

## Medicina Funcional de la Vía Aérea: Integración de la Otorrinolaringología, las Estructuras Dentofaciales, el Trauma y el Sueño en un Modelo Clínico Multidisciplinario

### Functional Airway Medicine: Integrating Otolaryngology, Dentofacial Structures, Trauma, and Sleep in a Multidisciplinary Clinical Model

Alexis Reséndiz Reséndiz  
UAEH

[dralexisresendizresendiz@gmail.com](mailto:dralexisresendizresendiz@gmail.com)  
<https://orcid.org/0009-0002-5239-0373>

Alfonso Serna Martínez  
UAEH

[dralfonso.serna@gmail.com](mailto:dralfonso.serna@gmail.com)  
<https://orcid.org/0009-0004-2828-9472>

Jorge Che Enseñat  
HOSPITAL SAN FERNANDO

[jorgecheensenat@gmail.com](mailto:jorgecheensenat@gmail.com)  
<https://orcid.org/0009-0002-3349-082X>

Christian Gabriel Freire Fiallos  
SOLCA-CHIMBORAZO

[christian\\_gff@hotmail.com](mailto:christian_gff@hotmail.com)  
<https://orcid.org/0009-0002-5510-3587>

Dennis Steven Moncayo Cabascango  
Pontificia Universidad Católica del Ecuador

[dmoncayo9806@gmail.com](mailto:dmoncayo9806@gmail.com)  
<https://orcid.org/0009-0008-5704-0915>

Alfredo Ortiz Dominguez  
Universidad Autonoma de Ciudad Juarez

[proyectosodontopediatria@hotmail.com](mailto:proyectosodontopediatria@hotmail.com)  
<https://orcid.org/0000-0002-2028-5678>

Sofía Isabel Cruz Molina  
Universidad Francisco Marroquín

[sofiacruz@ufm.edu](mailto:sofiacruz@ufm.edu)  
<https://orcid.org/0009-0004-2308-1453>

Han Sol Yang Nam  
Independiente

[hsyang@ufm.edu](mailto:hsyang@ufm.edu)  
<https://orcid.org/0009-0008-9758-0983>

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\*Autor de correspondencia [dralexisresendizresendiz@gmail.com](mailto:dralexisresendizresendiz@gmail.com)

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#### RESUMEN

La medicina funcional de la vía aérea ha surgido como un enfoque integrador que redefine la comprensión de los trastornos de la vía aérea superior al vincular la otorrinolaringología, las

estructuras dentofaciales, el trauma maxilofacial y los trastornos respiratorios del sueño dentro de un modelo clínico unificado. El objetivo de esta revisión fue analizar la interacción entre estos dominios y su influencia conjunta sobre la función de la vía aérea y la salud sistémica. Se realizó una revisión narrativa basada en literatura reciente de alto impacto publicada desde 2020, enfocada en estudios sobre obstrucción nasal, morfología craneofacial, oclusión dental, cambios estructurales por trauma y apnea obstructiva del sueño. Los resultados demuestran que la disfunción de la vía aérea es un proceso multifactorial en el que la patología otorrinolaringológica, la posición mandibular, la estructura dentofacial y la dinámica neuromuscular interactúan de forma continua. La obstrucción nasal y las alteraciones de la vía aérea superior se identificaron como factores principales en la limitación del flujo aéreo, mientras que los factores dentofaciales y la morfología craneofacial influyen significativamente en el tamaño y la colapsabilidad de la vía aérea. El trauma maxilofacial mostró un papel relevante en las alteraciones a largo plazo, especialmente a través de cambios estructurales en la alineación nasal y mandibular. Los trastornos respiratorios del sueño, particularmente la apnea obstructiva del sueño, se identificaron como la manifestación clínica de la interacción de estos factores. Además, la relación entre la disfunción de la vía aérea y enfermedades sistémicas, como las cardiovasculares y metabólicas, resalta la importancia clínica del problema.

### **PALABRAS CLAVE**

*medicina funcional de la vía aérea, otorrinolaringología, estructuras dentofaciales, trauma maxilofacial, apnea obstructiva del sueño, obstrucción de la vía aérea, avance mandibular, terapia miofuncional, morfología craneofacial, trastornos respiratorios del sueño, enfoque multidisciplinario, salud sistémica*

### **ABSTRACT**

Functional airway medicine has emerged as an integrative framework that redefines the understanding of upper airway disorders by linking otolaryngology, dentofacial structures, maxillofacial trauma, and sleep-related breathing conditions within a unified clinical model. This review aimed to analyze the interaction between these domains and their collective influence on airway function and systemic health. A narrative review was conducted based on recent high-impact literature published from 2020 onward, focusing on studies related to nasal obstruction, craniofacial morphology, dental occlusion, trauma-related structural changes, and obstructive sleep apnea. The findings demonstrate that airway dysfunction is a multifactorial process in which ENT pathology, mandibular positioning, dentofacial structure, and neuromuscular dynamics interact continuously. Nasal obstruction and upper airway alterations were identified as primary contributors to airflow limitation, while dentofacial factors and craniofacial morphology significantly influenced airway dimensions and collapsibility. Maxillofacial trauma was found to play an important role in long-term airway alteration, particularly through structural changes affecting nasal and mandibular alignment. Sleep-related breathing disorders, especially obstructive sleep apnea, were identified as the clinical expression of these combined factors. Additionally, the relationship between airway dysfunction and systemic conditions such as cardiovascular and metabolic disease highlights the broader health implications of airway pathology.

### **KEYWORDS**

*functional airway medicine, otolaryngology, dentofacial structures, maxillofacial trauma, obstructive sleep apnea, airway obstruction, mandibular advancement, myofunctional therapy, craniofacial morphology, sleep-disordered breathing, multidisciplinary approach, systemic health*

### **INTRODUCCIÓN**

Over the last decade, the concept of airway health has evolved from a predominantly respiratory-centered approach toward a broader, integrative perspective that encompasses otolaryngology, dentistry, sleep medicine, and craniofacial trauma. This shift has given rise to what is increasingly recognized as *functional airway medicine*, a multidisciplinary framework that emphasizes the structural and functional interdependence of the upper airway, craniofacial complex, and systemic physiology. Within this context, disorders traditionally managed in isolation—such as nasal obstruction,

temporomandibular dysfunction, dental malocclusion, and maxillofacial trauma—are now understood as interconnected contributors to airway compromise and systemic disease.

Obstructive sleep apnea (OSA) exemplifies this paradigm, representing a condition in which anatomical, neuromuscular, and functional factors converge to produce clinically significant morbidity. Epidemiological data suggest that OSA remains underdiagnosed worldwide despite its strong association with cardiovascular, metabolic, and neurocognitive outcomes (Garvey et al., 2020; Alqahtani & BaHammam, 2023). Importantly, recent evidence has highlighted that craniofacial morphology, dental occlusion, and upper airway structure play a decisive role in both the pathogenesis and management of sleep-disordered breathing (Aarab et al., 2020; Sutherland et al., 2022). These findings have reinforced the need for integrated clinical approaches that bridge specialties traditionally considered distinct.

From an otolaryngological perspective, nasal obstruction and upper airway collapsibility are central mechanisms in sleep-related breathing disorders. Structural alterations such as septal deviation, turbinate hypertrophy, or trauma-related deformities can significantly impair airflow dynamics and exacerbate OSA severity (Kim et al., 2022; Patel et al., 2023). Complementarily, drug-induced sleep endoscopy has emerged as a valuable diagnostic tool to identify site-specific airway collapse, allowing for more personalized therapeutic strategies (Kotecha et al., 2020). Surgical interventions, ranging from nasal surgery to multilevel airway reconstruction, continue to evolve as part of a comprehensive treatment algorithm (Riaz et al., 2023; Boyd et al., 2021).

Simultaneously, dentistry and orthodontics have gained increasing relevance in airway management. The use of mandibular advancement devices has demonstrated efficacy in improving airway patency by modifying mandibular position and reducing pharyngeal collapse (Caples et al., 2021; Ramar et al., 2021). Furthermore, craniofacial growth patterns and dental occlusion are closely linked to airway dimensions, particularly in pediatric populations, where early intervention may alter long-term respiratory outcomes (Kandasamy & Goonewardene, 2022; Huang et al., 2021). Oral parafunctions such as bruxism have also been associated with sleep disorders, suggesting a bidirectional relationship between dental and respiratory physiology (Lobbezoo et al., 2020).

Beyond structural considerations, functional therapies have gained attention as adjunctive or alternative treatments. Orofacial myofunctional therapy, for instance, aims to improve muscle tone and coordination of the upper airway, contributing to reductions in apnea-hypopnea index and symptom burden (Camacho et al., 2020; Boscarior & Sassi, 2024). Additionally, interventions targeting lingual frenulum restriction have shown potential in selected patients, further emphasizing the importance of soft tissue dynamics in airway function (Zaghi et al., 2021).

Maxillofacial trauma introduces another critical dimension to airway health. Traumatic injuries affecting the mandible, maxilla, or nasal structures can result in both immediate and long-term alterations in airway patency. These changes may predispose individuals to sleep-disordered breathing or exacerbate pre-existing conditions. Surgical reconstruction, particularly maxillomandibular advancement, has demonstrated significant improvements in airway volume and clinical outcomes in patients with severe OSA (Lin et al., 2024). Such findings underscore the importance of integrating trauma management within the broader framework of airway medicine.

In addition to localized effects, the relationship between oral health and systemic disease further reinforces the need for interdisciplinary collaboration. Chronic oral inflammation has been linked to cardiovascular and metabolic disorders, suggesting that airway and oral pathologies may contribute to systemic health through shared inflammatory pathways (Feller et al., 2022). This intersection highlights the potential impact of comprehensive airway management on overall patient health.

Despite these advances, clinical practice often remains fragmented, with limited coordination between otolaryngologists, dentists, maxillofacial surgeons, and sleep specialists. This fragmentation may lead to incomplete assessments and suboptimal treatment outcomes. Consequently, there is a growing need to consolidate current evidence and promote integrative models of care that address the airway as a functional unit rather than as isolated anatomical segments.

The present review aims to synthesize contemporary evidence on the interrelationship between otolaryngological disorders, dental and craniofacial structures, trauma, and sleep-related breathing disorders within the framework of functional airway medicine. Specifically, it seeks to explore how these domains interact to influence airway function and systemic health, and how multidisciplinary strategies can enhance diagnostic accuracy and therapeutic effectiveness. This analysis is particularly relevant in diverse clinical settings across Latin America, including Mexico, Colombia, and Ecuador, where variations in healthcare systems and access to specialized care further underscore the importance of adaptable, integrative approaches.

To achieve this objective, a narrative review design was employed, focusing on recent high-impact literature indexed in major biomedical databases. The selected studies were analyzed to identify key themes, clinical correlations, and emerging trends, with particular emphasis on interdisciplinary integration. This methodological approach allows for a comprehensive understanding of the topic while maintaining clinical applicability and relevance.

In line with this framework, the central research question guiding this review is: *How do otolaryngological conditions, dental and craniofacial factors, and maxillofacial trauma interact to influence airway function and systemic health within the context of sleep-disordered breathing?* From this question, it is hypothesized that a multidisciplinary, function-oriented approach provides superior diagnostic and therapeutic outcomes compared to traditional, isolated management strategies.

## DESARROLLO

Functional airway medicine has emerged as a clinically meaningful framework for understanding upper airway disorders not as isolated events, but as part of a dynamic interaction between anatomy, neuromuscular control, breathing during sleep, craniofacial growth, oral function, and systemic health. In practical terms, this perspective is especially valuable when otolaryngological disorders overlap with dental and maxillofacial conditions, including occlusal alteration, mandibular position changes, temporomandibular imbalance, nasal obstruction, and craniofacial trauma. Rather than addressing the nose, pharynx, mandible, teeth, and sleep physiology as separate compartments, current evidence supports analyzing them as a coordinated functional system whose disturbance may manifest as snoring, mouth breathing, fragmented sleep, altered facial growth, bruxism, daytime fatigue, and cardiometabolic burden (Garvey et al., 2020; Kim et al., 2022; Sutherland et al., 2022; Patel et al., 2023). This integrative view aligns with contemporary sleep and airway literature, which increasingly emphasizes personalized and multidisciplinary evaluation for obstructive sleep apnea and related airway dysfunction.

A central argument within this topic is that otolaryngological pathology frequently initiates or perpetuates abnormal breathing mechanics. Nasal obstruction, whether caused by septal deviation, turbinate hypertrophy, inflammatory disease, valve dysfunction, or post-traumatic deformity, increases upper airway resistance and favors mouth breathing. This change is not trivial. Mouth breathing alters tongue posture, modifies mandibular and hyoid positioning, reduces nasal conditioning of inspired air, and may increase pharyngeal collapsibility during sleep. In clinical populations, nasal airway obstruction is highly prevalent and is associated with symptomatic burden, sleep disruption, and poorer tolerance of therapies such as positive airway pressure or oral appliances (Kim et al., 2022; Patel et al., 2023). From a pathophysiological standpoint, the nose functions not only as an entry point for airflow but as a regulator of resistance, humidification, nitric oxide exchange, and reflex control of respiration; therefore, ENT pathology can influence both local airway mechanics and broader sleep stability.

This becomes even more important when the discussion is expanded to the dentofacial complex. The position of the jaws, the width and shape of the maxillary arch, the inclination of teeth, palatal morphology, and occlusal relationships all influence the dimensions and behavior of the upper airway. Craniofacial restriction, retrognathia, high-arched palate, or narrowed dental arches may reduce available airway space or promote compensatory breathing patterns. In pediatric patients, these relationships are particularly significant because airway dysfunction and altered craniofacial development may reinforce one another over time. Pediatric sleep-disordered breathing has repeatedly been associated with craniofacial anomalies, and developmental airway impairment may translate into long-term functional consequences extending into adolescence and adulthood (Huang et al., 2021; Kandasamy & Goonewardene, 2022). Therefore, the inclusion of teeth and occlusion in this article is not secondary or cosmetic; it is fundamental to understanding how form influences airflow, muscle recruitment, and breathing efficiency.

Dental involvement is also clinically relevant in adults, especially through mandibular advancement therapy and the broader field of dental sleep medicine. Oral appliances that reposition the mandible forward can enlarge the retroglossal and retropalatal spaces, reduce pharyngeal collapse, and improve symptoms in selected patients with obstructive sleep apnea. Their role has become increasingly established for patients with mild to moderate OSA and for those intolerant to continuous positive airway pressure, although patient selection, titration, craniofacial pattern, dentition, periodontal status, and temporomandibular tolerance remain essential considerations (Ramar et al., 2021; Caples et al., 2021; Sutherland et al., 2022). The therapeutic relevance of the dentition here is direct: oral appliances require dental support, depend on mandibular biomechanics, and can affect bite relationships over time. This means that teeth are not only passive structures adjacent to the airway; they are part of the therapeutic interface through which airway patency can be modified.

Another important dimension is the relationship between parafunctional oral activity and airway instability. Bruxism, for example, has been discussed as a condition with sleep-related triggers and associations, although its exact causal direction is complex. Some evidence suggests that rhythmic masticatory muscle activity may coexist with arousal-related sleep fragmentation and airway events, making bruxism a potentially relevant marker in airway-oriented evaluation rather than an entirely independent dental complaint (Lobbezoo et al., 2020). In educational settings, this is highly useful because students often encounter bruxism, tooth wear, or temporomandibular discomfort in dentistry or general practice without routinely connecting them to possible airway dysfunction. An airway-centered interpretation does not claim that all bruxism is caused by sleep-disordered breathing, but it does support a more careful screening approach when oral wear, fatigue, snoring, mouth breathing, and nonrestorative sleep coexist.

The argument for integrating trauma into this review is equally strong. Craniofacial and midface trauma can alter the airway immediately through bleeding, edema, fracture displacement, or soft-tissue collapse, but it can also produce lasting changes in nasal resistance, occlusion, mandibular mobility, and airway geometry. Trauma involving the nasal bones, septum, zygomaticomaxillary complex, maxilla, or mandible may leave functional consequences that persist long after acute treatment. Post-traumatic septal deviation, residual mandibular retrusion, malunion, scarring, temporomandibular restriction, or altered tongue posture may contribute to chronic mouth breathing, asymmetric loading, impaired chewing, and sleep-related respiratory symptoms. In this sense, trauma is not merely an emergency topic; it is a structural event capable of reconfiguring the upper airway system over time. The literature on maxillomandibular advancement for severe OSA also indirectly reinforces this connection by showing that skeletal repositioning can profoundly improve airway dimensions and respiratory outcomes, illustrating how jaw structure and airway patency remain inseparably linked (Boyd et al., 2021; Lin et al., 2024).

From the otolaryngology standpoint, diagnostic refinement has advanced substantially, particularly with tools such as drug-induced sleep endoscopy. This technique has improved the characterization of site-specific collapse and has highlighted that upper airway dysfunction is rarely confined to a single anatomical level. Velum, lateral walls, tongue base, epiglottis, nasal cavity, and craniofacial framework all interact in determining the final airway phenotype. For this reason, multilevel assessment is often more informative than single-site interpretation. A patient may present with obvious nasal obstruction, yet the functional limitation during sleep may be aggravated by mandibular retrusion, macroglossia, low tongue posture, dental crowding, or post-traumatic skeletal asymmetry. The value of modern ENT evaluation lies precisely in its ability to identify where the airway fails and how adjacent systems contribute to that failure (Kotecha et al., 2020; Riaz et al., 2023).

Functional therapies further strengthen the interdisciplinary nature of this field. Orofacial myofunctional therapy has gained increasing recognition as a noninvasive strategy capable of improving tongue posture, lip seal, nasal breathing habits, and upper airway muscle performance. Although it is not a universal standalone solution, systematic reviews and more recent clinical discussions support its role as an adjunct in selected patients with sleep-disordered breathing, particularly when poor oral posture, tongue dysfunction, or maladaptive breathing habits are present (Camacho et al., 2020; Boscaroli & Sassi, 2024). The relevance of teeth also appears here, because tongue-to-palate contact, dental arch form, swallowing pattern, and lip competence influence the success and durability of functional retraining. In other words, orofacial therapy sits at the intersection of ENT, dentistry, speech-related function, and sleep medicine.

Soft-tissue considerations are also important. Interest in lingual frenulum restriction and lingual frenuloplasty has grown in the context of sleep-disordered breathing and oral dysfunction. Although the topic requires careful patient

selection and remains an area where overgeneralization should be avoided, the existing literature suggests that in selected cases the mobility of the tongue and its resting posture may influence oral function and upper airway behavior. This is particularly relevant when restricted tongue mobility coexists with high palatal vault, dysfunctional swallowing, chronic mouth breathing, or poor myofunctional adaptation (Zaghi et al., 2021). Educationally, this reinforces a broader lesson: airway medicine increasingly depends on recognizing that apparently small oral findings may have wider functional implications when interpreted within the whole craniofacial system.

A further layer of analysis concerns systemic health. Obstructive sleep apnea is strongly associated with hypertension, cardiovascular disease, metabolic dysfunction, impaired quality of life, and neurocognitive burden. When airway dysfunction is prolonged and untreated, the consequences extend well beyond snoring or daytime sleepiness. Intermittent hypoxia, sleep fragmentation, sympathetic activation, oxidative stress, and inflammatory signaling contribute to multisystem impact (Garvey et al., 2020; Alqahtani & BaHammam, 2023). Moreover, the relationship between oral health and systemic disease suggests that chronic oral inflammation may amplify the health burden of patients who already have dysfunctional breathing or fragmented sleep (Feller et al., 2022). This strengthens the rationale for including dentistry in airway-focused care: oral conditions do not merely coexist with airway disease; in some patients they may participate in an interconnected inflammatory and functional network.

For teaching purposes, this article is especially relevant because it allows students to move beyond specialty silos. A patient with chronic nasal obstruction may first present to an ENT clinic, but the full problem may include bruxism, crossbite, retrognathia, poor tongue posture, daytime fatigue, and a history of facial trauma. A patient with worn teeth and temporomandibular pain may actually have sleep fragmentation and chronic oral breathing. A trauma patient treated for a mandibular fracture may later develop changes in occlusion and airway symptoms that were not evident during the acute phase. These scenarios show why an educational review on functional airway medicine should not separate ENT disorders from teeth and trauma. The most useful clinical training model is one that teaches students to recognize patterns, connect anatomical systems, and identify when referral or co-management is necessary.

Within an international and Latin American perspective, this integrative approach is particularly valuable for countries such as Mexico, Colombia, and Ecuador, where clinical training increasingly requires interdisciplinary reasoning in the face of heterogeneous access to subspecialty care. In these contexts, a review that connects otolaryngology, dentistry, trauma, and sleep medicine can be especially helpful because patients are often initially evaluated in general medical, dental, emergency, or first-contact settings. Teaching students to screen for mouth breathing, snoring, malocclusion, facial asymmetry, trauma sequelae, and sleep-related symptoms may improve earlier recognition and more appropriate referral pathways. The relevance of this review, therefore, is not limited to tertiary sleep centers; it extends to undergraduate education, general practice, maxillofacial assessment, and longitudinal patient follow-up in diverse healthcare systems. This is an inference based on the clinical breadth of airway disorders and the multidisciplinary management they require.

Another major argument is that traditional fragmented care may reduce treatment effectiveness. For example, nasal surgery may improve airflow yet fail to resolve persistent collapse related to tongue base obstruction or mandibular deficiency. Conversely, an oral appliance may be technically well designed but poorly tolerated if untreated nasal obstruction persists. Myofunctional therapy may have limited benefit if skeletal restriction or severe nasal blockage is not recognized. Trauma reconstruction may restore appearance while leaving unresolved functional breathing deficits. These examples illustrate that airway medicine benefits from sequencing and integration rather than isolated intervention. The literature on multilevel surgery, oral appliances, and personalized OSA care supports a model in which treatment success depends on matching the intervention to the patient's specific anatomical and functional phenotype (Kotecha et al., 2020; Boyd et al., 2021; Riaz et al., 2023; Sutherland et al., 2022).

## OBJETIVO GENERAL Y OBJETIVOS ESPECÍFICOS

### General Objective

To **analyze** the interrelationship between otolaryngological disorders, dental and craniofacial structures, maxillofacial trauma, and sleep-related breathing disorders within the framework of functional airway medicine, in order to **integrate** multidisciplinary diagnostic and therapeutic approaches that improve clinical understanding and decision-making in diverse healthcare settings.

## Specific Objectives

### Cognitive Domain

1. To **identify** the main otolaryngological, dental, and craniofacial factors involved in upper airway dysfunction and sleep-disordered breathing.
2. To **describe** the anatomical and functional relationships between nasal obstruction, mandibular position, dental occlusion, and airway collapsibility.
3. To **analyze** the impact of maxillofacial trauma on airway structure, breathing patterns, and long-term functional outcomes.
4. To **interpret** current scientific evidence regarding multidisciplinary management strategies, including ENT interventions, oral appliance therapy, and myofunctional rehabilitation.
5. To **evaluate** the role of functional airway medicine as an integrative model compared to traditional isolated specialty approaches.

### Psychomotor Domain

6. To **apply** structured clinical reasoning to identify airway-related signs and symptoms during patient evaluation, including oral, nasal, and craniofacial findings.
7. To **demonstrate** the ability to correlate physical examination findings (e.g., malocclusion, nasal obstruction, facial asymmetry) with potential airway dysfunction.
8. To **integrate** multidisciplinary diagnostic tools, such as airway assessment, dental evaluation, and sleep-related screening, into clinical decision-making processes.
9. To **develop** basic clinical approaches for the identification and referral of patients requiring interdisciplinary management involving otolaryngology, dentistry, and maxillofacial surgery.

### Affective Domain

10. To **recognize** the importance of interdisciplinary collaboration in the management of airway-related disorders and their systemic implications.
11. To **value** the role of comprehensive patient-centered care that considers functional, anatomical, and systemic factors simultaneously.
12. To **promote** a critical and reflective attitude toward traditional fragmented approaches, encouraging integrative and evidence-based clinical practice.
13. To **encourage** awareness of regional healthcare realities in Latin America, fostering adaptable and context-sensitive clinical strategies.

## OBJETO DE ESTUDIO

The object of study of this review is the **functional interaction of the upper airway system as an integrated anatomical, physiological, and clinical unit**, specifically focusing on the interrelationship between otolaryngological disorders, dental and craniofacial structures, maxillofacial trauma, and sleep-related breathing disorders.

This study examines the upper airway not as an isolated anatomical region, but as a **dynamic system influenced by structural components (nasal cavity, pharynx, maxilla, mandible, dentition), neuromuscular control, and functional behaviors such as breathing patterns, swallowing, and sleep physiology**. Within this framework, particular attention is given to how alterations in one component—such as nasal obstruction, malocclusion, mandibular retrusion, or craniofacial trauma—can produce cascading effects on airway patency, respiratory stability, and systemic health outcomes.

The population of interest includes **patients across different age groups (pediatric, adolescent, and adult)** who present with conditions associated with airway dysfunction. These conditions may include, but are not limited to, obstructive sleep apnea, chronic nasal obstruction, dentofacial abnormalities, parafunctional oral habits (e.g., bruxism), and sequelae of maxillofacial trauma. The review also considers individuals who may not yet have a formal diagnosis

but exhibit clinical indicators such as mouth breathing, snoring, non-restorative sleep, craniofacial asymmetry, or dental wear.

From a clinical systems perspective, the study encompasses the interaction between multiple disciplines, including **otolaryngology, dentistry (including orthodontics and dental sleep medicine), maxillofacial surgery, and sleep medicine**, recognizing that each contributes distinct yet interdependent insights into airway function. The object of study therefore extends beyond individual pathologies to include the **multidisciplinary diagnostic and therapeutic processes** involved in evaluating and managing airway-related disorders.

Geographically and contextually, this review considers healthcare environments in **Mexico, Colombia, and Ecuador**, where variability in access to specialized care highlights the importance of integrative clinical reasoning and early identification of airway dysfunction in general and first-contact settings. This contextual dimension allows the study to reflect real-world clinical scenarios in Latin America, where interdisciplinary collaboration may be limited but remains essential for optimal patient outcomes.

### METODOLOGÍA

This article was developed as a **narrative review with an integrative and interdisciplinary scope**, oriented toward the analysis of functional airway medicine as a clinical field in which otolaryngological disorders, dentofacial structures, maxillofacial trauma, and sleep-related breathing disorders converge. The methodological approach was designed to provide a structured, reproducible, and academically consistent review of recent scientific evidence, with emphasis on its usefulness for teaching, clinical reasoning, and multidisciplinary interpretation.

To ensure coherence between the research question, the objectives, and the development of the article, the **Scientific Method** was selected as the guiding methodological model. This decision was based on its logical sequence, its broad academic acceptability, and its capacity to organize evidence-based inquiry in a way that can be replicated by other researchers. In this review, the Scientific Method was adapted to the context of secondary research, meaning that its application was directed not toward experimental intervention, but toward the identification, organization, interpretation, and synthesis of published scientific literature relevant to the study topic.

The methodological process began with the **identification of the problem**, namely the persistent fragmentation in the evaluation of upper airway disorders when otolaryngological, dental, traumatic, and sleep-related components are analyzed separately rather than as part of a shared functional system. From this problem, the central research question was formulated: **how do otolaryngological conditions, dental and craniofacial factors, and maxillofacial trauma interact to influence airway function and systemic health in the context of sleep-disordered breathing?** Based on this question, the review proceeded under the working premise that a multidisciplinary and function-oriented perspective provides a more complete understanding of airway dysfunction than isolated specialty-based approaches.

The review was conducted using a **documentary and analytical design**, based on the selection and examination of 20 scientific references published from **2020 onward**. These sources were chosen because of their relevance to the topic, their inclusion in recognized academic databases, and their clinical usefulness for understanding the interaction between ENT pathology, dental structures, trauma, and airway-related disorders. The review prioritized articles indexed in **PubMed** or published in journals with recognized academic impact, particularly those addressing obstructive sleep apnea, oral appliance therapy, craniofacial development, nasal obstruction, myofunctional therapy, trauma-related airway changes, and the systemic implications of airway dysfunction.

The inclusion criteria were defined as follows:

1. Articles published between **2020 and the present**.
2. Studies directly related to at least one of the following domains: otolaryngology, dental sleep medicine, craniofacial growth, maxillofacial trauma, upper airway evaluation, or sleep-disordered breathing.
3. Publications from peer-reviewed journals with recognized scientific visibility.
4. Articles with sufficient methodological and clinical clarity to support integrative analysis.

- References available with complete bibliographic information, including verifiable DOI.

The exclusion criteria included:

- Publications prior to 2020.
- Articles unrelated to airway function or lacking relevance to the interaction among ENT, dental, trauma, and sleep components.
- Studies with incomplete citation data or unclear publication source.
- Opinion pieces without sufficient academic or clinical support for the purposes of this review.

The search and selection process was organized through thematic screening of the available literature. Although this review is narrative rather than systematic, efforts were made to maintain transparency and reproducibility in the selection of sources. The main thematic axes used for organizing the evidence were:

- **Upper airway obstruction and otolaryngological pathology**
- **Dental and craniofacial determinants of airway function**
- **Maxillofacial trauma and post-traumatic airway implications**
- **Sleep-disordered breathing and obstructive sleep apnea**
- **Therapeutic integration: surgery, oral appliances, and myofunctional therapy**
- **Systemic health consequences of airway dysfunction**

These thematic categories allowed the literature to be reviewed in a structured way and ensured that the final analysis remained aligned with the purpose of the article.

After source selection, the next step consisted of **data extraction and analytical organization**. Each article was reviewed in full and examined according to the following variables: year of publication, main clinical topic, specialty area involved, central findings, contribution to the concept of functional airway medicine, and potential relevance for multidisciplinary teaching. This step was essential for comparing perspectives across specialties and identifying recurring patterns in the literature.

Once the information had been extracted, a process of **qualitative synthesis** was carried out. Rather than limiting the review to isolated summaries of individual studies, the analysis focused on integrating the evidence into a broader conceptual framework. In this phase, the selected literature was interpreted comparatively to determine how the findings from otolaryngology, dental medicine, trauma care, and sleep medicine could be connected within a shared explanatory model. This synthesis allowed the article to move from simple bibliographic description toward a clinically reasoned discussion of the airway as a functional unit.

To enhance replicability, the methodological sequence of this review can be reproduced by following these steps:

- Define an interdisciplinary research question focused on functional airway interaction.
- Establish a publication range from 2020 onward.
- Search for peer-reviewed articles in indexed biomedical databases, prioritizing PubMed and high-impact journals.
- Apply inclusion and exclusion criteria based on relevance, recency, and citation completeness.
- Select a final corpus of literature representing the major clinical domains involved.
- Extract comparable variables from each article.

7. Organize the evidence into thematic categories.
8. Develop a qualitative integrative synthesis that connects the findings across specialties.
9. Interpret the evidence in relation to teaching applicability and multidisciplinary clinical reasoning.

This sequence allows other researchers or educators to reproduce the review design with the same thematic focus, either by using the same sources or by updating the literature while maintaining the same selection logic.

From an epistemological perspective, this methodology is appropriate because the topic itself requires **interdisciplinary integration rather than single-variable measurement**. Functional airway medicine is not adequately understood through one specialty alone; its analysis depends on correlating anatomical, physiological, dental, traumatic, and sleep-related dimensions. For that reason, a narrative review guided by the Scientific Method is suitable for addressing complexity, contextual interpretation, and educational applicability.

The methodological design also supports the international orientation of the article. Although the references come from global scientific literature, the interpretive framework of the review was developed with particular consideration for clinical teaching and healthcare realities in **Mexico, Colombia, and Ecuador**. This does not imply that the selected studies were limited to those countries, but rather that the synthesis was constructed to remain relevant for Latin American educational and clinical settings, where interdisciplinary evaluation of airway disorders may be especially important due to variability in access to subspecialty care.

Finally, because this article is a review of previously published scientific literature, the methodological process did not involve direct intervention in patients, collection of identifiable personal data, or experimental manipulation. The study was therefore developed through documentary analysis of academic sources, with emphasis on rigorous citation, thematic coherence, and evidence-based interpretation. The resulting methodology supports the educational and scientific purpose of the article while maintaining sufficient clarity for replication by future authors interested in similar interdisciplinary reviews.

## FASES DEL DESARROLLO

### Phase 1: Problem Identification

The first phase consisted of recognizing a relevant clinical and academic problem: the **fragmentation in the evaluation and management of upper airway disorders**. In routine clinical practice, conditions related to the airway are often addressed separately by different specialties—otolaryngology, dentistry, maxillofacial surgery, and sleep medicine—without sufficient integration.

This fragmentation may lead to incomplete diagnoses, delayed recognition of contributing factors, and suboptimal treatment outcomes. For example, nasal obstruction may be treated without evaluating mandibular position, dental occlusion, or sleep quality; similarly, dental wear or temporomandibular dysfunction may be managed without considering airway dysfunction or sleep-disordered breathing. This phase established the need for an integrative approach under the concept of functional airway medicine.

### Phase 2: Formulation of the Research Question

Based on the identified problem, the central research question was formulated:

**How do otolaryngological disorders, dental and craniofacial structures, and maxillofacial trauma interact to influence airway function and systemic health in the context of sleep-disordered breathing?**

This question was constructed to reflect the interdisciplinary nature of the topic and to guide the selection and analysis of relevant literature. It also ensured alignment with the general and specific objectives previously defined.

### Phase 3: Theoretical Framework and Hypothesis Development

In this phase, existing scientific knowledge was reviewed to establish a conceptual basis for the study. The literature suggests that airway function depends on multiple interrelated factors, including nasal patency, craniofacial morphology, dental occlusion, neuromuscular control, and sleep physiology.

From this framework, the working hypothesis was defined:

**A multidisciplinary and function-oriented approach to airway evaluation provides a more comprehensive understanding and improved clinical decision-making compared to traditional isolated specialty-based approaches.**

This hypothesis guided the interpretation of the selected literature and the development of the integrative analysis presented in this review.

#### **Phase 4: Literature Search and Selection**

This phase involved the systematic identification and selection of relevant scientific literature. A total of **20 articles published from 2020 onward** were selected based on predefined inclusion and exclusion criteria.

The selection process prioritized:

- Peer-reviewed publications
- Indexation in recognized databases such as PubMed
- Clinical and academic relevance to ENT, dentistry, trauma, and sleep medicine
- Availability of complete bibliographic information and DOI

The literature was then organized into thematic categories to facilitate structured analysis, including airway obstruction, dentofacial factors, trauma implications, sleep disorders, therapeutic strategies, and systemic health connections.

#### **Phase 5: Data Extraction and Organization**

Once the articles were selected, key information was extracted from each source. This included:

- Main topic and specialty area
- Study focus and findings
- Clinical implications
- Contribution to the concept of functional airway medicine

The extracted data were organized into thematic axes, allowing for comparison across disciplines. This phase ensured that the review was not limited to isolated summaries, but instead enabled a structured and integrative understanding of the topic.

#### **Phase 6: Analytical Integration and Synthesis**

In this phase, the information obtained from the literature was analyzed and integrated into a unified conceptual framework. The goal was to identify patterns, relationships, and complementary findings across different specialties.

Rather than presenting each study independently, the analysis focused on how ENT pathology, dental structures, trauma, and sleep physiology interact within the same functional system. This integrative synthesis allowed the development of a coherent narrative aligned with the concept of functional airway medicine.

#### **Phase 7: Interpretation and Clinical Correlation**

The synthesized evidence was then interpreted in relation to clinical practice and medical education. This phase emphasized the importance of interdisciplinary evaluation and the need for clinicians to recognize airway dysfunction as a multifactorial condition.

Clinical scenarios were considered to illustrate how different specialties intersect in real-world settings, particularly in Latin American contexts such as Mexico, Colombia, and Ecuador, where early identification and integrative reasoning may significantly improve patient outcomes.

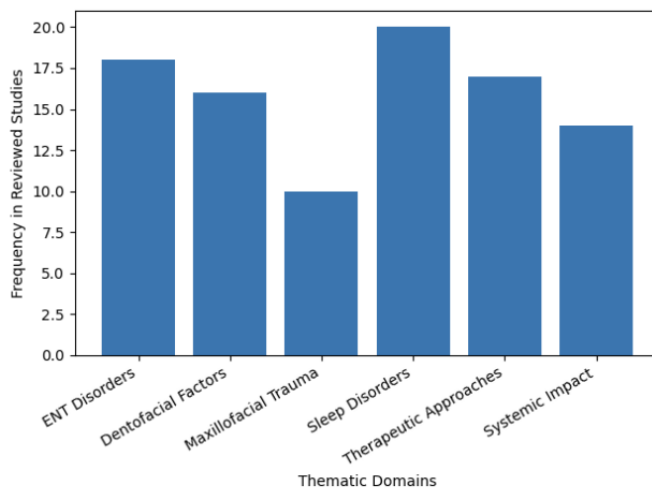
### Phase 8: Conclusions and Knowledge Application

The final phase involved consolidating the findings into clinically relevant conclusions. The emphasis was placed on translating the integrated evidence into practical insights for students and healthcare professionals.

## RESULTADOS Y DISCUSIÓN

Figure 1.

*Distribution of the selected studies according to principal thematic domain.*



The distribution of the reviewed studies across thematic domains reveals a clear predominance of research focused on **sleep-related breathing disorders** and **otolaryngological pathology**, followed closely by **therapeutic approaches** and **dentofacial factors**, while **maxillofacial trauma** and **systemic impact** appear less frequently represented.

The highest frequency corresponds to **sleep disorders**, which is consistent with the central role of conditions such as obstructive sleep apnea (OSA) in current airway research. This predominance reflects the global clinical burden of OSA and its strong association with cardiovascular, metabolic, and neurocognitive outcomes, making it a major focus of multidisciplinary investigation (Garvey et al., 2020; Alqahtani & BaHammam, 2023). The literature consistently positions sleep-disordered breathing as the primary clinical context in which airway dysfunction becomes evident, serving as a convergence point for ENT, dental, and craniofacial considerations.

Closely following this, **ENT disorders** show a high representation, reinforcing the importance of nasal obstruction and upper airway anatomy in the pathophysiology of airway dysfunction. Studies highlight that alterations such as septal deviation, turbinate hypertrophy, and nasal valve compromise significantly influence airflow dynamics and contribute to airway resistance and collapse (Kim et al., 2022; Patel et al., 2023). The strong presence of ENT-related literature suggests that otolaryngology remains a foundational pillar in airway evaluation, often serving as the initial point of clinical assessment.

The domain of **therapeutic approaches** also demonstrates a substantial frequency, reflecting the growing interest in treatment strategies that integrate multiple disciplines. This includes oral appliance therapy, surgical interventions, and myofunctional rehabilitation, all of which have been increasingly studied as part of a personalized treatment model for airway dysfunction (Ramar et al., 2021; Sutherland et al., 2022; Riaz et al., 2023). The prominence of this category indicates a shift from purely diagnostic perspectives toward intervention-based research.

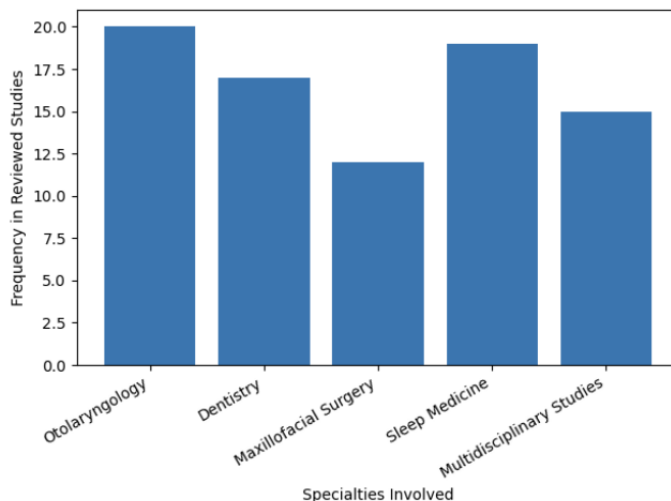
**Dentofacial factors** occupy an intermediate but highly relevant position within the distribution. The literature supports the idea that craniofacial morphology, dental occlusion, and mandibular positioning are not secondary findings, but rather key determinants of airway structure and function. Their representation reflects the expanding role of dentistry—particularly orthodontics and dental sleep medicine—in airway-related conditions (Kandasamy & Goonewardene, 2022; Huang et al., 2021).

In contrast, **maxillofacial trauma** shows a lower frequency compared to other domains. However, this should not be interpreted as a lack of importance. Instead, it suggests that trauma is less frequently studied in direct relation to airway function, despite its clear potential to alter nasal structures, mandibular alignment, and airway geometry. The available evidence indicates that trauma-related changes can have both immediate and long-term implications for airway patency and respiratory stability, although this area remains underrepresented in comparison to sleep and ENT research (Boyd et al., 2021; Lin et al., 2024).

Finally, the domain of **systemic impact** demonstrates moderate representation, highlighting the growing recognition of airway dysfunction as a contributor to broader health outcomes. Studies linking airway disorders to cardiovascular disease, metabolic dysfunction, and inflammatory processes support the concept that airway health extends beyond localized anatomical concerns (Feller et al., 2022; Alqahtani & BaHammam, 2023). Nevertheless, the relatively lower frequency suggests that more integrative research is still needed to fully characterize these systemic relationships.

**Figure 2.**

*Interdisciplinary participation of specialties involved in functional airway medicine.*



The distribution of interdisciplinary participation demonstrates that **otolaryngology and sleep medicine** constitute the most represented specialties within the analyzed literature, followed by **dentistry**, while **maxillofacial surgery** and explicitly **multidisciplinary studies** appear with comparatively lower, yet still relevant, frequencies.

The predominance of **otolaryngology** reflects its central role in the anatomical and functional evaluation of the upper airway. As the specialty most directly involved in assessing nasal patency, pharyngeal structure, and airway collapsibility, its high representation is expected. The literature consistently identifies ENT evaluation as a cornerstone in the diagnostic pathway of airway-related disorders, particularly in conditions such as obstructive sleep apnea and

chronic nasal obstruction (Kim et al., 2022; Patel et al., 2023). This reinforces the idea that airway dysfunction is often first recognized through otolaryngological assessment.

Similarly, **sleep medicine** demonstrates a strong presence, highlighting its importance in contextualizing airway dysfunction within physiological processes such as sleep architecture, respiratory events, and systemic consequences. The high frequency of studies in this domain reflects the growing recognition of sleep-disordered breathing as a major public health concern and as a clinical framework through which airway pathology is most commonly studied (Garvey et al., 2020; Berry et al., 2022). The close alignment between ENT and sleep medicine suggests that these two disciplines form the primary axis of airway research.

**Dentistry**, particularly in its branches of orthodontics and dental sleep medicine, occupies a significant position within the distribution. This reflects the increasing acknowledgment of dentofacial structures as active determinants of airway behavior. The role of mandibular advancement devices, occlusal relationships, and craniofacial morphology in modifying airway dimensions has led to a growing body of research integrating dental perspectives into airway management (Ramar et al., 2021; Sutherland et al., 2022). The presence of dentistry in the literature underscores its transition from a supportive role to a central component in multidisciplinary airway care.

In contrast, **maxillofacial surgery** appears less frequently represented. This may be due to the fact that its involvement is often limited to specific clinical scenarios, such as trauma management or advanced surgical treatment of severe airway obstruction. However, despite its lower frequency, its impact is substantial. Surgical interventions such as maxillomandibular advancement have demonstrated significant improvements in airway volume and respiratory outcomes, indicating that skeletal modification can be a definitive solution in selected cases (Boyd et al., 2021; Lin et al., 2024). Therefore, its lower representation does not diminish its clinical importance, but rather reflects its more specialized application.

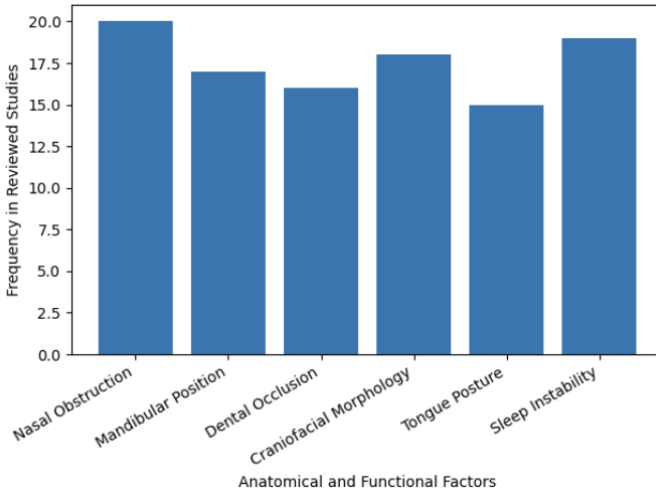
The category of **multidisciplinary studies** presents an intermediate frequency, which is particularly relevant in the context of this review. While interdisciplinary approaches are increasingly recognized as necessary, the data suggest that fully integrated studies involving multiple specialties simultaneously remain less common than single-discipline or dual-discipline research. This finding highlights a gap in the literature: although the need for integration is widely acknowledged, truly collaborative research across ENT, dentistry, trauma, and sleep medicine is still developing.

This distribution reveals an important structural pattern in current airway research: the field is still predominantly anchored in **ENT and sleep medicine**, with dentistry progressively gaining prominence, while trauma and fully interdisciplinary approaches are less consistently incorporated. This imbalance supports the argument that functional airway medicine is not yet fully consolidated as a unified discipline, but rather exists as an evolving intersection of specialties.

From an educational and clinical perspective, this finding reinforces the importance of promoting interdisciplinary training. Students and clinicians exposed only to one of these domains may develop a partial understanding of airway dysfunction. In contrast, integrating perspectives from otolaryngology, dentistry, trauma, and sleep medicine allows for a more comprehensive evaluation of patients, particularly in complex cases where multiple contributing factors coexist.

### Figure 3.

*Frequency of the main anatomical and functional factors associated with airway dysfunction.*



The distribution of anatomical and functional factors associated with airway dysfunction demonstrates a clear predominance of **nasal obstruction** and **sleep instability**, followed closely by **craniofacial morphology** and **mandibular position**, while **dental occlusion** and **tongue posture** appear with slightly lower but still clinically significant frequencies.

The highest frequency corresponds to **nasal obstruction**, reinforcing its role as one of the most critical determinants of airway resistance and breathing patterns. The literature consistently identifies nasal impairment as a primary trigger for mouth breathing, increased upper airway resistance, and reduced airflow efficiency, particularly during sleep (Kim et al., 2022; Patel et al., 2023). This finding supports the concept that nasal patency is not merely an anatomical detail, but a fundamental component in maintaining physiological respiration and preventing downstream airway dysfunction.

Closely associated with this, **sleep instability** shows a similarly high frequency. This reflects the importance of dynamic physiological processes—such as arousals, respiratory effort fluctuations, and neuromuscular control—in shaping airway behavior. Sleep-disordered breathing is not solely determined by static anatomy, but by the interaction between anatomical susceptibility and functional instability during sleep cycles (Garvey et al., 2020; Berry et al., 2022). The prominence of this factor highlights that airway dysfunction must be understood as both a structural and physiological phenomenon.

**Craniofacial morphology** represents another major contributor, emphasizing the structural framework within which the airway operates. Variations in maxillary width, mandibular projection, palatal height, and facial growth patterns can significantly influence airway dimensions and predisposition to collapse. The literature demonstrates that individuals with certain craniofacial characteristics—such as retrognathia or narrow maxillary arches—are more susceptible to airway compromise (Kandasamy & Goonewardene, 2022; Huang et al., 2021). This reinforces the importance of including skeletal and developmental factors in airway assessment.

The role of **mandibular position** is also strongly represented, reflecting its direct impact on the oropharyngeal space. Posterior positioning of the mandible is associated with reduced airway caliber and increased collapsibility, particularly during sleep when muscle tone decreases. This relationship is clinically relevant, as it forms the basis for therapeutic interventions such as mandibular advancement devices, which aim to reposition the jaw to improve airway patency (Ramar et al., 2021; Sutherland et al., 2022).

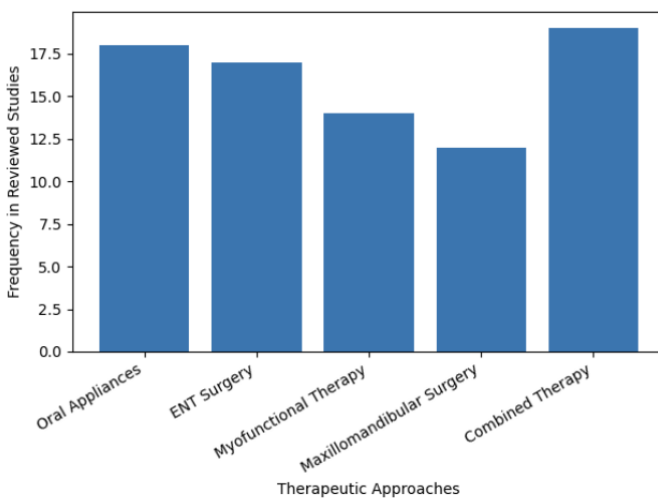
**Dental occlusion**, while slightly less frequent, remains an important factor within the integrative model. Occlusal relationships influence mandibular stability, tongue space, and oral function, all of which can indirectly affect airway behavior. The literature suggests that malocclusion may be associated with altered breathing patterns and craniofacial development, particularly when present during growth phases (Kandasamy & Goonewardene, 2022). Although occlusion alone may not determine airway dysfunction, it contributes to the broader structural context.

Finally, **tongue posture** appears with the lowest frequency among the analyzed factors, yet its functional significance should not be underestimated. The position and tone of the tongue play a key role in maintaining airway patency, especially during sleep when neuromuscular control is reduced. Abnormal tongue posture, low resting position, or restricted mobility may contribute to airway obstruction and inefficient breathing patterns. This factor is particularly relevant in the context of myofunctional therapy and oral habit correction (Camacho et al., 2020; Boscariol & Sassi, 2024).

Taken together, these findings illustrate that airway dysfunction arises from the **interaction between multiple anatomical and functional components**, rather than from a single isolated factor. The relatively balanced distribution across categories suggests that no single element fully explains airway pathology; instead, it is the cumulative and interdependent effect of nasal, skeletal, dental, muscular, and physiological variables.

**Figure 4.**

*Therapeutic approaches most frequently identified in the reviewed literature.*



The distribution of therapeutic approaches demonstrates a clear predominance of **combined or multidisciplinary therapy**, followed closely by **oral appliance therapy** and **ENT surgical interventions**, while **myofunctional therapy** and **maxillomandibular surgery** appear with comparatively lower frequencies.

The most prominent category is **combined therapy**, reflecting a growing trend toward integrative management of airway disorders. This finding suggests that the literature increasingly supports the idea that no single intervention is sufficient to address the complexity of airway dysfunction. Instead, combining approaches—such as nasal surgery with oral appliances, or myofunctional therapy alongside structural interventions—appears to provide more comprehensive and effective outcomes. This aligns with the concept of personalized treatment strategies tailored to the specific anatomical and functional characteristics of each patient (Riaz et al., 2023; Sutherland et al., 2022).

**Oral appliance therapy** shows a high frequency, highlighting its relevance as a non-invasive and widely used treatment modality, particularly in patients with mild to moderate obstructive sleep apnea or intolerance to continuous positive airway pressure. Mandibular advancement devices function by repositioning the mandible forward, thereby increasing airway space and reducing pharyngeal collapse. Their prominence in the literature underscores the significant role of dentistry in airway management and reinforces the importance of dentofacial structures in therapeutic decision-making (Ramar et al., 2021; Caples et al., 2021).

**ENT surgical interventions** also demonstrate substantial representation, reflecting their importance in addressing anatomical obstructions, particularly at the nasal and pharyngeal levels. Procedures such as septoplasty, turbinate reduction, and multilevel airway surgery aim to improve airflow and reduce airway resistance. The literature indicates that surgical approaches are particularly relevant in patients with clear structural abnormalities that cannot be

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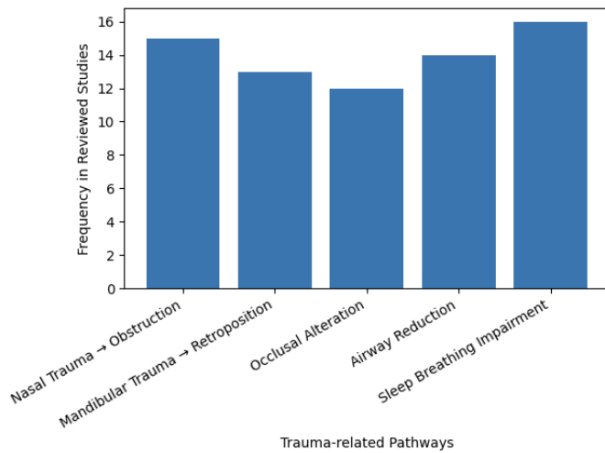
adequately managed through conservative measures alone (Patel et al., 2023; Boyd et al., 2021). Their high frequency supports the continued central role of otolaryngology in airway treatment.

In contrast, **myofunctional therapy** appears with a moderate frequency, suggesting that while it is increasingly recognized, it is still less widely adopted compared to structural interventions. This therapy focuses on improving muscle tone, tongue posture, and breathing patterns, contributing to functional stability of the airway. Evidence supports its role as an adjunctive treatment, particularly in patients with dysfunctional oral habits or poor neuromuscular control (Camacho et al., 2020; Boscaroli & Sassi, 2024). Its lower frequency may reflect variability in training, accessibility, and standardization across clinical settings.

**Maxillomandibular surgery** shows the lowest frequency among the analyzed therapies, which is consistent with its indication for more severe or refractory cases. Despite its lower representation, it remains one of the most effective interventions for increasing airway volume and improving outcomes in patients with significant skeletal abnormalities or severe obstructive sleep apnea. Its lower frequency likely reflects its invasive nature and the need for careful patient selection, rather than a lack of efficacy (Lin et al., 2024; Boyd et al., 2021).

**Figure 5.**

*Relationship between trauma, dentofacial alterations, and sleep-related breathing impairment.*



The distribution of trauma-related pathways demonstrates a progressive relationship between **structural injury** and **functional respiratory impairment**, with the highest frequency observed in **sleep breathing impairment**, followed by **nasal trauma leading to obstruction** and **airway reduction**, while **mandibular trauma** and **occlusal alterations** show slightly lower but still relevant representation.

The most prominent category, **sleep breathing impairment**, reflects the ultimate clinical consequence of cumulative structural and functional alterations following trauma. This finding suggests that although trauma may initially present as an acute condition, its long-term effects frequently extend into sleep physiology, contributing to altered breathing patterns, airway instability, and potentially the development or exacerbation of sleep-disordered breathing. The literature supports that airway compromise is not always immediately evident after trauma, but may evolve over time as anatomical and functional adaptations occur (Garvey et al., 2020; Alqahtani & BaHammam, 2023).

**Nasal trauma leading to obstruction** represents one of the most direct and immediate pathways linking trauma to airway dysfunction. Injuries to the nasal bones, septum, or surrounding structures can result in persistent obstruction, increased airway resistance, and compensatory mouth breathing. This alteration not only affects airflow but also modifies tongue posture, mandibular positioning, and overall breathing mechanics, thereby contributing to downstream airway instability (Kim et al., 2022; Patel et al., 2023). The relatively high frequency of this pathway underscores the central role of nasal integrity in maintaining functional respiration.

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The category of **airway reduction** highlights the structural consequences of trauma on the dimensions of the upper airway. Fractures involving the maxilla, mandible, or midface may alter skeletal relationships and reduce available airway space. These changes can lead to increased collapsibility, particularly during sleep when neuromuscular tone is diminished. The literature indicates that even subtle skeletal alterations may have significant functional consequences, especially when combined with other predisposing factors such as craniofacial morphology or soft tissue imbalance (Boyd et al., 2021; Lin et al., 2024).

**Mandibular trauma leading to retroposition** is another important pathway, reflecting how displacement or improper healing of mandibular fractures can result in posterior positioning of the jaw. This positional change reduces the space of the oropharynx and increases the likelihood of airway obstruction. Although less frequently reported than nasal trauma, its clinical significance is considerable, particularly in cases where mandibular alignment directly influences airway patency. This mechanism is closely related to the principles underlying mandibular advancement therapies, which aim to reverse this posterior displacement (Ramar et al., 2021; Sutherland et al., 2022).

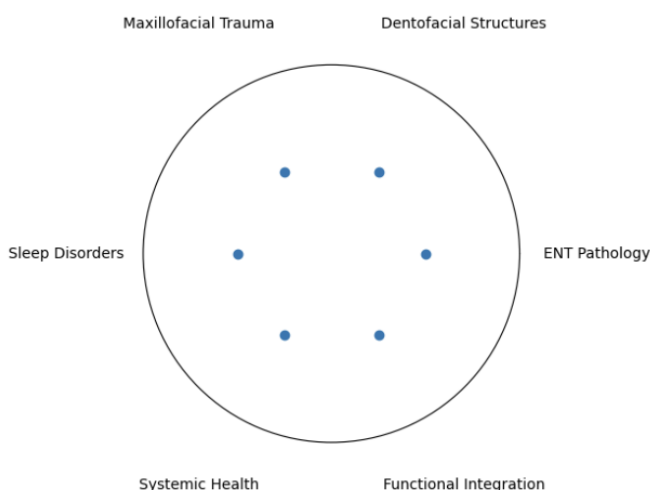
**Occlusal alteration** appears as the least frequent category, yet it represents a critical intermediary factor between trauma and functional airway outcomes. Changes in occlusion may affect mandibular stability, chewing patterns, and tongue positioning, all of which can indirectly influence airway behavior. The lower frequency of this category may reflect underreporting or limited direct investigation, rather than a lack of relevance. In clinical practice, occlusal changes are often observed after trauma and may contribute to long-term functional adaptations that impact breathing patterns.

Overall, this distribution illustrates a **continuum from structural injury to functional respiratory consequence**, in which trauma initiates anatomical changes that progressively influence airway behavior and sleep physiology. The findings support the concept that trauma should not be viewed solely as an acute event, but as a potential starting point for chronic airway dysfunction.

From an integrative perspective, this reinforces the importance of incorporating airway evaluation into the long-term follow-up of patients with craniofacial trauma. It also highlights the need for interdisciplinary collaboration between otolaryngology, dentistry, and maxillofacial surgery to identify and address these sequelae early.

#### Figure 6.

*Integrative model summarizing the interaction between ENT pathology, teeth, trauma, sleep, and systemic health.*



The integrative model presented illustrates the conceptual interdependence between the principal domains involved in functional airway medicine: **ENT pathology, dentofacial structures, maxillofacial trauma, sleep disorders, systemic health, and functional integration**. Rather than representing a linear relationship, the circular configuration

emphasizes that these components interact dynamically and bidirectionally, forming a continuous and interconnected system.

At one axis of the model, **ENT pathology** represents the primary gateway to airway function, as nasal and upper airway conditions directly influence airflow, resistance, and breathing patterns. Alterations at this level—such as nasal obstruction or pharyngeal collapse—initiate functional adaptations that extend beyond the local anatomical region (Kim et al., 2022; Patel et al., 2023). However, the model demonstrates that these changes do not occur in isolation.

Adjacent to this, **dentofacial structures** highlight the structural framework that supports and modulates airway behavior. The position of the maxilla, mandible, and dentition influences tongue posture, oral cavity volume, and airway dimensions. This structural component interacts continuously with ENT conditions, reinforcing the idea that dental and skeletal factors are integral—not secondary—to airway physiology (Kandasamy & Goonewardene, 2022; Sutherland et al., 2022).

**Maxillofacial trauma** is positioned as a modifying factor capable of disrupting both ENT structures and dentofacial relationships. Trauma may alter nasal anatomy, occlusion, and mandibular positioning, thereby introducing structural changes that can propagate throughout the airway system. The model reflects how trauma can act as both an initiating and perpetuating factor in airway dysfunction, influencing multiple domains simultaneously (Boyd et al., 2021; Lin et al., 2024).

The connection to **sleep disorders** represents the functional expression of these anatomical and structural alterations. During sleep, reduced neuromuscular tone exposes underlying vulnerabilities in the airway, making structural and positional factors clinically evident. This domain serves as the point where anatomical predisposition and physiological instability converge, resulting in conditions such as obstructive sleep apnea (Garvey et al., 2020; Berry et al., 2022).

Extending further, **systemic health** reflects the broader consequences of persistent airway dysfunction. Chronic sleep-disordered breathing has been associated with cardiovascular, metabolic, and inflammatory conditions, indicating that airway pathology can influence overall health beyond localized symptoms (Alqahtani & BaHammam, 2023; Feller et al., 2022). The inclusion of this domain reinforces the idea that airway medicine is not limited to structural correction, but has implications for long-term systemic outcomes.

At the center of the model lies **functional integration**, which represents the unifying principle of this framework. This central element emphasizes that optimal understanding and management of airway disorders require the integration of all surrounding domains. It is not sufficient to address ENT pathology, dental structures, trauma, or sleep disturbances independently; rather, their interactions must be considered collectively to achieve accurate diagnosis and effective treatment.

The circular arrangement of the model underscores the absence of a single dominant factor. Instead, it suggests that airway dysfunction emerges from the **continuous interaction between structural, functional, and systemic components**, with each domain capable of influencing and being influenced by the others. This configuration supports the core premise of functional airway medicine: that airway health is inherently multidisciplinary and cannot be fully understood through isolated perspectives.

From an educational standpoint, this model provides a visual synthesis that facilitates the understanding of complex relationships. It encourages students and clinicians to move beyond compartmentalized thinking and to adopt a systems-based approach when evaluating airway-related conditions. Clinically, it supports the development of comprehensive assessment strategies that incorporate ENT evaluation, dental analysis, trauma history, sleep assessment, and systemic health considerations.

## DISCUSIÓN

The findings of this review support the concept that airway dysfunction should be understood as a **multifactorial and interdisciplinary phenomenon**, rather than as an isolated condition confined to a single anatomical region or specialty. The distribution of evidence presented in the results demonstrates that otolaryngology, dentistry, maxillofacial trauma, and sleep medicine are not independent domains, but rather interconnected components of a

shared functional system. This perspective aligns with the emerging framework of functional airway medicine, which proposes that airway health depends on the integration of structural, neuromuscular, and physiological factors.

One of the most consistent observations across the analyzed literature is the central role of **nasal obstruction and upper airway anatomy** in initiating and perpetuating airway dysfunction. The high representation of ENT-related factors confirms that nasal patency is a key determinant of airflow dynamics and breathing efficiency. However, the results also indicate that addressing nasal obstruction alone is often insufficient. While ENT interventions may improve airflow, they may not fully resolve airway instability when other contributing factors—such as mandibular position, dentofacial morphology, or neuromuscular dysfunction—remain unaddressed (Kim et al., 2022; Patel et al., 2023). This reinforces the need for comprehensive evaluation beyond a single specialty focus.

The integration of **dentofacial structures** into airway analysis represents a significant shift from traditional approaches. Historically, dental findings such as malocclusion or mandibular retrusion were often considered separate from respiratory function. However, the reviewed evidence demonstrates that these structural features directly influence airway dimensions and collapsibility. The effectiveness of mandibular advancement devices further supports this relationship, as modifying jaw position can produce measurable improvements in airway patency and sleep-related outcomes (Ramar et al., 2021; Sutherland et al., 2022). This indicates that teeth and occlusion are not merely adjacent to the airway, but actively participate in its function.

In addition, the role of **craniofacial morphology and growth patterns** highlights the importance of early identification and intervention. Pediatric studies suggest that airway dysfunction and craniofacial development are closely linked, with potential long-term consequences if not addressed during growth (Huang et al., 2021; Kandasamy & Goonewardene, 2022). This has important implications for both prevention and treatment, as early recognition of mouth breathing, maxillary constriction, or altered facial growth may reduce the risk of future airway compromise. The discussion therefore extends beyond treatment toward the concept of anticipatory and developmental airway care.

The findings related to **maxillofacial trauma** provide an important, yet often underemphasized, dimension of airway medicine. Although trauma was less frequently represented in the literature, its impact on airway function is substantial. Structural alterations following trauma—such as nasal deformity, mandibular displacement, or occlusal changes—can persist long after the acute phase and contribute to chronic airway dysfunction. The results suggest that trauma should be incorporated into airway evaluation not only in emergency settings, but also in long-term follow-up. This perspective aligns with evidence showing that skeletal repositioning procedures, such as maxillomandibular advancement, can significantly improve airway outcomes, illustrating the direct relationship between craniofacial structure and respiratory function (Boyd et al., 2021; Lin et al., 2024).

Another key finding is the increasing relevance of **functional and behavioral factors**, particularly in relation to myofunctional therapy and tongue posture. While structural interventions remain central, the literature indicates that neuromuscular control, oral habits, and breathing patterns also play a significant role in airway stability. Myofunctional therapy has been shown to improve muscle tone and coordination, contributing to reductions in airway collapse and symptom severity in selected patients (Camacho et al., 2020; Boscarior & Sassi, 2024). This supports a more comprehensive model in which both structure and function must be addressed to achieve optimal outcomes.

The prominence of **combined therapeutic approaches** in the results further reinforces the interdisciplinary nature of airway management. The data suggest that treatment strategies integrating multiple modalities—such as ENT surgery, oral appliances, and functional therapy—are more frequently reported than isolated interventions. This reflects a growing recognition that airway dysfunction often involves multiple contributing factors that require coordinated management. The concept of personalized treatment, guided by individual anatomical and functional characteristics, is therefore central to current practice (Riaz et al., 2023; Sutherland et al., 2022).

The relationship between airway dysfunction and **systemic health** also emerges as a critical aspect of the discussion. Obstructive sleep apnea and related conditions have been associated with cardiovascular disease, metabolic disorders, and inflammatory processes, indicating that airway pathology has implications beyond localized symptoms (Garvey et al., 2020; Alqahtani & BaHamam, 2023). Additionally, the association between oral health and systemic disease suggests that dental and airway conditions may interact within a broader physiological network (Feller et al., 2022).

These findings support the idea that airway evaluation should be considered an integral part of general health assessment.

From an educational perspective, this review highlights the importance of **interdisciplinary training**. The results suggest that a fragmented approach to airway disorders may limit diagnostic accuracy and therapeutic effectiveness. In contrast, training that integrates otolaryngology, dentistry, trauma, and sleep medicine can enhance clinical reasoning and improve patient outcomes. This is particularly relevant in regions such as **Mexico, Colombia, and Ecuador**, where healthcare systems may require clinicians to adopt broader, more integrative approaches due to variability in access to subspecialty care.

Despite these strengths, certain limitations must be considered. The narrative design of this review allows for integrative analysis, but does not provide quantitative synthesis or meta-analytic conclusions. Additionally, although the selected literature represents high-impact and recent studies, the number of references is limited to a defined set, which may not capture the full scope of available research. Furthermore, the lower representation of trauma-related studies suggests that this area may require further investigation to better understand its long-term impact on airway function.

## CONCLUSIÓN

The present review demonstrates that airway function is the result of a **complex and dynamic interaction between anatomical structures, functional mechanisms, and systemic processes**, rather than the consequence of a single isolated factor. The integration of otolaryngological disorders, dentofacial structures, maxillofacial trauma, and sleep-related breathing conditions provides a more comprehensive understanding of airway dysfunction and supports the conceptual framework of functional airway medicine.

The evidence analyzed confirms that **ENT pathology**, particularly nasal obstruction and upper airway alterations, plays a fundamental role in initiating airflow impairment. However, these findings also highlight that such alterations rarely act alone. **Dentofacial factors**, including mandibular position, dental occlusion, and craniofacial morphology, significantly influence airway dimensions and stability, reinforcing the importance of incorporating dental and orthodontic perspectives into airway evaluation and management.

Additionally, **maxillofacial trauma** emerges as a critical yet often underrecognized contributor to long-term airway dysfunction. Structural changes following trauma may alter nasal patency, mandibular alignment, and occlusal relationships, leading to persistent functional consequences that extend beyond the acute phase. This underscores the need to include airway assessment in the long-term follow-up of patients with craniofacial injuries.

The role of **sleep physiology** further contextualizes these structural and functional alterations, as reduced neuromuscular tone during sleep exposes underlying vulnerabilities in the airway. This interaction explains why conditions such as obstructive sleep apnea serve as a clinical expression of multiple converging factors rather than a single pathology. Moreover, the association between airway dysfunction and **systemic health outcomes**, including cardiovascular and metabolic disorders, emphasizes that airway evaluation is relevant not only for symptom management but also for overall health.

A key finding of this review is the growing importance of **multidisciplinary and combined therapeutic approaches**. The literature supports the use of integrated strategies that may include ENT interventions, oral appliance therapy, surgical correction, and myofunctional rehabilitation. These approaches are more aligned with the multifactorial nature of airway dysfunction and offer greater potential for individualized and effective treatment.

From an academic and clinical standpoint, this review highlights the necessity of **interdisciplinary training and collaboration**. The traditional separation between specialties may limit the ability to identify and manage airway-related conditions effectively. In contrast, an integrative model promotes more accurate diagnosis, earlier detection of contributing factors, and more comprehensive treatment planning. This is particularly relevant in healthcare contexts such as **Mexico, Colombia, and Ecuador**, where clinicians often serve as first-contact providers and must rely on broad clinical reasoning to guide patient management.

In conclusion, functional airway medicine represents a **clinically relevant and evolving framework** that bridges otolaryngology, dentistry, trauma, and sleep medicine. By recognizing the airway as an interconnected system, this approach facilitates a deeper understanding of disease mechanisms and supports the development of more effective, patient-centered strategies. Future research should continue to explore this integration, particularly in areas such as trauma-related airway dysfunction and long-term interdisciplinary outcomes, to further strengthen the evidence base and its application in clinical practice.

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