusion have narrow pharyngeal airways. Silva *et al.* [14] reported the reduction of the sizes of the oropharynx and nasopharynx among individuals with Class II malocclusion. Classes II and III of malocclusion are also correlated with low pharyngeal spaces [20]. The patients having hyperdivergent facial patterns have narrow upper pharynxes, which are contributive to Class I and II malocclusion [12]. The width of the pharynx has an association with the ease of flow of air within the respiratory system. Negative pressure on the pharyngeal airway also leads to an elevated nasal resistance, which was found to be considerably higher among individuals with Class II malocclusion, as compared to those with classes I and III [11]. Thus, an obstruction of the pharyngeal airway causes retrognathia that is common in children with Class II malocclusion.

The review reveals that one of the manifestations of upper airway obstruction is mouth breathing, which is a bad oral habit with consequences on craniofacial growth, especially among children [8]. Airway obstruction that leads to habitual mouth breathing can, therefore, contribute to the development of malocclusion [17]. The craniofacial growth effects that arise include the development of a long face, the upper dental arch contracting, palates that are arched high, and both Class II and III dental malocclusions [8]. These growth effects arise from the lack of muscle balance function that results from mouth breathing and its involvement with the rotation of the mandibles in the posterior and inferior directions. Furthermore, the children with breathing disorders during sleep have abnormal dental and facial development, with upper respiratory obstruction being the cause [13]. The authors indicate that obstruction can lead to the development of vertical facial growth, narrower palates, and dental occlusion.

Airway obstruction can also be manifest through the positioning of the hyoid bone, which provides the structure for the attachment of the tongue and the muscles in the oral cavity. Its positioning affects the amount of airway volume [9]. The review reveals that when the airway volume is low, the individual is likely to have symptoms of Class II malocclusion [9]. The hyoid bone structure is one of the contributors to the low airway volume. The morphology of the upper airway and hard and soft tissues also play a role in determining airway obstruction. According to Lopatiene *et al.* [10], the airways have a negative correlation with the width of the lower pharynx, meaning that airway constriction is highest when the pharyngeal width is lowest. Growth factors contribute to pharyngeal width, with the review revealing that patients with oral disturbances could have an inappropriate development of the maxillofacial system [10]. Thus, the disturbances contribute to an increase in the nasomental, upper lip-chin, and lower lip-chin angles, which are characteristics of different types of malocclusions.

The review also highlights some cases where there is no significant relationship between airway obstruction and malocclusion. Tinano *et al.*'s [4] quantitative study revealed that the airway obstruction caused by tonsillitis, adenoid enlargement, and allergic rhinitis have no statistically significant association with Class II malocclusion. Abe *et al.* [18], who conducted a retrogressive analysis, revealed that there is significant awareness of the association between the conditions causing airway obstruction and malocclusions, but recommended the conduction of more studies to establish the statistical significance.

## Conclusion

Malocclusion occurs as a result of various factors, including genetic, environmental factors, and oral practices. Airway obstruction, as well, has emerged as a risk factor for the development of various classes of malocclusion. The systematic review, which included 14 articles, affirmed that there is an association between airway obstruction and malocclusion. Airway obstruction occurs at the nose and the pharynx and produces symptoms such as sneezing, poor airflow through the nose, sleep apnea, and obstructive sleep apnea, and arises from conditions such as allergic rhinitis, tonsillitis, adenotonsillar hypertrophy, asthma, and other upper respiratory disorders. The review indicates that these conditions affecting the airway are causative factors for dental malocclusions. Conditions that also lead to the malformation of the upper airway sizes and lengths – reduced oropharynx and nasopharynx, narrow pharyngeal sizes, and negative pressure on the pharynx – elevate nasal resistance and cause retrognathia, which is typical in children with Class II malocclusion. The studies, therefore, point out that airway obstruction is a potential cause of malocclusion.

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