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50 Years of the *IJOM*

Perspectives and Future Directions in Orofacial
Myology and Myofunctional Therapy

Edited by
Nancy Pearl Solomon

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**50 Years of the *IJOM*: Perspectives and
Future Directions in Orofacial
Myology and Myofunctional Therapy**

50 Years of the *IJOM*: Perspectives and Future Directions in Orofacial Myology and Myofunctional Therapy

Guest Editor

Nancy Pearl Solomon



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About the Editor

Nancy Pearl Solomon

Nancy Pearl Solomon, PhD, CCC-SLP, is Research Speech-Language Pathologist at Walter Reed National Military Medical Center and Professor in the Department of Surgery at the Uniformed Services University of the Health Sciences in Bethesda, MD. She also holds an adjunct appointment in Hearing and Speech Sciences at the University of Maryland, College Park. Dr. Solomon serves as Editor-in-Chief of the *International Journal of Orofacial Myology and Myofunctional Therapy* and previously held editorships with the *Journal of Speech-Language-Hearing Research* and the *American Journal of Speech-Language Pathology*. Dr. Solomon's work is grounded in the theories and principles of speech motor control, as she has expanded her research over the years to address assessments and treatments for oral motor function, speech production, vocalization, swallowing, and most recently, obstructive sleep apnea. IJOM is the official journal of the International Association of Orofacial Myology.



Editorial

Commemorating IJOM's 50 Years of Publishing

Nancy Pearl Solomon

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Fifty years of continuous publishing of a specialized scientific journal is deserving of celebration. To commemorate this auspicious milestone for the *International Journal of Orofacial Myology and Myofunctional Therapy* (IJOM), MDPI has encouraged and assisted me in several activities, all of which are archived under Special Issues (closed) on the journal's webpage. In addition to a historical timeline, testimonials from International Association of Orofacial Myology (IAOM) leaders, IJOM editorial board members (EBMs), and authors, as well as free access to an hour-long webinar featuring selected EBMs, the culminating feature of this celebration is a collection of articles published in this Special Issue.

This issue's theme is "50 Years of the IJOM: Perspectives and Future Directions in Orofacial Myology and Myofunctional Therapy." As Guest Editor for this issue, I invited and collated papers from researchers, clinicians, and thought leaders that reflect a variety of viewpoints. Articles highlight historical context, recent developments, and future directions in orofacial myology and myofunctional therapy. With the exception of editorials, all articles underwent the same rigorous peer review process as all articles published in the journal, resulting in high-quality publications that are as informative as they are stimulating.

This issue begins with a fitting tribute to the late Dr. Marvin Hanson by his colleague and friend, Dr. Robert "Bob" Mason. Dr. Hanson was one of the founders of the IAOM and was a frequent author in the IJOM, including its inaugural January 1975 issue. His contributions to the journal and the field have reverberated across the decades.

Three papers in this issue highlight the perspectives of clinical providers as well as patients. Sharon Smart and colleagues surveyed speech-language pathologists (SLPs), orofacial myofunctional therapists, dentists and orthodontists in Australia about their knowledge and approaches to managing atypical swallowing (tongue thrust). They also conducted in-depth interviews with a small cohort of SLPs. Elias Ghosein and colleagues surveyed pediatric dentists in Lebanon about myofunctional therapy and obstructive sleep apnea (OSA). Both of these studies revealed the need for additional and expanded professional education internationally, and emphasized the importance of interdisciplinary collaboration. Diana Dobran Hansen and colleagues tracked adherence and interviewed adults with OSA to determine facilitators and barriers when carrying out orofacial myofunctional therapy. Patients' quotes are particularly poignant reminders of the need to consider individualized patient perspectives when assigning therapeutic exercises.

Three comprehensive and instructional papers critically examine and share clinical approaches to various orofacial myofunctional disorders. Pedro Contreras Salinas and colleagues reviewed the literature on myofunctional therapy in atypical swallowing. This review is a helpful resource for demonstrating that swallow function and tongue posture improve with orofacial myofunctional therapy in most studies, especially when combined with home practice and orthodontic treatment. They also reported that comparison across studies was difficult due to inconsistent and nonstandardized protocols. In what could be considered an unplanned response to the need for consistent protocols, Soroush Zaghi

and colleagues shared their internally standardized protocols and clinical outcomes for the evaluation and treatment of lingual frenuloplasty. In addition to the impressive clinical outcomes data reported for 379 pediatric and adult patients, practitioners will appreciate the clinical protocols provided as supplementary materials with this article. Rosalba Courtney published her clinical perspectives on Integrative Breathing Therapy, which considers the upper and lower airways as an integrated system according to a multidimensional framework. This highly educational and well-organized article is a must-read for orofacial myofunctional therapists delving into the topic of behavioral treatments for OSA.

Two final papers in this special collection focused on historically contextualizing and advancing orofacial myology—they are destined to become classic articles and should be required reading for all current and future orofacial myologists. Soroush Zaghi and colleagues wrote an enlightening and thoughtful article following the history of orofacial myofunctional therapy, from ancient through current practices, and proposes new avenues for advancing orofacial myofunctional therapy. The authors identify key inflection points that have altered the course of this therapeutic approach, from targeted exercises to broader functional frameworks. They describe efforts to standardize terminology, clarify the scope of practice, and advance professional standards by proposing tiered models of care. Lucas Ferreira led an international group of experts to co-author a stimulating and provocative non-institutional position paper that challenges traditional representations of orofacial myology (e.g., orofacial myofunctional disorders and orofacial myofunctional therapy) to be recognized and standardized internationally as a field of practice called orofacial motricity. The authors recognize and describe the diversity of international approaches to the development of these terms and concepts, often paralleled by professional associations, scholarly literature, and educational programs. These two papers together offer fertile ground for considering productive approaches for the future of research and clinical practice related to orofacial myofunctional disorders.

Overall, this issue provides rich reading material for anyone striving to grasp the breadth and depth of the study and management of orofacial myofunctional disorders, as well as those already deeply immersed in orofacial myology looking for inspiration from the past and aspirations for the future. I invite you to peruse this Special Issue, lingering on content that compels you to pause and reconsider your own perspectives while contemplating future directions.

Here's to another 50 years!

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Editorial

Tribute to Dr. Marvin Hanson

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Dr. Marvin L. Hanson, PhD, Professor of Communication Disorders at the University of Utah, died on 26 May 2025, at the age of 92. Dr. Hanson was one of the founders of the International Association of Orofacial Myology (IAOM) and an international leader in the field of orofacial myology. He contributed to the field's development through speaking and teaching at conferences in Europe, South America, and the USA and through his many publications.

In addition to teaching and carrying out clinical responsibilities at the University of Utah in which he trained countless students, Dr. Hanson served as Chairman of the Department of Communication Disorders from 1984 to 1994. Dr. Hanson served three terms as President of the IAOM (1975–1977, 1991–1993, and 1993–1995) and was a frequent speaker at IAOM conventions. In the 40 articles he published in the *International Journal of Orofacial Myology* (IJOM) and in publications in other professional journals, his carefully planned and implemented clinical research serves as a “master class” in how to design and conduct well-controlled clinical studies involving individuals with orofacial myofunctional disorders.

Dr. Hanson was honored as a fellow of the American Speech, Language, and Hearing Association for his many contributions to ASHA. The IAOM granted him the distinguished President's Award in 1977 and the Richard H. Barrett Award in 1981 and recognized him as an Honorary Life Member in 1986.

Dr. Hanson authored seven textbooks that continue to be widely used in universities. His last textbook, titled *Orofacial Myology: International Perspectives*, was published by Charles C. Thomas Publisher in 2003. The Hanson and Mason textbook continues to be the world leading textbook on orofacial myology. It has been translated into Chinese and is now being published and circulated in China.

Dr. Hanson maintained a private practice in speech therapy and orofacial myofunctional disorders long after his retirement from his university position. He continued to volunteer abroad, providing speech therapy during more than 20 Operation Smile missions. He also provided speech therapy to incarcerated individuals.

Having trained countless student clinicians in speech pathology and orofacial myology, Dr. Marvin “Marv” Hanson leaves a legacy of service to others that will not be forgotten.

Marv Hanson was a gentleman and a cherished friend to many of us.

Robert M Mason, DMD, PhD

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Perspective

A Historical Perspective on Orofacial Myofunctional Therapy: Bridging Ancient Practices with Contemporary Clinical Science

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Abstract

Background/Objectives: Orofacial myofunctional therapy (OMT) is a system of targeted neuromuscular exercises and behavioral retraining intended to optimize tongue, lip, jaw, and airway function during rest, breathing, swallowing, and sleep. Historically associated with tongue thrust and abnormal swallowing, OMT is now applied across an expanding range of clinical contexts, including sleep-disordered breathing (SDB), tongue-tie rehabilitation, orthodontic stability, and perioperative functional recovery. As its use has broadened, persistent questions have followed: what is myofunctional therapy, where did it originate, and how did a set of oral exercises evolve into an intervention increasingly integrated with airway health, sleep medicine, and surgical care? **Methods:** This article presents a narrative historical review with a perspective component, synthesizing foundational literature, interdisciplinary contributions, and selected contemporary evidence to examine the evolution of OMT from ancient functional practices to modern clinical science. It is written to trace recurring clinical observations, shifts in educational frameworks, and key inflection points that shaped how OMT has been taught and applied over time. **Results:** OMT did not emerge from randomized controlled trials or standardized protocols. It arose from repeated clinical encounters with patients with atypical craniofacial development, relapse of structural correction, persistent mouth breathing, and/or unresolved swallowing and speech dysfunction despite technically successful treatment. These patterns suggested that anatomy alone could not account for outcome variability. Over time, clinical attention expanded beyond isolated tongue function to include breathing patterns, posture, neuromuscular tone, and airway behavior. In the past two decades, controlled trials, cohort studies, and systematic reviews have supported selected applications of OMT, particularly in SDB and adjunctive airway care, while also revealing ongoing challenges related to training variability, terminology, scope of practice, and standardization. **Conclusions:** OMT has historically been described as a system of targeted neuromuscular and behavioral interventions aimed at modifying orofacial rest posture and function. Over time, the field has expanded beyond localized muscle retraining toward a broader functional framework that integrates airway physiology, craniofacial growth, sleep, and interdisciplinary rehabilitation.

Keywords: orofacial myofunctional therapy; oral posture; nasal breathing; tongue function; sleep-disordered breathing; craniofacial growth; historical review

1. Introduction

Orofacial Myofunctional Therapy (OMT) is often discussed as a single, clearly defined intervention. In practice, it has never been that simple. Across dentistry, speech-language pathology, orthodontics, and medicine, clinicians continue to ask the same foundational questions: What is myofunctional therapy? Is it sets of exercises, rehabilitation strategies, or a broader way of understanding how function influences development and health? Where did it begin and who is responsible for delivering it?

These questions persist because OMT did not arise from a single discipline or unified theoretical models. Long before it was formalized, clinicians across fields noticed a recurring problem: structural correction alone did not reliably produce stable outcomes. Teeth relapsed after orthodontic treatment. Mouth breathing persisted despite patent airways. Swallowing and speech patterns failed to normalize even when anatomy appeared corrected. The structure looked improved, yet function had not changed. These observations raised a critical question that anatomy alone could not answer: what role does function play in long-term stability and health?

OMT was initially described as a set of targeted neuromuscular and behavioral interventions focused on modifying orofacial functions, particularly abnormal swallowing patterns, and lip incompetence. These early approaches emphasized visible, measurable behaviors rather than a comprehensive functional model. Over time, however, clinicians recognized these behaviors could not be fully understood or sustainably corrected in isolation. Clinical experience and emerging research revealed oral function is inseparable from breathing patterns, postural control, neuromuscular coordination, and airway behavior. This recognition gradually challenged reductionist models of care and reframed OMT as a broader functional framework rather than solely localized muscle retraining. In this context, measurable behaviors refer to observable and documentable functional patterns such as breathing mode, tongue-to-palate rest posture, lip competence, swallowing mechanics, chewing coordination, and speech-related orofacial behaviors when relevant.

As the clinical scope of OMT expanded, so did its applications. What was once associated primarily with orthodontic stability and speech concerns began to intersect with sleep-disordered breathing (SDB), temporomandibular joint dysfunction, feeding therapy, tongue-tie rehabilitation, and perioperative care [1–3]. This rapid expansion generated new tension. Training pathways multiplied. Terminology blurred. Scope-of-practice questions intensified. At the same time, emerging research demanded clearer definitions, standardized outcome measures, and reproducible protocols. The field began to mature scientifically while becoming more fragmented operationally.

This review does not attempt to resolve every debate surrounding OMT. Instead, it asks a more fundamental and necessary question: how did the field arrive at its current moment? By examining OMT through a historical lens beginning with early embodied practices, progressing through clinical experimentation and professional organization, and culminating in contemporary evidence-informed integration, this paper seeks to clarify what OMT has been, what it has become, and why these distinctions matter now more than ever.

2. Methods

Narrative Historical Review Design

This article was developed as a narrative historical review with an interpretive perspective component. Literature was identified through targeted searches of PubMed, Scopus, Google Scholar, and archival issues of the *International Journal of Orofacial Myology and Myofunctional Therapy (IJOM)*. Searches included combinations of keywords such as orofacial myofunctional therapy, oropharyngeal exercises, tongue posture, airway, sleep-disordered

breathing, myofunctional rehabilitation, and motricidade orofacial, along with historical figures and milestone publications relevant to each era discussed.

Literature selection prioritized peer-reviewed clinical studies, foundational theoretical texts, consensus statements, and institutional or policy documents that materially influenced the evolution of clinical practice, education, or scientific understanding within the field. Titles and abstracts were screened for relevance to each historical era, and full texts were reviewed when publications were conceptually influential, frequently cited, or represented a methodological or institutional milestone.

The chronological structure of the review was constructed iteratively, aligning published evidence with documented shifts in clinical focus, professional organization, and research methodology. Earlier eras rely more heavily on descriptive and theoretical sources, while later periods emphasize controlled trials, systematic reviews, and consensus-based guidance.

This approach prioritizes historical and conceptual influence over quantitative synthesis and is intended to contextualize the evolution of OMT rather than to assess pooled treatment efficacy. Given the interdisciplinary and evolving nature of OMT, the goal of this article is not exhaustive coverage of all published material, but rather a structured synthesis of foundational concepts, key inflection points, and representative evidence that shaped the field's development over time. Emphasis is placed on historical continuity, shifts in clinical reasoning, and the emergence of evidence-informed frameworks rather than formal outcome aggregation.

Methodological Limitations. As a narrative historical review, this manuscript does not claim exhaustive coverage of all global contributions to OMT. The literature reviewed is subject to language and database accessibility limitations, with unavoidable overrepresentation of English-language and North American publications. Although international contributions are incorporated where possible, particularly from Europe and Latin America, regional disparities in indexing and publication access may introduce selection bias.

3. Results

Pre-Modern Origins: Cultural Practices and Functional Awareness (1500 BCE–500 CE)

Long before OMT existed as a clinical concept, human cultures were paying attention to how the mouth and airway functioned at rest. These observations were not framed as treatment, nor were they measured in modern terms. They emerged from lived experience: patterns noticed across generations, linked to vitality, endurance, and physical development.

Across ancient civilizations, breathing through the nose, maintaining oral rest posture, and coordinating tongue position with posture were not viewed as isolated mechanics. They were embedded within broader frameworks of health, longevity, and human performance. While these practices should not be interpreted as early forms of therapy, they reflect a shared, intuitive recognition that how the mouth and airway function influences the body as a whole.

Historical records frequently cited in secondary literature illustrate this pattern of embodied functional awareness:

India: Ancient and classical yogic traditions describe Pranayama (breath regulation) and Bandhas (muscular locks) as tools for physiological regulation. Later Hatha yoga texts describe Khechari Mudra as a specialized lingual practice directed toward the palate and nasopharyngeal region [4].

China: Qi Gong practices integrated breath and jaw posture into vitality-preserving routines [5].

Greece: Hippocratic texts differentiated nasal and oral respiration, linking mouth breathing with fatigue and health decline [6].

Indigenous Societies: Ethnographic accounts described how nasal breathing, oral rest posture, and tough foods were taught early and correlated with healthy facial development [7,8].

Egypt and Mesoamerica: Archaeological depictions suggest ritualized oronasal awareness and feeding practices that promoted symmetrical craniofacial development [9,10].

These examples reflect a widespread, intuitive recognition of the connection between form, function, and health, principles that contemporary OMT now formalizes through clinical science. Figure 1 represents a conceptual synthesis of key developments and evolution from the authors' perspective and is not intended to provide an exhaustive or strictly chronological account of all historical events.

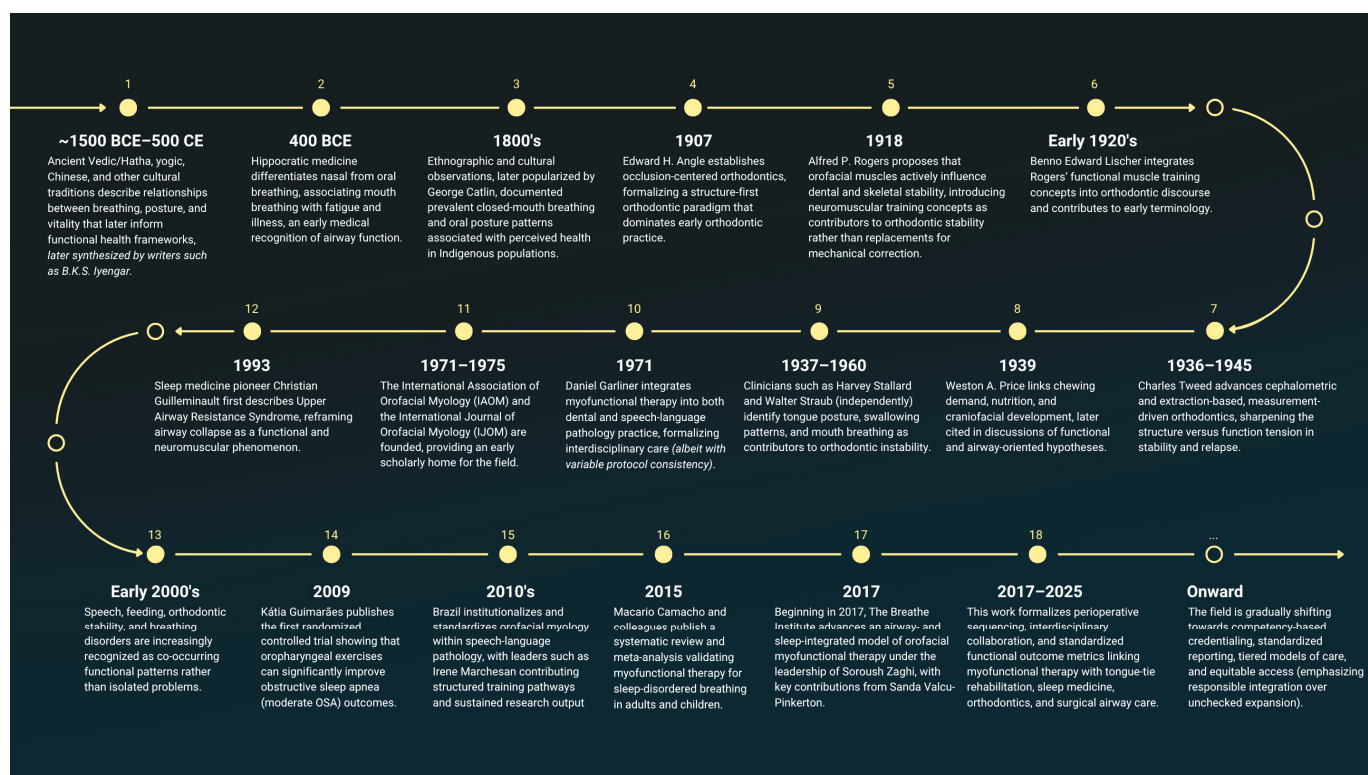


Figure 1. Evolution of Orofacial Myofunctional Therapy Concepts, Principles, and Therapeutic Practices.

Limitations: These interpretations rely on secondary sources, symbolic representations, and translations that vary across time and culture. They should be understood as illustrative of early functional awareness rather than empirical documentation of therapeutic practice.

4. Early Clinical Foundations (1800s–1960s)

Functional Orthodontics and Muscle Training

If orthodontic treatment corrected tooth position, why did so many patients relapse? This question troubled clinicians long before OMT had a formal name. Teeth could be aligned and appliances removed, yet oral habits such as mouth breathing or atypical swallowing often persisted, making long-term stability inconsistent. Structural correction alone appeared insufficient to explain these outcomes, prompting early inquiry into the relationship between form and function.

Throughout the first half of the twentieth century, orthodontic thought diverged along functional and structural lines. Increasing emphasis on measurement, appliance efficiency, and standardized mechanics reinforced a predominantly structural model, while others

questioned whether mechanical precision alone could ensure stability in the presence of persistent oral habits and altered respiratory patterns.

By the late nineteenth and early twentieth centuries, orthodontics was increasingly formalized as a mechanical discipline. Edward H. Angle systematized the field through classification of malocclusion and appliance-based correction, emphasizing occlusal relationships and craniofacial morphology as the foundation of treatment planning [11]. Although Angle primarily focused on mechanical alignment, historical accounts indicate that he acknowledged muscular pressures and oral posture, even if these were not incorporated into a structured therapeutic system.

A contrasting perspective emerged through the work of Alfred P. Rogers [12], who argued that muscle function should be considered an active determinant of orthodontic outcomes. In his 1918 paper, Rogers described exercise therapy intended to improve strength and coordination of the tongue, lips, and facial musculature. He conceptualized the orofacial muscles as a “living orthodontic appliance,” framing neuromuscular activity as a force capable of influencing dentofacial development rather than merely responding to skeletal form [12]. Rogers’ work is widely cited in historical accounts as an early functional foundation for what would later be termed Orofacial Myofunctional Therapy.

Rather than a single formal introduction, historical summaries suggest that the label “myofunctional therapy” emerged gradually. Subsequent historical accounts indicate that Benno E. Lischer was among the first to formally refer to Rogers’ exercise-based approach as OMT, reflecting an early attempt to define muscle function as a therapeutic target rather than a passive consequence of craniofacial form [13]. This attribution reflects the gradual convergence of language around practices that were already in clinical use, rather than the sudden emergence of a defined discipline.

A significant contribution during this period came from Walter J. Straub, whose clinical work and lectures in the 1950s focused on abnormal swallowing patterns and muscle tone. Straub highlighted what he termed “perverted swallowing” and emphasized the role of tongue posture and orofacial musculature in dentofacial development and orthodontic relapse [14]. Notably, he incorporated speech-language pathologists (SLPs) into treatment delivery and documentation, reflecting an early and influential step toward interdisciplinary collaboration between dentistry and speech pathology [15].

This functional argument was directly challenged by contemporaries such as Charles Tweed, who emphasized cephalometric measurement, extraction-based orthodontics, and quantifiable structural correction [16]. To Tweed, reliance on muscle training risked delaying definitive treatment. To Rogers, ignoring muscle behavior risked relapse. Their disagreement reflected a deeper uncertainty about whether long-term stability could be engineered mechanically or required behavioral adaptation, a question that remains central to OMT today.

As these debates unfolded, additional clinicians began identifying patterns that neither extreme fully explained. Walter Straub’s emphasis on mouth breathing and muscle tone further highlighted respiration as a contributing factor in facial development [15]. Raymond Begg and Harvey Stallard introduced orthodontic philosophies that emphasized individual variability in growth trajectories and treatment response, complicating one-size-fits-all structural models [17,18]. Collectively, these observations suggested that function, growth, and anatomy interacted in ways not yet fully understood.

Interest in function-driven growth resurfaced prominently with the development of orthotropics, introduced by John and Michael Mew and later taught in the United States by William Hang [19,20]. Orthotropics emphasized growth guidance, oral posture, and functional habits over mechanical correction. While influential in expanding awareness

of posture and airway considerations, sceptics of orthotropics will point out the limited empirical standardization and variable regulatory acceptance [21].

These ideas increasingly crossed disciplinary boundaries. Building on Straub's foundation, Daniel Garliner advanced the field by formalizing orofacial muscle re-education within clinical practice and education, helping to establish structured, cross-disciplinary clinical frameworks integrating dentistry and speech-language pathology [22]. His work shifted myofunctional concerns from isolated dental problems toward shared functional challenges across professions.

This interdisciplinary shift was further supported by the work of Robert M. Ricketts, whose bioprogressive philosophy integrated muscle activity, airway dynamics, and facial aesthetics into orthodontic planning [23]. Ricketts reinforced the concept that craniofacial growth could not be fully understood through static structural models alone.

In the following decade, Robert Mason and Marvin Hanson built upon these foundations, reframing OMT as a preventive, evidence-informed discipline grounded in interdisciplinary collaboration rather than an isolated technique [24,25].

Taken together, this period did not produce consensus. Instead, it produced the core dilemma that still defines OMT: structural correction can change form, but without addressing function, stability remains uncertain. OMT emerged not as a solution in search of evidence, but as a response to a persistent clinical problem that structure alone could not solve.

5. Professional Foundations and Institutional Development (1960s–2015)

As OMT began to gain traction across multiple clinical disciplines, a fundamental question emerged: if clinicians were repeatedly observing functional patterns that influenced treatment stability and patient outcomes, why did the field remain so fragmented? The organizational foundations of modern orofacial myology can be traced to collaborative efforts in the late 1960s, culminating in a formal meeting in 1972 in San Francisco, where early clinicians across speech pathology and dentistry convened to establish what would later evolve into the International Association of Orofacial Myology (IAOM) [26].

By the mid-twentieth century, practitioners in orthodontics, speech-language pathology, dentistry, and dental hygiene were independently addressing oral posture, swallowing, muscle tone, and breathing behaviors. Yet these observations developed in parallel rather than in concert. There was a lack of shared frameworks, inconsistent terminology, and no central scientific forum through which ideas could be critically examined, debated, or preserved. Functional insights existed, but they lacked a common language and institutional continuity.

This period represents what can be described as the Professional Foundations Era of OMT. Clinical practice during this time was driven largely by experiential knowledge, case reports [27–30], and clinician-developed protocols emphasizing muscle function, oral posture, swallowing patterns, and early interdisciplinary collaboration [31–36]. Although standardized metrics and high-level evidence were limited, this era was essential. It established conceptual scaffolding, educational momentum, and cross-disciplinary curiosity that later enabled systematic investigation and validation.

Importantly, the professionalization of OMT during this period did not reflect consensus. It reflected necessity. Clinicians needed mechanisms to organize shared observations before they could rigorously test them. The formation of professional societies and the launch of the *IJOM* provided a scholarly home for a field that was still defining itself, allowing functional hypotheses to be documented, refined, and transmitted rather than repeatedly rediscovered. This foundational era established the clinical and concep-

tual groundwork for OMT but was not yet defined by standardized research or unified clinical endpoints.

Despite this early momentum, the field soon encountered significant institutional resistance. Prior to the mid-1970s, OMT was widely utilized in the management of tongue thrust, oral habits, and orofacial posture. However, position statements issued by the American Speech-Language-Hearing Association (ASHA), the American Dental Association (ADA), and the American Association of Orthodontists (AAO) in 1974–1975 questioned the efficacy of OMT and advised against its routine use pending further research [37–39]. Although direct causal relationships are difficult to establish, these position statements are frequently cited as contributing to a decline in research activity and clinical adoption during this period. Rather than stimulating investigation, these statements contributed to a period of reduced academic engagement and professional skepticism, with some clinicians and researchers characterizing the field as lacking sufficient scientific foundation [38].

A revised ASHA position statement developed in 1989 and adopted in 1991 marked a partial shift, acknowledging the role of orofacial myofunctional disorders within the scope of practice. This was followed by the 1993 publication of “Orofacial Myofunctional Disorders: Knowledge and Skills” [40]. Despite these developments, the earlier period of skepticism had a lasting impact on research momentum and interdisciplinary perception.

5.1. Why a Shared Scientific Home Was Necessary: The Emergence of IJOM

If clinicians across multiple disciplines were encountering similar functional challenges, why was there no shared scientific home for these observations?

Prior to the 1970s, insights related to orofacial muscle function, oral posture, and breathing appeared sporadically across speech-language pathology journals, orthodontic meetings, dental education forums, and continuing education courses. These contributions were meaningful, but they remained siloed. Without a centralized platform, ideas were frequently rediscovered rather than systematically refined, and the field lacked a durable institutional memory capable of supporting cumulative progress.

The founding of *IJOM* in 1975 [41], shortly after the establishment of IAOM, represented a response to this fragmentation rather than a declaration of disciplinary consensus. The organization initially operated under earlier designations, including the American Association of Oral Myo Therapists, before adopting an international scope and ultimately transitioning to the IAOM as terminology and conceptual framing evolved. *IJOM* provided a dedicated forum where clinicians and researchers could document functional observations, explore emerging hypotheses, and begin developing shared terminology within an interdisciplinary context.

As the field matured, *IJOM* evolved in parallel. PubMed indexing in the 1980s expanded academic visibility and legitimacy, while the transition to digital open access by 2020 broadened international reach. The journal’s formal renaming in 2020 to the *International Journal of Orofacial Myology and Myofunctional Therapy* reflected a growing recognition of the distinction between scientific investigation of muscle function (myology) and its clinical application through therapy [42].

The 2025 partnership between IAOM and the Multidisciplinary Digital Publishing Institute (MDPI) further strengthened *IJOM*’s editorial infrastructure and dissemination capacity, coinciding with the journal’s fiftieth anniversary [43]. These developments did not resolve ongoing debates regarding scope, training, or application. Instead, they reinforced the *IJOM*’s role as a stable scholarly platform where such questions could be openly examined, revisited, and advanced over time.

5.2. Education and Training Pathways: Building an Interdisciplinary Field

The professionalization of OMT did not occur through a single curriculum, discipline, or governing body. Instead, it emerged through the efforts of educators working at the intersections of speech-language pathology, dental hygiene, orthodontics, and medicine [24,25]. Early educational approaches focused on observable dysfunction [14,15,22]. Over time, these frameworks expanded to incorporate breathing patterns, craniofacial development, airway health, and neuromuscular regulation, reflecting growing recognition that orofacial function could not be understood in isolation from broader physiologic systems [19,20,25].

Early academic incorporation of orofacial myology into formal education occurred through programs such as those developed at the University of Detroit Mercy and Kalamazoo Valley Community College, where interdisciplinary coursework began to introduce dental and speech professionals to functional assessment, habit modification, and therapeutic principles within structured curricula.

These early educational efforts played a critical transitional role. They converted clinical observation into teachable frameworks when standardized outcome measures and formal research validation were limited [24,25]. Concurrently, they revealed a persistent challenge that continues to shape the field: training pathways varied substantially in depth, rigor, scope, and regulatory recognition depending on professional background, geographic region, and healthcare system.

As OMT gained visibility across regions, professional societies, interdisciplinary associations, and educational organizations emerged to support clinician training, research dissemination, and professional dialogue [26,42]. See Supplementary Materials for more information. Rather than reflecting a single governing structure, these developments represented diverse regional responses to shared clinical challenges, including variability in scope-of-practice regulations, credentialing models, and institutional oversight. Educational infrastructures evolved through a combination of university-based curricula, professional association initiatives, hospital-affiliated training, and continuing education pathways, underscoring the absence of a unified global educational standard [24–26].

Within this evolving landscape, individual educators contributed to the dissemination and refinement of myofunctional concepts through publications, teaching, mentorship, and curriculum development. Their work helped bridge theory and clinical application across disciplines, often shaping how functional principles were interpreted and implemented in practice [24]. Importantly, these contributions did not represent a single school of thought, but rather a broader lineage through which modern education in OMT emerged. Supplementary Materials contains information on a non-exhaustive group of contributors whose peer-reviewed publications or documented academic output materially influenced the development, teaching, or scientific evaluation of OMT. Inclusion reflects historical relevance rather than endorsement of specific methods, training pathways, or institutional affiliations.

5.3. Interdisciplinary Convergence and Professional Identity

As clinicians across different disciplines began addressing oral function, a practical question became increasingly difficult to ignore: why were speech, feeding, orthodontic stability, and breathing problems so often appearing in the same patients? From the earliest phases of the field, SLPs, dental professionals, and orthodontists were already encountering overlapping patterns and engaging in informal interdisciplinary collaboration [14,15,20].

Although these concerns were framed differently depending on professional training, patterns of overlap emerged repeatedly. Patients rarely presented with a single isolated dysfunction. Instead, clinicians encountered recurring constellations involving tongue posture, lip competence, breathing patterns, feeding mechanics, and craniofacial development.

Over time, isolated treatment models proved insufficient. Tongue posture influenced orthodontic stability [14,15]. Breathing patterns shaped facial growth and neuromuscular tone [19,20]. Feeding mechanics intersected with airway readiness and postural control. These relationships could not be adequately explained within disciplinary silos. Oral function was no longer understood as a collection of discrete behaviors, but as an interconnected system influencing growth, development, and long-term clinical outcomes [25].

This recognition shifted how OMT was applied. Preventive and rehabilitative strategies expanded beyond localized symptom management toward integrated functional frameworks. Pediatric orthodontics, developmental care, and early intervention settings increasingly incorporated breathing, posture, and neuromuscular coordination alongside structural goals. Speech clarity, feeding competence, and airway stability were reframed not as separate endpoints, but as interdependent expressions of functional health [25].

Efforts to standardize terminology through professional organizations, academic journals, and emerging certification pathways represented a critical step in the field's maturation [32]. Clear language did not resolve all professional or regulatory questions, but it established the foundation necessary for interdisciplinary collaboration, research integrity, and ethical clinical practice. By defining OMT not merely by technique, but by purpose and functional intent, the field articulated a professional identity capable of supporting future integration, validation, and growth.

6. The Sleep and Airway Paradigm Shift (2000s–2015)

By the early 2000s, sleep medicine was confronting a problem that craniofacial anatomy alone could not explain. Patients with similar skeletal structure exhibited markedly different airway behavior during sleep. Some collapsed, some compensated, and some remained stable. The question became unavoidable: if anatomy was similar, what else was influencing airway patency?

This question marked a turning point for OMT. Rather than viewing the upper airway as a static anatomical tube, clinicians increasingly recognized it as a dynamic, neuromuscular system shaped by tone, posture, and learned behavior [41]. Oral posture, tongue position, and functional adaptation began to enter conversations previously dominated by bone, fat distribution, and surgical metrics.

The first major validation of this perspective arrived in 2009, when Guimarães et al. published a randomized controlled trial evaluating oropharyngeal exercises for obstructive sleep apnea (OSA) [31]. The study demonstrated significant reductions in apnea–hypopnea index (AHI), improvements in oxygen saturation, and enhanced sleep-related quality of life. More importantly, it established that targeted neuromuscular training could measurably alter SDB outcomes. OMT was no longer a theoretical adjunct. It had entered the domain of testable, non-invasive intervention.

Concurrently, conceptual advances within sleep medicine were reshaping how airway collapse itself was understood. Dr. Christian Guilleminault, a founding editor of *Sleep* and the first to describe Upper Airway Resistance Syndrome (UARS), emphasized that airway instability could arise from neuromuscular tone, oral behaviors, and adaptive responses rather than fixed obstruction alone [44]. His work reframed SDB as a functional spectrum, bridging respiratory physiology with orofacial behavior and creating a conceptual opening for interdisciplinary, functionally informed care.

This paradigm shift reached a consolidation point in 2015 with the publication of Camacho et al.'s systematic review and meta-analysis in *Sleep* [45]. Using PRISMA methodology, the authors synthesized global evidence on OMT for SDB, reporting reductions in AHI of approximately 50% in adults and 62% in children, alongside improvements in oxygen saturation, snoring, and daytime symptoms. This analysis did more than confirm

efficacy. It transformed decades of heterogeneous clinical observations into reproducible, quantitative outcomes, effectively closing the question of whether functional therapy could influence SDB.

Beyond outcome validation, the emerging research reshaped methodological expectations across the field. Attention shifted toward exercise dosing, adherence monitoring, outcome measure selection, and the need for transparent therapist training descriptions. These considerations directly informed subsequent investigations into perioperative integration, adjunctive interventions such as frenuloplasty, and interdisciplinary care pathways involving orthodontics, surgery, and sleep medicine.

Despite these advances, limitations persisted throughout this era. Protocol heterogeneity, variability in therapist training, and inconsistent outcome measures continued to challenge cross-study comparison. The participatory nature of therapy complicated blinding in randomized trials, underscoring the importance of adherence tracking, adverse event reporting, and psychometric validation of emerging screening and outcome tools.

Collectively, the period from 2000 to 2015 represents a critical inflection point in the evolution of OMT. During this time, OMT transitioned from clinically intuitive practice to evidence-informed intervention, and from isolated provider innovation to coordinated interdisciplinary relevance within sleep and airway medicine. Rather than resolving the question of efficacy, the period following 2015 marked a shift toward more structured investigation of specific applications of OMT, particularly in SDB. While randomized trials and meta-analyses have demonstrated benefit in SDB populations, questions regarding generalizability, standardization, and broader clinical efficacy remain actively debated across disciplines. Recent systematic reviews, including Cochrane analysis, highlight both the potential benefits and the limitations of current evidence, underscoring the need for further high-quality, standardized research [45–48].

7. Evidence Integration and Implementation Era (2015–2026)

The period following 2015 is best understood not as a resolution of efficacy, but as a shift toward more structured investigation and selective clinical application of OMT. Randomized trials and meta-analyses, particularly in the context of SDB, have demonstrated benefit in specific populations [30,31,44–49]. Research and clinical focus increasingly shifted toward defining appropriate indications, clarifying therapeutic scope, standardizing assessment metrics, and determining how OMT could be responsibly integrated within interdisciplinary systems of care [1,44,49,50]. However, these findings have not uniformly translated across all domains of OMT, and questions regarding standardization, generalizability, and clinical implementation remain active areas of debate. Accordingly, the central focus of this era has shifted from broad claims of effectiveness to more targeted clinical questions: how should OMT be applied, in which patient populations, and within what interdisciplinary frameworks of care.

Within contemporary interdisciplinary practice, the concept of perioperative functional recovery refers to the role of functional rehabilitation before and after procedures that alter or depend on oropharyngeal anatomy. In the context of OMT, this most commonly includes lingual frenuloplasty, orthognathic and dentofacial orthopedic interventions, upper airway surgery, and expansion-adjacent therapies [1–3]. Emerging clinical observations and cohort-based investigations suggest that integrated OMT may support perioperative functional adaptation, reduce maladaptive compensatory behaviors following procedures such as lingual frenuloplasty, and improve adherence to adjunctive therapies including continuous positive airway pressure (CPAP) [1,51–53]. These observations will benefit from further investigation through prospective validation, including systematic evaluation of functional outcomes, durability of change, and cost-effectiveness within integrated care models.

During this era, OMT became increasingly embedded within interdisciplinary care models rather than functioning as a standalone intervention. Integration included how to sequence therapy relative to structural intervention, how readiness and progress should be defined across disciplines, and how professional roles should align within differing scope-of-practice frameworks.

At the same time, evidence integration exposed structural vulnerabilities within the field. As OMT scaled globally, variability in therapist training, protocol design, and outcome reporting became more visible. While new tools emerged to support screening, assessment, and progress tracking, consensus around formally validated outcome measures, adverse event reporting, and scope boundaries lagged behind clinical adoption [45]. Rapid growth made these gaps increasingly difficult to overlook.

In response, this period also catalyzed more intentional efforts toward coordination. Shared terminology, tiered models of care, interdisciplinary referral pathways, and collaborative research initiatives began to take shape. Rather than fragmenting further, the field increasingly recognized that long-term credibility would depend on alignment, transparency, and methodological rigor rather than proliferation alone.

Viewed in retrospect, the evidence integration and implementation era represents a maturation phase. OMT transitioned from a therapy seeking legitimacy to a discipline responsible for stewardship. The defining question of this period is no longer whether OMT belongs in modern care, but how it can be implemented safely, consistently, and ethically within comprehensive airway, sleep, and craniofacial health systems.

7.1. Clinical Evidence and Key Findings (Post-2015)

As efficacy was being established, what questions did clinical research need to answer next?

In the post-2015 period, rather than isolating OMT as a standalone intervention, studies increasingly examined its role within coordinated treatment pathways spanning airway management, speech, swallowing, orthodontics, and perioperative recovery. Building on the clinically significant reductions in AHI reported in 2015 [45], subsequent cohort-based investigations focused on implementation and outcome characterization. Research led by Zaghi and colleagues evaluated lingual frenuloplasty combined with perioperative myofunctional therapy, introducing objective functional metrics such as the Tongue Range of Motion Ratio (TRMR) [50,51] building off the works of Kotlow and Marchesan [54,55] and the Wound Healing Integration Maturation Scale (WHIMS) [1]. These tools addressed a persistent limitation of earlier work: the lack of standardized, reproducible measures of tongue mobility, tissue healing, and functional integration over time.

Why did outcome measurement need to expand beyond airway indices alone?

As OMT became embedded in interdisciplinary care, it became increasingly clear that airway metrics could not fully capture functional readiness or therapeutic impact. Studies during this era therefore incorporated additional endpoints, including lingual–palatal suction, compensatory oral behaviors, and neuromuscular coordination relevant to speech, swallowing, and surgical outcomes [1,50]. This broader outcome framework reflected an evolving understanding of OMT as a behavioral and neuromuscular intervention with system-wide implications, rather than a single-mechanism therapy.

Importantly, several of the most influential validation studies and regulatory recognitions shaping contemporary acceptance of OMT emerged outside North America, particularly in Europe and Brazil. Contributions from European cohorts, including work by Lichnowska and colleagues, further supported this shift [56]. Structured myofunctional interventions were associated with improvements in speech production, swallowing efficiency, and airway-related function, reinforcing the generalizability of OMT across

populations and healthcare systems. Collectively, post-2015 findings strengthened the evidentiary foundation of OMT while clarifying the need for standardized metrics, defined protocols, and longitudinal follow-up as the field moved toward reproducible, evidence-integrated practice.

7.2. Global Growth and Organizational Expansion

As OMT gained international traction, a central question emerged: how does a function-based, interdisciplinary approach scale across regions with differing professional boundaries, regulatory systems, and educational traditions?

Early international evidence played a critical role in shaping this expansion. A randomized control trial conducted in Switzerland by Puhan et al. in 2006 demonstrated that structured upper airway muscle engagement, achieved through didgeridoo training, reduced symptoms of OSA [57]. Although not framed as OMT at the time, this study represented a foundational proof-of-concept linking functional training with airway outcomes and is now widely recognized as a historical inflection point.

Brazil occupies a distinctive position in the global development of OMT. The randomized controlled trial by Guimarães et al. [31] provided one of the earliest structured therapeutic protocols demonstrating functional improvement in adults with SDB, while subsequent work by de Felício and colleagues further advanced standardized assessment methods and treatment frameworks [58]. Unlike many regions where OMT developed at the margins of existing disciplines, Brazil formally recognized the field as a clinical specialty within speech-language pathology under the designation *Motricidade Orofacial*. This regulatory recognition, overseen by the Federal Council of Speech-Language Pathology and Audiology (CFFa), enabled standardized training pathways, academic integration, and consistent research output. As a result, Brazil continues to contribute disproportionately to peer-reviewed literature, editorial leadership, and international collaboration.

European contributions further strengthened the evidence base and broadened the field's scope. Pediatric research by Villa et al. in 2017 demonstrated improvements in tongue tone and symptom burden in children with SDB following OMT, extending functional rehabilitation concepts beyond adult populations [49]. At a consensus level, the International Consensus Document on OSA, published in *Archivos de Bronconeumología* (2022), marked a pivotal milestone by formally incorporating myofunctional therapy into evidence-based management algorithms for OSA [59].

The Spanish Ministry of Health, following a national Health Technology Assessment coordinated with the Canary Islands Health Service, evaluated oropharyngeal rehabilitation as an adjunctive therapeutic option for OSA within its national health framework to become the first governmental authority to recognize OMT [60]. This institutional endorsement represents a critical transition from emerging clinical evidence to policy-level validation and reflects growing international acceptance of functional rehabilitation within airway care.

As OMT spread globally, however, it did not do so uniformly. Across North America, Europe, Asia, and Latin America, implementation evolved within highly variable regulatory and educational frameworks. Differences in scope of practice, credentialing, and clinical authority reflected the inherently interdisciplinary nature of the field, while simultaneously introducing challenges related to training consistency, outcome reporting, and professional accountability. These variations underscored the need for organizational and educational structures capable of supporting shared standards without constraining cross-disciplinary contribution.

Recent analyses have also highlighted that global growth exposed persistent variability in protocol design and outcome measurement. A 2025 scoping review by da Silva

et al. emphasized heterogeneity across oropharyngeal exercise protocols, reinforcing the need for clearer reporting standards, cross-validation of outcome measures, and cautious interpretation of emerging data across populations and indications for sleep SDB [61].

Viewed collectively, the global and organizational expansion of OMT for improving OSA reflects its transition from a niche clinical interest to an internationally coordinated, evidence-informed discipline. This evolution has been driven not by uniformity, but by the convergence of clinical evidence, regulatory recognition, and consensus-based guidance capable of supporting interdisciplinary practice across diverse healthcare systems.

7.3. Measurement Tools and Protocol Development

The contemporary era of OMT reflects a shift from rapid clinical adoption toward structural maturation. Variability in clinician training, scope interpretation, and therapeutic sequencing exposed limitations in relying solely on subjective observation or experiential judgment. Without shared benchmarks, it became increasingly difficult to compare outcomes, replicate interventions, or distinguish therapeutic response from compensatory adaptation.

In response, the SDB field increasingly prioritized the development of standardized measurement tools capable of translating functional change into observable and documentable data. Screening instruments designed to characterize functional readiness for functional frenuloplasty, along with outcome measures such as the TRMR, lingual–palatal suction metrics, and structured wound-healing scales including the WHIMS, were introduced to support more consistent assessment of mobility, tissue quality, and post-intervention integration [1,50,51].

A key refinement in contemporary measurement frameworks and protocol integration has been the systematic identification and control of compensatory movement patterns. In patients with restricted tongue mobility, the body often recruits adjacent musculature to simulate functional range. Without accounting for these substitutions, tongue mobility may be overestimated and therapeutic response misinterpreted.

Common compensations include floor of mouth elevation (FOM), in which sublingual tissues rise instead of true intrinsic tongue elevation; facial grimace (FG), characterized by overuse of the facial muscles in the upper, mid- and lower face, most notably seen as mentalis strain; neck engagement (NE), involving excessive activation of the platysma or suprahyoid musculature; jaw protrusion (JP), where the mandible excessively advances; and jaw lateralization (JL), in which the mandible shifts horizontally to artificially increase apparent reach. These strategies allow patients to complete tasks such as tongue tip elevation or lingual–palatal suction while masking underlying restriction or weakness [1].

Standardized testing conditions, including bite-block stabilization and the floor-of-mouth hold maneuver, were incorporated to reduce accessory muscle recruitment and isolate intrinsic lingual function. Functional endpoints were defined not only by the range achieved, but by the absence of FOM, FG, NE, JP, and JL. Treating compensation control as a prerequisite for reproducible measurement improves interpretability of outcomes and strengthens reliability across providers and settings [1].

Preoperative and early-phase interventions prioritize measurable capacities such as nasal hygiene, suction endurance, jaw–lingual dissociation and stability, before escalation to higher-complexity interventions or surgical procedures [1]. This sequencing reflects a growing recognition that functional preparedness influences both short-term outcomes and long-term stability.

Importantly, the movement toward standardized measurement did not originate exclusively with any single instrument or framework. International myofunctional traditions had long emphasized multidomain functional assessment, including breathing mode, rest posture, swallowing pattern, chewing efficiency, and speech-related function [34–36,62].

Contemporary tools should therefore be understood as complementary refinements rather than replacements for broader whole-function assessment traditions that developed earlier across diverse geographic and professional contexts.

The integration of standardized measurement with protocol-driven sequencing marks an important inflection point for the field. OMT has moved from predominantly clinician-dependent assessment toward data-supported functional characterization that facilitates longitudinal tracking and multi-site comparison.

7.4. Clarifying Scope and Advancing Professional Standards

As OMT became increasingly integrated into clinical care, a central question emerged: who is responsible for delivering OMT, and under what conditions should it be applied?

OMT now sits at the intersection of multiple health disciplines, including speech-language pathology, dental hygiene, dentistry, otolaryngology, sleep medicine, and other allied health professions. This interdisciplinary strength has enabled broad adoption, but it has also intensified the need for clarity around scope of practice, competency, and professional accountability.

At the same time, consensus has grown around foundational behaviors such as nasal breathing, lip seal, chewing, swallowing, and oral rest posture. While these concepts are increasingly disseminated through public education, pediatric settings, and preventive health initiatives, a critical distinction has become necessary. Foundational awareness supports prevention; clinical intervention requires training, licensure alignment, and defined competencies. As OMT expanded globally, this distinction became essential for patient safety, consistency of care, and ethical implementation.

Contributions from different disciplines reflect areas of depth within a shared functional system. SLPs bring expertise in swallowing, articulation, and neuromotor integration. Dental hygienists and dentists contribute a comprehensive understanding of oral and maxillofacial development, including dentoalveolar structures, maxillary growth, craniofacial development, occlusion, and temporomandibular function. Otolaryngologists and sleep medicine specialists address airway physiology, structural contributors, and sleep-related outcomes. These perspectives are not intended to function in isolation, but to inform one another within a coordinated clinical framework.

International regulatory models further highlight this need for clarity. In Brazil, OMT is formally recognized as a clinical specialty within speech-language pathology, enabling standardized academic training, sustained research output, and integration within interdisciplinary care frameworks [63]. This model illustrates how formal scope recognition can coexist with collaborative practice, rather than constrain it.

Distinct functional clinical domains have emerged within OMT, including pediatric oral-motor development and feeding, speech and articulation therapy, orthodontic and dentofacial integration, airway and SDB rehabilitation, temporomandibular and craniofacial pain management, and post-surgical recovery. Clarifying competencies and terminology across these domains supports appropriate referral, strengthens interdisciplinary communication, and improves research consistency.

Ultimately, advancing professional standards in OMT requires more than expanded access. It requires tiered models of care that align provider expertise with patient complexity, distinguish education from treatment, and balance interdisciplinary inclusion with professional responsibility. These refinements do not limit the field. They enable its safe, ethical, and scalable integration into evidence-informed healthcare systems.

7.5. Tiered Models of Care

As OMT expanded across clinical, educational, and community settings, a central practical challenge became increasingly apparent: how can a field characterized by variability in training, patient complexity, and access deliver care ethically, safely, and at scale?

In response, tiered models of care were proposed as organizational frameworks rather than proprietary systems. These models were developed to align patient needs with appropriate levels of training, supervision, and interdisciplinary involvement. Tiering reflects differences in scope, responsibility, and clinical complexity, not hierarchy or clinical value. The intent is to support transparent referral pathways, appropriate delegation, and timely escalation of care when indicated.

Tier 1: Foundational Functional Screening and Education

At a foundational level, the field benefits from standardized functional screening, patient education, and habit-awareness strategies that support early identification of functional risk patterns while respecting professional scope of practice. This entry tier is best conceptualized as functional literacy and implementation support, rather than therapeutic intervention.

Core components include recognition of common functional risk indicators such as habitual mouth breathing, lip incompetence, low tongue rest posture, and inefficient chewing or swallowing patterns when observable. This tier emphasizes patient-centered education, environmental and behavioral awareness, and clearly defined referral triggers for comprehensive evaluation. Tier 1 does not include exercise prescription, diagnosis, or treatment planning.

These activities commonly occur in community, preventive, or public-facing contexts, including educational programs, wellness initiatives, early childhood settings, and screening encounters embedded within broader healthcare interactions.

Tier 2: Structured Functional Support Under Supervision

The second tier involves structured functional support delivered by providers operating within defined scopes of practice and, where applicable, under supervision or collaborative frameworks. Care at this level focuses on reinforcing foundational behaviors, identifying overt compensatory patterns, and facilitating timely referral when complexity exceeds the provider's role or expertise.

Importantly, therapeutic exercises are not predefined or universally applied. Indication, anatomy, developmental status, comorbidity, and compensatory behavior determine whether and which interventions may be appropriate. When exercise-based strategies are used, they should be individualized, supported by documented clinical rationale, aligned with professional scope, and delivered within clearly defined supervision and safety parameters.

Tier 3: Structured Clinical Therapy

Structured clinical therapy represents the core therapeutic tier of OMT. Care at this level is delivered by credentialed clinicians with formal training and is individualized, time-limited, and guided by functional readiness metrics and measurable clinical milestones. Interventions focus on neuromuscular coordination, reduction of maladaptive compensatory behaviors, and preparation for interdisciplinary or procedural care when indicated.

Tier 4: Advanced and Interdisciplinary Care

Patients presenting with greater complexity may require advanced clinical management, including presentations involving neurosensory factors, retained reflexes, entrenched

compensatory strategies, limited response to prior intervention, or coexisting medical and developmental conditions. Providers at this tier utilize advanced assessment approaches and collaborate closely with referring clinicians to guide escalation and care planning.

At the highest level, interdisciplinary and medically integrated care addresses multifactorial presentations involving airway obstruction, craniofacial growth disturbances, temporomandibular dysfunction, post-surgical rehabilitation, or combined structural and functional impairment. Care is delivered through coordinated collaboration among dentistry, otolaryngology, sleep medicine, speech-language pathology, and other allied professionals within clearly defined scopes of practice.

Tiered models of care do not simplify OMT. They organize it. By aligning provider expertise with patient need, these frameworks offer a pragmatic approach to ethical growth, interdisciplinary integration, and sustainable implementation as the field continues to mature within evolving healthcare systems.

7.6. Equity and Access

As OMT becomes more specialized and integrated into complex care pathways, a parallel question emerges: how can access to care expand without diluting clinical standards or compromising patient safety?

One practical response has been the adoption of hybrid delivery models. Telehealth has proven particularly useful for follow-up, maintenance therapy, caregiver education, and longitudinal monitoring, while blended models combining in-person, virtual, and self-guided components have reduced geographic, financial, and logistical barriers. When implemented with appropriate clinical oversight and clear scope boundaries, these approaches can extend reach while preserving therapeutic integrity.

Equitable access also depends on workforce development. Many regions face shortages of trained providers, particularly outside major academic or urban centers. Addressing this gap will require expanded training pipelines, including multilingual educational resources, hybrid learning platforms, and partnerships with universities, professional organizations, and public health systems. Open-access tools and non-proprietary training frameworks may further support ethical dissemination while maintaining accountability and clinical oversight.

Finally, access must be contextual. Protocols developed in well-resourced healthcare systems may not translate directly across cultural, regulatory, or infrastructural settings. Effective dissemination therefore requires adaptability, ensuring that evidence-based principles are implemented in ways that respect local healthcare structures, professional roles, and sociocultural norms.

Taken together, equity in OMT is not achieved through simplification, but through thoughtful system design. Expanding access while preserving rigor will remain a defining challenge as the field continues to mature and globalize.

7.7. Future Growth and Challenges (2026 and Beyond)

As OMT enters its next phase of clinical maturity, the central challenge is no longer whether the field has value, but how it will organize itself. Having transitioned from anecdotal practice to protocol-informed, evidence-integrated care, OMT now faces decisions that will shape its long-term role within healthcare systems, education, and regulation.

One of the most consequential issues ahead is credentialing. At present, training pathways and professional recognition remain highly variable across regions and disciplines. Movement toward clearer, competency-based credentialing frameworks, ideally developed through interdisciplinary collaboration, may support public trust, facilitate reimbursement

discussions, and provide more transparent professional development pathways without restricting appropriate cross-disciplinary participation.

Another opportunity lies in the selective integration of functional screening into pediatric and school-based health settings. Brief, non-diagnostic screening measures assessing features such as nasal breathing, mentalis strain, tonsillar hypertrophy, palatal width, and tongue mobility may help identify children at risk for functional impairment. When paired with defined referral pathways, such screening could support earlier intervention while preserving the role of diagnosis and treatment within appropriately trained providers.

Global expansion brings additional responsibilities. Many regions remain underserved by trained clinicians or lack culturally and linguistically relevant educational resources. Addressing this gap will require scalable training models, including hybrid and multilingual programs, partnerships with universities and public health institutions, and the continued development of non-proprietary, open-access clinical tools that balance accessibility with accountability.

As the evidence base matures, research priorities must also evolve. Future work will need to extend beyond efficacy to address implementation science: how OMT is adopted in real-world systems, its cost-effectiveness, barriers to integration, and long-term outcomes. Collaborative registries, standardized outcome measures, and shared data infrastructure will be essential to this next phase of evidence generation.

Finally, the field must guard against fragmentation. As functional clinical domains continue to emerge, spanning pediatric feeding, airway optimization, and surgical rehabilitation, the risk of siloed practice increases. Tiered, role-based models of care aligned with provider training and patient complexity offer a pragmatic way forward, preserving interdisciplinary collaboration while respecting scope and expertise.

In the coming decade, OMT will be defined less by novelty and more by governance. Its future will depend on how clearly it articulates standards, how thoughtfully it scales access, and how well it sustains collaboration across disciplines. The task ahead is not expansion for its own sake, but consolidation with purpose, ensuring that functional care remains both scientifically grounded and responsibly delivered.

8. Discussion

8.1. *Origins in Clinical Observation*

Before OMT could be measured, it first had to be noticed.

OMT did not emerge from controlled trials or predefined outcome measures. It emerged from clinicians observing patterns that existing models failed to explain: orthodontic relapse despite technically successful treatment, persistent mouth breathing after structural correction, abnormal swallowing patterns resistant to speech intervention, and compensatory muscle behaviors that anatomy alone could not resolve.

In response, early myofunctional approaches developed through iterative observation, patient-specific adjustment, and longitudinal follow-up rather than formal statistical modeling. These efforts were pragmatic rather than prescriptive, aimed at solving clinical problems in real time.

Although these early protocols would not meet contemporary standards for randomized controlled trials, they functioned as a hypothesis-generating phase of clinical science. Repeated observations revealed consistent relationships among oral posture, neuromuscular coordination, swallowing behavior, breathing patterns, and craniofacial development. These relationships were not inferred abstractly; they were observed repeatedly across patients and settings.

Importantly, the participatory and individualized nature of OMT remains both a strength and a methodological challenge. Unlike passive interventions, OMT requires

active patient engagement, adaptive progression, and individualized sequencing. In many contexts, this limits the feasibility of traditional double-blind trial designs and necessitates alternative approaches to evidence generation, including cohort studies, functional metrics, and longitudinal outcome tracking.

The field did not begin with answers; it began with questions raised by patients whose outcomes did not align with prevailing assumptions. Understanding this origin is essential for interpreting both the strengths and the limitations of the current evidence base, and for appreciating why OMT continues to resist overly reductionist models of evaluation.

8.2. Balancing Empirical Rigor and Clinical Judgment

The evolution of OMT underscores a central challenge common to functional and behavioral healthcare disciplines: how to integrate standardized evidence with the realities of individualized clinical care. While validated assessment tools now support diagnosis, treatment planning, and outcome tracking, effective therapy often depends on clinical judgment that cannot be fully reduced to discrete metrics.

OMT interventions require active patient participation, adaptive sequencing, and real-time response to compensatory strategies, neuromuscular fatigue, behavioral adherence, and developmental variability. These features complicate traditional randomized controlled trial designs, particularly those relying on blinding or rigid protocol uniformity. As a result, some clinically meaningful changes may precede or elude formal quantification, not because they are insignificant, but because available measurement tools are still evolving.

This tension does not diminish the importance of empirical rigor. Rather, it highlights the need for research frameworks capable of accommodating complexity without oversimplification. Advances in standardized functional metrics, treatment fidelity models, and implementation science represent important progress toward this goal. However, preserving the clinician's role in interpretation and individualized adjustment remains essential for maintaining therapeutic effectiveness.

The future credibility of OMT depends not on choosing between measurement and clinical insight, but on refining methods that allow both to inform one another. Integrating empirical validation with skilled clinical reasoning offers the most reliable path forward, ensuring that scientific progress strengthens rather than constrains patient-centered care.

8.3. Interdisciplinary Collaboration and Horizontal Models

As awareness of OMT grows, a practical question has become unavoidable: how can foundational functional principles be widely taught without blurring the line between education, screening, and clinical treatment?

Foundational concepts such as nasal breathing, oral rest posture, and chewing mechanics can be introduced early through public health initiatives, school-based programs, and pediatric wellness settings, supporting preventive awareness without substituting for clinical care.

To facilitate early identification, brief screening tools, such as six-point functional screeners, e.g., Functional Airway Evaluation Screening Tools (FAirEST-6), may be applied in educational or wellness contexts to flag potential concerns related to nasal breathing, lip seal, mentalis strain, tonsillar size, palatal width, and lingual mobility [64]. These tools should be used to support referral to appropriately trained and credentialed providers for comprehensive evaluation and treatment when indicated.

In this respect, preventive OMT screening parallels established public health practices such as hearing and vision screening, which aim to identify risk without encroaching on the domain of clinical diagnosis or intervention. Such horizontal, interdisciplinary models

offer a framework for integrating oral function into population health initiatives while preserving clinical accountability, professional boundaries, and patient safety.

8.4. Structure and Function: Revisiting the Rogers–Tweed Parable

If structure can be corrected, why does function still matter?

This question sits at the center of the historical tension often illustrated by the Rogers–Tweed debate. Alfred Rogers proposed that neuromuscular function could influence craniofacial form and long-term stability, while Charles Tweed emphasized precise, measurement-driven structural correction as the primary determinant of outcome. At the time, these positions appeared oppositional, shaping divergent clinical philosophies and contributing to siloed approaches across orthodontics, speech pathology, and related fields.

With the benefit of contemporary science, this dichotomy no longer holds. Advances in craniofacial biology, neuroplasticity, and functional rehabilitation have demonstrated that structure and function are not competing variables, but interdependent systems. Structural correction alters functional capacity, while neuromuscular behavior determines whether those structural changes are maintained, adapted to, or undermined over time. Stability, rather than correction alone, has become the defining clinical outcome. OMT addresses how patients use the structures they have, both before and after structural intervention, recognizing that untreated compensations can persist even in anatomically optimized systems.

Seen through this lens, the Rogers–Tweed parable is no longer a debate to be resolved, but a lesson in evolution. The field has moved beyond choosing between structure or function. Sustainable outcomes emerge when both are addressed deliberately, sequentially, and collaboratively. In this way, the historical tension that once divided disciplines now serves as a foundation for horizontal models of care that integrate structural correction with functional rehabilitation to support durable, patient-centered change.

8.5. Reporting Standards and Research Integrity

As OMT moves from an emerging discipline toward sustained scientific legitimacy, the quality of how research is reported becomes as important as the findings themselves. The field has generated a growing body of clinically meaningful work, but inconsistent reporting practices have limited comparability, reproducibility, and broader integration into evidence-based healthcare.

Much of the early and transitional OMT literature reflects strong clinical reasoning yet variable methodological transparency. Differences in outcome definitions, intervention descriptions, adherence tracking, and follow-up intervals have made it difficult to synthesize results across studies or translate promising findings into standardized clinical guidance. Addressing these limitations is essential for the field’s continued maturation.

Alignment with established reporting frameworks offers a practical pathway forward. Randomized controlled trials should adhere to CONSORT guidelines, observational studies to STROBE criteria, and systematic reviews to PRISMA methodology. Equally critical, intervention-based research should incorporate TIDieR reporting standards to clearly describe therapeutic content, dosing, progression, provider training, and contextual factors that influence outcomes. These frameworks do not impose rigidity; they provide the clarity needed for interpretation and replication.

Research integrity also depends on prospective trial registration, transparent analytic plans, and responsible data stewardship. Preregistration clarifies intent and reduces selective reporting, while appropriate data sharing supports secondary analysis, meta-synthesis, and cumulative knowledge building. Together, these practices strengthen confidence in findings and allow individual studies to contribute meaningfully to a coherent evidence base.

Adopting rigorous reporting standards for OMT allows nuanced clinical practice to be communicated in a shared scientific language. By prioritizing transparency and methodological consistency, the field can preserve its clinical depth while ensuring that its evidence is credible, interpretable, and capable of informing interdisciplinary care at scale.

8.6. Controversies, Skepticism, and Evidence Gaps

The expansion of OMT has highlighted not only its clinical potential, but also the structural challenges that accompany rapid growth. As OMT has gained broader clinical and academic visibility, variability in how therapy is delivered, taught, and studied has become increasingly apparent. This heterogeneity limits comparability across studies and slows consensus-building.

A central challenge lies in protocol heterogeneity. Differences in exercise selection, dosing, sequencing, therapist training, and outcome measurement complicate cross-study interpretation and weaken pooled analyses. While individualized care is a defining feature of OMT, the absence of agreed-upon core outcome sets and standardized reporting frameworks makes it difficult to determine which therapeutic components are essential, adaptable, or population-specific.

Regulatory and credentialing variability further contributes to inconsistency. OMT is practiced within speech-language pathology, dentistry, dental hygiene, occupational therapy, physical therapy, and related craniofacial and sleep-health disciplines, each operating under distinct scopes of practice, educational standards, and oversight mechanisms. This interdisciplinary diversity enriches the field, but complicates efforts to calibrate training expectations, ensure patient safety, and align research methodologies across regions.

Systematic safety reporting remains underdeveloped. Although OMT is generally regarded as low risk, the absence of structured adverse event registries limits the ability to characterize non-responders, treatment-related setbacks, or unintended consequences. Without consistent documentation of complications and treatment failures, opportunities to refine patient selection, clarify contraindications, and strengthen risk stratification remain constrained.

These limitations are reflected in the current evidence base. Systematic reviews and methodological analyses have documented variability in study design, small sample sizes, inconsistent outcome measures, and limited long-term follow-up data [2,45,46,61]. Such concerns are particularly relevant in functional domains beyond SDB, where controlled evidence remains uneven.

Importantly, this skepticism has served a constructive and catalytic role. Ongoing scientific critique has prompted calls for clearer reporting standards, improved trial design, standardized outcome metrics, and greater transparency in defining indications and intervention parameters. These critiques have informed subsequent research and emerging efforts toward consensus-based guidance, encouraging more cautious interpretation alongside more rigorous evaluation.

This measured positioning is also reflected in major clinical practice guidelines. North American guidelines for OSA, including those issued by the American Academy of Sleep Medicine (AASM), continue to prioritize positive airway pressure therapy, oral appliance therapy, surgical referral when indicated, and weight management as first-line treatments [65–68]. Within these frameworks, OMT is not positioned as a primary intervention and is generally referenced, when included, as adjunctive. This placement underscores the ongoing need for larger randomized trials, standardized protocols, and long-term outcome data across diverse populations.

Rather than undermining the field, recognition of uncertainty and variability has contributed to its maturation. The shift from broad, generalized claims toward indication-

specific, evidence-aligned applications represents an important step toward durable integration within interdisciplinary healthcare. Continued engagement with rigorous scientific critique will remain essential as OMT advances toward responsible, evidence-informed incorporation across disciplines.

8.7. Bridging Structure and Function in Contemporary Care

The past decade established OMT as a legitimate, interdisciplinary approach to functional health within the realm of SDB. The coming years will determine whether it can mature into a cohesive clinical discipline with shared standards, durable infrastructure, and equitable reach.

A critical task ahead is the development of unifying frameworks that do not erase professional diversity. OMT is practiced across multiple disciplines, each contributing distinct expertise. Future credentialing efforts must therefore focus on competency rather than professional exclusivity, defining core skills, ethical boundaries, and outcome expectations while allowing flexibility in delivery. Advancing psychometric validation of assessment tools and harmonizing protocols across subspecialties will be essential to this effort.

Equally important is clarifying the boundary between public education and clinical care. Foundational behaviors such as correct oral rest posture, chewing, and swallowing belong in preventive health and early developmental settings. Therapeutic intervention, however, requires formal training, clinical reasoning, and accountability. Thoughtful expansion of screening initiatives in pediatric and school-based contexts, paired with clear referral pathways, offers a practical way to promote early identification without blurring professional roles.

Access remains a defining issue. As awareness grows, disparities in availability and affordability risk widening. Addressing this challenge will require scalable delivery models that include multilingual training pathways, hybrid education, tiered care frameworks, and supervised delegation, particularly in underserved or geographically isolated regions. Expanding access must proceed alongside safeguards that preserve clinical standards and patient safety.

Scientific credibility must also continue to deepen. A mature field demands rigorous methodology, transparent reporting, and long-term outcome tracking. Pre-registered studies, shared datasets, standardized adverse event reporting, and open-access dissemination will help ensure that enthusiasm for OMT is supported by reproducible evidence rather than anecdotes or advocacy.

Finally, the future of OMT depends on sustaining collaboration over competition. The field's strength lies in horizontal integration, where dentists, SLPs, hygienists, physicians, surgeons, and therapists apply shared functional principles within their respective scopes. Preserving this collaborative posture will be increasingly important as institutional, academic, and commercial pressures grow.

If the last decade demonstrated that OMT can work, the next must demonstrate that it can work consistently, safely, and responsibly across diverse populations and healthcare systems. The success of OMT will ultimately be measured not only by outcomes, but by how thoughtfully the field organizes itself to deliver them.

9. Conclusions

OMT has evolved from a set of clinically observed patterns into a structured, evidence-informed approach to functional health. What began as practitioner-driven experimentation, focused largely on swallowing and tongue posture, has expanded into a multidisciplinary framework addressing breathing, airway stability, craniofacial development,

tongue-tie rehabilitation, and perioperative recovery. This evolution reflects not a change in philosophy, but a refinement in how function is understood, measured, and applied.

At its core, OMT rests on a simple but powerful premise: repeated functional behaviors influence biological adaptation. Advances in assessment tools, outcome tracking, and protocol design have allowed this premise to be applied with increasing precision and accountability. The integration of OMT into sleep medicine, orthodontics, surgery, and preventive care demonstrates how functional therapy can complement structural intervention rather than compete with it.

As the field moves forward, improved standards, transparent research practices, clearly defined scopes of practice, and equitable access will determine whether OMT matures into a durable component of interdisciplinary healthcare or remains unevenly applied. The responsibility now lies not only in demonstrating efficacy, but in ensuring consistency, safety, and ethical dissemination.

Viewed through this historical lens, OMT is an evolving clinical discipline shaped by observation, refined by evidence, and sustained through collaboration. Its future will be defined by how well it balances innovation with rigor, accessibility with specialization, and shared principles with professional accountability across the lifespan of care.

Supplementary Materials: The following supporting information can be downloaded at: <https://www.mdpi.com/article/10.3390/ijom52010007/s1>, Supplementary Material A (SM.A) Professional and Interdisciplinary Organizations; Table S1: Representative Professional and Educational Organizations Referenced in the Evolution of OMT; Supplementary Material B (SB): Contributors; Table SB1: Major Figures in Dentistry and Orthodontics Who Contributed to the Development of Myofunctional Therapy; Table SB2: Major Figures in Speech-Language Pathology Who Contributed to the Development of Myofunctional Therapy; Table SB3: Major Figures in Dental Hygiene Who Contributed to the Development of Myofunctional Therapy; Table SB4: Major Myofunctional Appliance Innovators; Table SB5: Major Figures in Medicine and Surgery Who Have Contributed to the Development of Myofunctional Therapy; Table SB6: Major Figures in Advocacy Who Have Contributed to the Development of Myofunctional Therapy.

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Abbreviations

The following abbreviations are used in this manuscript:

OMT	Orofacial Myofunctional Therapy
SDB	Sleep-Disordered Breathing
IJOM	<i>International Journal of Orofacial Myology</i>
IAOM	International Association of Orofacial Myology
SLP	Speech-Language Pathologist
ASHA	American Speech-Language-Hearing Association
ADA	American Dental Association
AAO	American Association of Orthodontists
MDPI	Multidisciplinary Digital Publishing Institute
OSA	Obstructive Sleep Apnea
AHI	Apnea-Hypopnea Index
UARS	Upper Airway Resistance Syndrome
TRMR	Tongue Range of Motion Ratio
WHIMS	Wound Healing Integration Maturation Scale
FOM	Floor of Mouth Elevation
FG	Facial Grimace
NE	Neck Engagement
JP	Jaw Protrusion
JL	Jaw Lateralization
FAirEST	Functional Airway Evaluation Screening Tools
AASM	American Academy of Sleep Medicine
CPAP	Continuous positive airway pressure
CFFa	Federal Council of Speech-Language Pathology and Audiology

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Perspective

Orofacial Motricity: From the Emergence of a Field to the Path Toward Global Terminology Standardization

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Abstract

Background: The consolidation of specialized fields in health care requires not only scientific evidence and clinical refinement, but also clearly defined scope, competencies, and language, since terminological ambiguity increases overlap and hinders communication,

comparability, education, and the organization of care. In this context, Orofacial Motricity was first recognized in Brazil as a field of practice, supported by institutional milestones that have defined its scope, standardized its terminology, and updated professional competencies. Furthermore, it has been consistently adopted in Latin American and European countries (e.g., Peru, Chile, and Portugal). In English-speaking countries, professionals working with Orofacial Myofunctional Disorders (OMDs) and Orofacial Myofunctional Therapy (OMT) are often organized under the designation Orofacial Myology, within diverse institutional and educational frameworks. **Methods:** This manuscript was developed as a non-institutional position paper based on structured reports from international collaborators, a documentary review of institutional and regulatory sources, and an exploratory terminological survey of databases. **Results:** Heterogeneity was observed in the use and conceptual level of these designations across countries and institutions, with more frequent convergence at the level of clinical condition and intervention (OMDs/OMT) than at the level of field or area. **Conclusion:** Clarifying the distinction among field/area, clinical condition, and therapeutic intervention may reduce ambiguities and foster scientific and educational comparability in the international context.

Keywords: orofacial motricity; terminology; standardization; scope of practice; speech-language pathology; stomatognathic system; myofunctional therapy; health education; interdisciplinarity; clinical specialty

1. Introduction

The development and consolidation of specialized fields in health care tend to emerge from the need to organize more specific technical–scientific responses to the rapid expansion and increasing complexity of knowledge and care demands. This scenario has driven ongoing reviews and updates of educational and training pathways over time [1,2]. At present, greater complexity and interdependence among professions can be observed, highlighting the need to clarify boundaries and roles and to reduce ambiguities that affect the quality, safety, and organization of teamwork [3]. The consolidation of a field depends not only on evidence and clinical refinement, but also on the explicit definition of its scope, competencies, and specialized language. In this regard, terminological imprecision increases conceptual overlap and hinders professional communication, scientific comparability, education, and the organization of care [3–5].

Within this context, Orofacial Motricity may be understood as an expression of this broader movement of scientific and professional expansion. Over recent decades, advances in knowledge regarding structure–function relationships within the stomatognathic system and orofacial myofunctional disorders have contributed to broadening the scope and centrality of this topic in Speech–Language Pathology (SLP) practice. In Brazil, this process has been accompanied by institutional milestones that formally recognized Orofacial Motricity as a field/specialty [6], established technical–scientific terminology for the area [7], and updated the professional competencies of speech–language pathologists in the assessment and treatment of the orofacial myofunctional system and orofacial functions [8] thereby supporting the clinical management of related conditions. At the same time, the designation Orofacial Motricity has also been identified in other countries (Chile [9–12], Peru [13–15], and Portugal [16–20]), although formal recognition is not yet a reality in all of them.

In dialogue with this movement, the literature on professional language and disciplinary boundaries emphasizes that terminological divergences are related to the ways in which fields negotiate scope, professional identities, competencies, and evidentiary

frameworks. These differences may re-emerge as practice and scientific production evolve and new terms arise [4,21]. In addition, a particularly robust institutional indicator of nominal standardization can be observed when scientific and professional organizations consistently retain the label of the field in their official names, as occurs in institutions in the areas of Audiology [22–28] and Dysphagia [29–36], suggesting greater stability at the field/area level.

Despite the growing international use of terms such as Orofacial Myology, Orofacial Myofunctional Disorders (OMDs), Orofacial Myofunctional Therapy (OMT), and Orofacial Motricity, there is still insufficient conceptual clarity regarding the distinction among field of knowledge, clinical condition, and therapeutic intervention/approach. Accordingly, this manuscript aims to analyze institutional and terminological traditions across different countries and to present a comparative synthesis. This work seeks to identify shared conceptual elements, make points of divergence explicit, and foster dialogue toward gradual international convergence.

2. Methods

This qualitative–descriptive study was structured as a non-institutional position paper and developed through an international collaborative initiative involving speech–language pathologists with recognized specialization and/or professional practice in Orofacial Motricity across different countries. The manuscript was prepared based on a narrative qualitative synthesis and a documentary analysis of institutional and regulatory sources relevant to the field, complemented by an exploratory terminological review of databases.

2.1. Collaborators and Eligibility Criteria

Experts, researchers, and/or clinicians with recognized experience in Orofacial Motricity in their respective countries were considered eligible as collaborators, based on at least one of the following criteria: (i) relevant academic output in the field (e.g., articles, book chapters, books, or technical documents); (ii) involvement in teaching, clinical training, and/or coordination of courses or training activities in the area; (iii) leadership or participation in professional, scientific, or academic organizations related to the field; and/or (iv) professional recognition based on an established career trajectory and consolidated clinical practice. Collaborators were invited by the coordinating authors according to these eligibility criteria and were included as co-authors of the manuscript. International collaborators also contributed to the critical appraisal, complementation, and contextual verification of information related to their respective countries, particularly with regard to terminological usage, educational milestones, institutional recognition, and relevant references.

2.2. Data Collection and Organization Procedures

Data collection and organization were conducted through a documentary review of institutional sources from regulatory bodies, professional/scientific associations, and educational organizations related to the topic. Whenever available, the review sought to identify formal definitions, scope/competencies, and the institutional use of the designations (e.g., Orofacial Motricity, Orofacial Myology, OMDs, OMT, and related terms) and their conceptual levels (field–clinical condition–intervention), as well as other complementary information, such as the main designations used for the field in the countries participating in the study, educational arrangements (undergraduate education, specialization programs, courses, and research lines), and institutional/regulatory recognition, when applicable. To this end, public websites and documents from the main professional/scientific organizations related to the field were reviewed, including the American Speech–Language–Hearing Association (ASHA); International Association of Orofacial Myology (IAOM);

British Society of Myofunctional Therapy (BSMFT); Associazione Squilibrio Muscolare Oro-facciale Italia (Italian Association of Orofacial Muscle Imbalance; SMOF Italia); Academy of Orofacial Myofunctional Therapy (AOMT); Academy of Applied Myofunctional Sciences (AAMS); Australian Academy of Orofacial Myology; Australian Association of Orofacial Myology; the Departamento de Motricidade Orofacial da Sociedade Brasileira de Fonoaudiologia (Orofacial Motricity Department of the Brazilian Speech–Language–Hearing Society; SBFa); the Departamento de Motricidade Orofacial da Sociedade Portuguesa de Terapia da Fala (Orofacial Motricity Department of the Portuguese Speech and Language Therapy Society; SPTF); and the Associação Brasileira de Motricidade Orofacial (Brazilian Association of Orofacial Motricity; ABRAMO). Selection prioritized organizations with an explicit institutional scope (e.g., definitions, scope/competencies, certification/training, and/or regulatory documents) and recognized relevance in their respective countries.

As an additional verification step, an exploratory terminological search was conducted in biomedical and Ibero-Latin American databases: MEDLINE (Medical Literature Analysis and Retrieval System Online) via PubMed (National Library of Medicine, USA); SciELO (Scientific Electronic Library Online); Scopus (Elsevier); Web of Science (WoS); Dialnet; Redalyc (Red de Revistas Científicas de América Latina y el Caribe, España y Portugal); Cochrane Library; Embase (Excerpta Medica database); and Google Scholar. A time filter covering the last 5 years was applied, comparing two lexical families: (1) “Orofacial Motricity” and its English and Spanish equivalents, and (2) “Oral/Orofacial Myology” and its Portuguese and Spanish equivalents. For descriptive comparison purposes between these terminological families, the counts of records retrieved within the defined time frame were summarized by family and expressed as a retrieval ratio ($Q1/Q2$) and as their proportion of the combined total [$Q1/(Q1 + Q2)$ and $Q2/(Q1 + Q2)$]. Search strategies, search fields/indexes, and application of the time filter varied across databases (e.g., PubMed in All fields; Google Scholar via allintitle; SciELO, Dialnet, and Redalyc via general search; Embase via general search with time filter; and Cochrane Library via general search with the time filter applied through the interface). For the analysis, two coordinating authors conducted the searches independently and subsequently compared the numbers of retrieved records. The results were checked for consistency, and any discrepancies were resolved by consensus.

After the initial compilation, one collaborating representative from each country reviewed, supplemented, and verified the contextual and terminological adequacy of the syntheses related to their national context, in addition to contributing suggestions for revisions and additional references when appropriate. Subsequently, the final version was reviewed by the coordinating authors to ensure that the text accurately reflected the reported local/institutional perspective and framing.

2.3. Data Analysis and Synthesis of Data Sources

Initially, the information extracted from the institutional and documentary sources, as well as the review and complementary contributions provided by the collaborators, was organized into a synthesis matrix presented in the Section 3. These data were then analyzed comparatively across the different national contexts, with priority given to identifying terminological, scope-related, and conceptual convergences and divergences. The counts retrieved through the exploratory terminological verification were used descriptively and comparatively across the lexical families, without any intention of statistical inference. Editorial adjustments were made to ensure internal consistency and analytical uniformity while preserving the substantive content reported and reviewed for each country. The results of the terminological verification conducted in the databases were presented in the Section 3. The findings from the institutional analysis and database searches, as well as

the group's discussion of the study position and its interpretations, were presented and discussed in the Section 3, which was organized into two subsections: (i) conceptual aspects and current status: terminological convergences and divergences; and (ii) proposal and next steps: pathways toward convergence.

2.4. Ethical Aspects

This manuscript did not involve the recruitment of human participants, the collection of clinical data, identifiable data, or patient information. Rather, it consisted of a synthesis of author contributions and an analysis of publicly available sources; therefore, it did not require ethical review, since the research did not involve human subjects.

3. Results and Discussion

3.1. Conceptual Aspects and Current Status: Terminological Convergences and Divergences

From a narrative–qualitative perspective, the historical analysis of Orofacial Motricity and Orofacial Myology across different countries reveals diverse trajectories. Despite this, there is convergence in recognizing that the stomatognathic system, in interaction with other systems, plays a fundamental role in human communication, craniofacial development, feeding, and breathing, with implications for overall health and sleep quality [37–40]. This expanded clinical and scientific understanding has strengthened both Orofacial Motricity and Orofacial Myology as strategic fields in different countries. This strengthening has occurred, not only within SLP but also across other health professions through multiprofessional engagement. This development has resulted from pioneering efforts that established models of care, foundational theoretical-practical training principles, and scientific societies in a variety of contexts. Although there are country-specific particularities and different forms of professional organization, a global movement can be observed toward strengthening Orofacial Motricity as a field/area. This movement also reaffirms orofacial functions as an integrating axis of SLP care in this domain and reinforces the need for shared guidelines to support its continued development.

Within this context of international expansion and consolidation, the stabilization of a field depends not only on the accumulation of evidence and clinical refinement, but also on processes of institutionalization, educational organization, and scientific leadership. In the United States, historical-professional accounts have identified a core group of pioneering professionals in the 1970s who promoted and consolidated the tradition of Orofacial Myology in its early stages, most notably Bill Zickefoose, Marvin Hanson, Richard H. Barrett, Barbara Moore, and Galen Peachey. These individuals are associated with some of the earliest organizational decisions in the field, including the development of internal standards, the discussion of a representative designation for the emerging domain, and explicit goals aimed at raising educational standards and promoting research [41]. In Brazil, the developmental trajectory of Orofacial Motricity is often linked to a technical–scientific and professional–political movement articulated since the 1980s, with a central role attributed to Dr. Irene Queiroz Marchesan. The formal regulatory recognition of Orofacial Motricity as a specialty within SLP dates back to 1995, followed by subsequent international expansion through courses, specialization programs, scientific meetings, and scholarly production, with dissemination and growth across Latin American countries as well as in European dialogues (e.g., Portugal, Spain, and Italy) [42]. Taken together, these trajectories show that different designations and traditions were consolidated through different leaderships and dissemination networks, thereby underscoring the need to clarify, in the following section, how Orofacial Motricity and Orofacial Myology have been defined and operationalized in institutional sources and how this relates to the position proposed in this perspective.

At the level of institutional definitions, these trajectories have taken shape through different ways of delineating the field and its competencies. In Brazil, the regulatory definition issued by the Federal Council of Speech–Language Pathology and Audiology (Conselho Federal de Fonoaudiologia, CFFa) described Orofacial Motricity as the field within SLP dedicated to the study, research, prevention, assessment, diagnosis, development, habilitation, improvement, and rehabilitation of the structural and functional aspects of the orofacial and cervical regions [6]. Its scope of practice extends across all stages of life, from birth to senescence, and across different levels of care, including outpatient, rehabilitation, and hospital settings, while maintaining continuous integration with medical and dental specialties as well as other health and education professions [6,8,43]. In Brazil, this scope includes, among other areas of focus, structural and/or myofunctional changes related to sucking, breathing, chewing, swallowing, and speech; breastfeeding [44] and pediatric feeding disorders [45]; temporomandibular, craniofacial, cervical, neurological, and muscular disorders; sleep-disordered breathing [46] and bariatric surgery [47]; and adaptations associated with facial aesthetics and aging [6], in addition to health promotion and disease prevention actions [8]. This delimitation, already established by regulation for the specialty in the country since 1995 [48], has been reinforced by recent regulatory documents issued by the CFFa [8], which update and further specify professional competencies and skills involving the assessment, diagnosis/prognosis, and (re)habilitation of the orofacial and cervical myofunctional system, including orofacial functions.

By contrast, in contexts where the designation Orofacial Myology has historically become established, the delineation of the domain tends to appear less as a normative definition of a “specialty” and more as a combination of field of study, clinical condition, and intervention. In a classic formulation of the area, Orofacial Myology is defined as the study of normal and abnormal patterns of mouth and facial use and their relationships with dentition, speech, and vegetative functions [49]. In professional scope documents, Orofacial Myology is also described operationally as a clinical practice aimed at recognizing/identifying and treating OMDs across the lifespan, with goals often centered on lip seal, tongue resting posture against the palate, optimized swallowing patterns, and the reduction/correction of dysfunctional habits [50]. Along the same lines, institutional materials from the IAOM delineate the domain primarily through the characterization of OMDs and the description of OMT as the practice of the certified professional, so that the “field” is often presented more as a framework defined by the condition and the intervention than as a formal definition of a professional area [51].

Terminological variation, however, is not limited to the contrast between Orofacial Myology and Orofacial Motricity and is expressed across different countries and institutions. Although several countries develop equivalent practices, the nomenclature used is not always the same across professionals and organizations, with some being more specific at the level of the clinical condition, such as OMDs, as described in the Practice Portal of ASHA in the United States of America, in which the focus is placed on the competencies and responsibilities of the Speech–Language Pathologist (SLP) [52]; “Función Oral Faríngea” (Oral-Pharyngeal Function) in Colombia [53,54], as an institutional formulation of the object/focus and competence of the SLP; and others being broader, such as “Fonoestomatología” (Phonostomatology) in Argentina, where it is recognized as a specialty within SLP [55], as well as in Uruguay [56,57] and Paraguay [58,59], although the terminology Orofacial Motricity has also been adopted by some public and educational institutions [60–64] in these countries, which demonstrates the absence of consensus. In contrast, the nomenclature Orofacial Motricity has been used recurrently in different countries, such as Chile [9–12], Peru [13–15], and Portugal [16–20], and in a still limited way in education in Spain.

Additionally, several organizations in Latin American and European countries have taken positions in support of and endorsed the celebration of World Orofacial Motricity Day [65–78], established in 2015 by a group of specialists during a scientific event held in Peru [79]. Although the terminology Orofacial Motricity is present, terminological heterogeneity and variation in conceptual level, in formal recognition by regulatory and scientific bodies, and in the designation adopted for the field of practice are still observed. This scenario hinders data comparability, the production of scientific evidence, the development of clinical guidelines, the alignment of educational processes, and the consolidation of shared competencies. In a context of global expansion, the absence of institutional-level uniformity reduces the communicative coherence of the field, weakens its political and scientific strength, and compromises the development of integrated health care strategies.

To further qualify this discussion, it should be made explicit that, internationally, terms within the same lexical family have been used for distinct conceptual levels. The analysis of institutional documents/publications indicates that, in different countries, related terminological labels have been used to designate: (1) specialty/professional field (domain of knowledge and area of practice), (2) clinical condition (what will be identified/diagnosed), and (3) therapeutic intervention/approach (what will be performed). This misalignment may lead to imprecise interpretations when Orofacial Myology/Myofunctional Therapy/OMT are used interchangeably to refer to both the intervention and the discipline/field itself, because, although OMT is correctly described as a therapeutic modality, some institutional and regulatory sources use “Myofunctional Therapy” as the designation of the professional discipline itself or present Orofacial Myology/OMT interchangeably, thereby favoring overlap between the name of the treatment and the name of the field [50,80–82]. These divergences reinforce the need for conceptual and terminological standardization, since such debates tend to re-emerge as scope, education, and evidence evolve. Moreover, standardization is not limited to a nominal change: it involves the (re)definition and renegotiation of professional and institutional boundaries and, when implemented through policies/declarations, may be challenged by practice and by the emergence of new terms, with movements of (de)standardization [4,21].

Although divergence is more pronounced at the level of the designation of the field/area, a certain degree of international convergence can be observed at the levels of clinical condition and intervention, especially through the recurrent use of the labels OMDs and OMT in institutional documents and training materials. However, this convergence is predominantly nominal: the operational definitions, descriptive criteria, and scope attributed to OMDs and OMT vary across organizations, professions, and educational systems. These divergences reflect distinct regulatory arrangements and historical-institutional trajectories and, in part, the absence of a formal and shared definition of the “field” at the international level [7,51,52,82–90]. Thus, the most persistent comparative problem lies not only in residual differences in the conceptualization of condition and intervention, but above all in the oscillation of the designation used for the field/area. From this perspective, the standardization required should focus primarily on the conceptual delimitation of the field and on the explicit mapping of equivalences across levels (field–clinical condition–intervention), with a view to reducing inconsistent cross-readings and increasing scientific and educational comparability.

In order to understand these divergences, the authors analyzed institutional websites and documents from organizations in the field across several countries, examining whether distinctions are made among field of practice, clinical condition, and therapeutic intervention/approach. In the ASHA Practice Portal, the focus is essentially at the level of the clinical condition and its management by SLPs. ASHA describes OMDs as movement patterns of the oral and orofacial musculature that may result in improper tongue position-

ing at rest and during swallowing, breathing, and speech; they may occur throughout the lifespan, and the diagnosis of OMDs takes into account the impact of atypical movement patterns on structural changes and functional abilities [52,91–93]. In addition, ASHA itself explicitly states that orofacial myofunctional interventions are carried out by properly trained SLPs, within the context of interprofessional teams, and guides practice through normative documents such as the Code of Ethics, the Scope of Practice, and the Preferred Practice Patterns [94–96].

The historical organization in the field, the IAOM, uses the term Orofacial Myology to refer to the professional domain associated with practice involving OMDs, in alignment with the foundational assumptions of this field [97]. On its institutional website, the emphasis is placed primarily on the clinical condition and the intervention (OMDs/OMT). The IAOM defines OMDs as maladaptive functional patterns arising from structural and/or muscular deficits in the orofacial complex, resulting in compensations, undesirable habits, and/or additional impact on the orofacial structures. In addition, it describes OMDs as the “nexus between structure and function”: in some cases, a structural anomaly gives rise to functional challenges; in others, atypical oral habits and limited functional skills lead to undesirable structural changes. The organization also defines OMT as an individualized program designed to help the patient re-educate these maladaptive patterns of muscle function and to help create and maintain a healthy orofacial environment [51]. These authors did not identify a formal definition of Orofacial Myology as a field of practice on the institutional website or in the available materials.

In the Australian context, the Australian Association of Orofacial Myology defines Orofacial Myology as the study of the oral and facial muscles in relation to their movement patterns in daily life. Myofunctional Therapy is described as the application of training and exercise-based techniques that may be delivered by health professionals with a well-established knowledge of human biology and physiology, acting directly on the structures and functions of the head, face, mouth, and throat. Within this framework, inadequate movement patterns are collectively known as Myofunctional Disorders and may be identified through manifestations such as mouth breathing, speech, feeding, and/or swallowing difficulties, orofacial pain, orthodontic problems, and sleep-disordered breathing [90]. In a convergent manner, the Australian Academy of Orofacial Myology defines OMT as the treatment of disorders of the muscles of the face and mouth, including non-nutritive sucking habits, inadequate swallowing patterns, and incorrect postures and functions of the tongue, lips, jaw, and facial muscles. In addition, it states that these dysfunctions (OMDs) are often associated with speech alterations, such as articulatory difficulties, mandibular thrust during speech, frontal and/or lateral lisp, and hypernasality or hyponasality [89].

In the United Kingdom, the British Society of Myofunctional Therapy (BSMFT) characterizes OMT as the neuromuscular re-education/repatterning of the orofacial muscles and OMDs as alterations of the muscles and functions of the face and mouth, while also detailing professional eligibility and education/certification in Orofacial Myology across various professions [83]. However, while the BSMFT constitutes an institutional reference in the United Kingdom, its representativeness within the broader professional landscape appears to be limited in terms of professional representation and it should not be taken as fully representative of the UK context as a whole. In Italy, SMOF Italia characterizes Squilibrio Muscolare Orofaciale (Orofacial Muscular Imbalance; SMOF) as an alteration of one or more oral functions (swallowing, breathing, chewing, phonemic articulation, and resting posture) and defines OMT as a speech–language therapy pathway for the education and re-education of oral functions [84]. This should be interpreted alongside the fact that FLI (Federazione Logopedisti Italiani; Italian Federation of Speech–Language Therapists) had already recognized OMT as a discipline within Speech–Language Pathology prior to the

creation of SMOF Italia. In the United States, the Academy of Orofacial Myofunctional Therapy (AOMT) defines OMDs as disorders of the muscles and functions of the face and mouth and describes OMT as a program aimed at correcting breathing/swallowing/chewing alterations, normalizing freeway space, stabilizing the bite, and eliminating harmful oral habits [85–87]. Similarly, the Academy of Applied Myofunctional Sciences (AAMS) defines OMDs in similar terms and describes OMT as an exercise-based program designed to eliminate many of the causes of swallowing abnormalities and inadequate tongue resting posture [88]. Overall, a recurring pattern can be observed in the clear description of the clinical condition and/or the intervention, despite variation across definitions, with less emphasis on the formal definition of the “field” as a discipline.

In contrast, in Brazil there is a normative and associative formalization that includes definitions provided by the regulatory body and scientific institutions. CFFa Resolution No. 320/2006 describes Orofacial Motricity as a field focused on the study, research, prevention, assessment, diagnosis, development, habilitation, improvement, and rehabilitation of structural and functional aspects of the orofacial and cervical regions, while also delineating the profile of the specialist [6]. Some documents issued by the Orofacial Motricity Department of the SBFa explicitly address the field of practice and terminological/vocabulary standardization and provide definitions of OMD (an alteration involving the oral, facial, and/or cervical musculature that interferes with the growth, development, or functioning of orofacial structures and functions) and OMT (a therapeutic action applied to the musculature through modification of orofacial function or functions) [7,98], while the ABRAMO specifies the specialist’s domains of expertise that encompass OMDs [99]. The Brazilian case is presented as an example of normative and conceptual formalization that operationally distinguishes the levels of field of practice, clinical condition, and therapeutic intervention/approach, as well as the terminology to be used in the area. Nevertheless, this standardization applies to the Brazilian national context since 1995 [48], without any intention of mandatory extrapolation to other countries or regulatory systems. Even so, in several Latin American and European countries, Brazilian references and regulations in Orofacial Motricity have been adopted as a basis for defining the field.

This expanded analysis has thus far made it possible to identify the existence of two main designations used to refer to the field of practice of professionals who intervene in OMDs and OMT across different countries. Orofacial Myology was found to remain more closely associated with English-speaking contexts, where it is often described as a field of study or discipline [49,82,83,90], and is practiced by different professional categories according to local educational and regulatory arrangements. Orofacial Motricity, in turn, is established in Brazil as a specialty within SLP, with a specific professional delimitation; moreover, in several Latin American and European countries, this same logic of linking the field to SLP/Speech and Language Therapists/Logopedics/Speech Therapy has also been observed [6,8,9,11,13,16,17,100–105].

From this terminological standpoint, Orofacial Myology and Orofacial Motricity do not operate as direct synonyms, since they tend to carry different institutional scopes and levels of coverage depending on the country and the professional-regulatory arrangement. In several institutional sources, greater emphasis is placed on the description of clinical conditions and interventions (e.g., OMDs/OMT) than on the formal definition of the “field” as a discipline. In contrast, in Brazil, and in some Latin American and European countries, it became clear that Orofacial Motricity is recognized primarily as a field/area. Thus, the purpose of this manuscript is not to replace consolidated traditions in other countries, nor to erase the historical and institutional trajectory of Orofacial Myology in contexts in which this nomenclature has structured education, certification, and clinical practice, but rather to promote greater uniformity in the term used to designate the field within SLPs, especially

in contexts in which the nomenclature Orofacial Motricity is already present, undergoing consolidation, or being introduced, through formal consensus-building processes that present definitions and scope boundaries in a transparent and reproducible manner within the scope of international SLPs.

This terminological misalignment was also reflected in the exploratory database search. Greater retrieval was observed for studies using the designation Orofacial Motricity ($n = 153$) and its English and Spanish equivalents (Orofacial/Oral Motricity; Motricidad Orofacial) than for the designation Oral/Orofacial Myology ($n = 20$). In descriptive terms, the Orofacial Motricity family was 7.65 times higher in retrieved volume within the five-year period ($n = 153$ vs. $n = 20$), representing 88.4% of the combined total of records for both terminological families (153/173), whereas Oral/Orofacial Myology accounted for 11.6% (20/173). Additionally, in the main Ibero-Latin American databases consulted, the designation Oral/Orofacial Myology and its equivalent translations into Portuguese and Spanish (Miologia/Miología Oral/Orofacial) showed particularly limited retrieval within the same time frame ($n = 4$ across SciELO, Redalyc, and Dialnet combined), pointing to lower regional circulation of this terminological family in these databases.

Despite this, these findings should be interpreted only as descriptive indicators of record retrieval, according to the search strategies and filters applied by the authors in the databases consulted for this publication, and not as a bibliometric estimate of the field's scientific production. This interpretation is warranted in light of the heterogeneity in platform coverage, the duplicate retrieval of records across databases, variation in the search fields/indexes consulted, and the possibility that relevant journals in the field (e.g., the International Journal of Orofacial Myology and Myofunctional Therapy [IJOM] and Revista CEFAC: Current Evidence on Feeding, Audiology, and Communication) may not be indexed uniformly across all databases. Based on this retrieval pattern, the overall set of findings is compatible with the hypothesis that there is greater homogeneity in the use of the lexicon Orofacial Motricity as the designation for the field of practice in Latin-language countries (Portuguese, Spanish, Italian) and within SLP, whereas in English-speaking countries (United States, United Kingdom, Australia), Orofacial Myology retains centrality, coexisting with designations anchored in the field and designations oriented toward condition and intervention (e.g., OMDs/OMT) within a multiprofessional arrangement. Even so, within the last five years, the retrieval of records associated with this terminological family (Orofacial Myology) proved to be low even in international databases with broader circulation in English-speaking contexts, which may reflect lexical dispersion across multiple labels, limitations in coverage and indexing, and possibly lower contemporary circulation or reduced centrality of this term in part of the literature. This pattern, however, does not in itself support a hierarchical reading of these terminological traditions, nor does it allow them to be treated as fully equivalent outside their contexts of use.

Beyond a semantic discussion, this divergence reflects distinct professional arrangements. In several contexts, competencies related to orofacial functions are organized as an area/field within the "speech professions," with institutional structures and educational programs that explicitly designate Orofacial Motricity as a domain, for example, the Orofacial Motricity Department of SPTF and the Orofacial Motricity Department of SBFa, as well as postgraduate programs and complementary training initiatives that adopt Orofacial Motricity as a specialization area in some countries in Europe (Spain, Portugal, Italy) and Latin America (Chile, Peru, Colombia, Paraguay) [9,13,16,18,20,105–112]. In contrast, in part of the North American context and in related educational initiatives, the topic is often organized around OMDs/OMT, within an interprofessional framework in which different professional backgrounds participate in the provision of services and certifications [51,52,83,85–90]. This difference, however, should not be interpreted as a sign

of lesser robustness in the tradition associated with Orofacial Myology, but rather as an expression of different ways of organizing the field, its professional boundaries, and its conceptual architecture. This dichotomy supports the need for conceptual and terminological standardization that distinguishes field–clinical condition–intervention, as well as for explicit terminological mapping to enable scientific comparability and the organization of this field within SLPs across different countries.

To understand the roots of this heterogeneity, it is necessary to recognize that the terminological diversity observed internationally arises from distinct educational traditions, the historical influence of different curricular frameworks, and the fragmented evolution of clinical practices over time. In operational terms, many of these labels “collapse” distinct levels (field–clinical condition–intervention) or privilege only one fraction of the domain, which helps explain the variability observed. Although the historical legitimacy and contribution of all these designations to the development of the area are acknowledged, none of them fully and integratively encompasses the anatomical, physiological, neuromuscular, functional, behavioral, and intersystemic complexity that characterizes the contemporary understanding of Orofacial Motricity. In this sense, the terminology adopted preferentially/by consensus to designate this area should be capable of conveying, accurately and integratively, the breadth of the structures and functions related to the orofacial and cervical regions, as well as their practical, scientific, and educational implications. A designation aligned with these principles has strategic political-institutional potential to enable international terminological unification, the consolidation of shared competencies, harmonized educational frameworks, and stronger professional representation before regulatory bodies, scientific associations, and health systems. The adoption of a standard term, therefore, has scientific relevance, direct clinical impact, and structural importance for the global positioning of this area.

Moreover, considering professional education and practice in SLP, the standardized adoption of terminology contributes to conceptual coherence and to a common language across education, regulation, and practice, thereby reducing ambiguities that affect communication and professional collaboration [113,114]. Empirical evidence in the field of Orofacial Motricity shows that, as the area expands and becomes institutionalized, education tends to be organized through diverse offerings, with descriptive variations in designations and scopes, which reinforces the value of stable terminological references for educational and professional comparability [115]. Terminological heterogeneity, in turn, tends to hinder the synthesis and generalization of evidence and interoperability across information systems, thereby affecting scientific comparability and the organization of care [116]. From a professional standpoint, the explicit presence of a standardized nomenclature in curricula, continuing education records, and competency certification tends to strengthen institutional recognition before regulatory bodies and health systems and to reduce uncertainty regarding boundaries of practice [117].

Likewise, the systematic use of terminology in scientific output, including articles, books, book chapters, clinical guidelines, protocols, technical materials, and institutional documents, is essential to ensure the traceability and visibility of knowledge production [118,119] in the field. The use of a term as a descriptor, keyword, and indexing category in national and international databases will make it possible for studies related to the field to be identified accurately [120], retrieved in bibliographic searches, and included in systematic reviews, meta-analyses, and evidence mappings [121]. The absence of such terminological uniformity fragments the literature, makes the identification of relevant studies and their systematic retrieval more difficult, and compromises evidence synthesis and the formulation of evidence-based recommendations. In this context, the field is at a decisive moment for moving in this direction through a globally standardized termino-

logical structure with the potential to enhance scientific credibility and social impact. The adoption of a unified terminology may help raise levels of evidence, expand comparative analyses, strengthen knowledge production, and advance the scientific recognition of the field, with clearly established methods and conceptual foundations.

3.2. *Proposal and Next Steps: Pathways Toward Convergence*

This group proposes that progress toward international convergence in the field should be conducted through a periodic Virtual International Forum, conceived as a formal body for deliberation and governance of this work. It is recognized, however, that other institutions and groups may adopt alternative harmonization strategies, according to their regulatory contexts, educational priorities, and scientific traditions. In this direction, the convergence proposed here presupposes greater transparency in clarifying correspondences, limits of use, and conceptual levels among the nomenclatures currently in circulation. In the model proposed here, decisions would be made during the Forum's virtual meetings, with explicit documentation of the proceedings (e.g., minutes/draft minutes, decision matrix, and timeline), and with the establishment of international working groups including representatives from different scientific societies, regulatory bodies, researchers, and academic/clinical professionals. The central objective will be to develop a minimum terminological framework that operationally specifies three conceptual levels: (i) field of practice/area (disciplinary domain and set of competencies), (ii) clinical condition (what is described/identified and, when applicable, diagnosed), and (iii) therapeutic intervention/approach (what is carried out in clinical practice). Such clarification may reduce ambiguities and overlaps, especially when historically consolidated designations come to be used interchangeably to refer simultaneously to the field and the treatment, or when they do not sufficiently encompass the current scope of practice.

At the operational level, this group proposes that the Virtual Forum deliberate on and coordinate four sequential stages. First, the Forum will define and approve the work plan and commission a scoping review specifically focused on terminology, covering: (a) designations for the field/area, (b) terms referring to clinical conditions, and (c) terms referring to therapeutic intervention/approach, with systematization of existing definitions, variations in use, conceptual gaps, and institutional frameworks. Second, based on the findings of this review, the Forum will deliberate on the design of the international consensus process, including its scope, participants, languages, item matrix, agreement criteria, transparency strategies, and dissemination plan. Third, the Forum will conduct the consensus process using structured methods carried out entirely in a virtual environment (e.g., modified Delphi, nominal group technique in synchronous sessions, and/or virtual consensus meetings with explicit documentation of decisions), with the aim of producing a consensus statement that operationally defines and delimits the three conceptual levels of the domain, including minimum criteria for terminological use, a multilevel glossary, and mapping of the designations used across different countries/languages. Fourth, after consolidation of the deliberations, the Forum will organize the publication and updating of the outputs, including a final version for submission to a scientific journal, public availability of supplementary materials (e.g., glossary and terminological tables), and periodic reviews to keep the framework aligned with scientific advances and the needs of health systems.

Subsequently, from the perspective advocated here, it is suggested that the consensus recommendations be gradually incorporated into educational curricula, continuing education programs, scope/competency documents, and clinical guidelines, so that standardization will not remain merely conceptual, but will also extend to education and care delivery. Finally, this process should remain dynamic, with cycles of reassessment defined by the Forum itself, thereby ensuring continuous updating and international applicability.

4. Conclusions

This position paper argues that international convergence will depend, first and foremost, on operationally clarifying the distinction among three conceptual levels—(i) field/area, (ii) clinical condition, and (iii) therapeutic intervention/approach—as well as on mapping equivalences among the designations used across different countries and institutional traditions. By reducing overlaps and cross-interpretations, this framework may increase communicative coherence, support more stable definitions of scope and competency, and provide a more robust basis for guidelines, education, and scientific comparability across educational and professional systems.

Given this context and the growing demands of the field, the future development of an international consensus aimed at standardizing terminology, scope of practice, and professional skills/competencies may bring substantial benefits to the field, with direct impact on educational and care quality as well as on interdisciplinary communication. The adoption of a unified nomenclature, articulated with global parameters for education and practice, will likely foster scientific production, expand international comparability across curricula, strengthen the development of public policies, and reinforce the professional identity of Orofacial Motricity.

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Abbreviations

The following abbreviations are used in this manuscript:

AAMS	Academy of Applied Myofunctional Sciences
ABRAMO	Associação Brasileira de Motricidade Orofacial
AOMT	Academy of Orofacial Myofunctional Therapy
ASHA	American Speech–Language–Hearing Association
BSMFT	British Society of Myofunctional Therapy
CEAF	Centro de Especialización y Atención Fonoaudiológica
CEFAC	Current Evidence on Feeding, Audiology, and Communication
CFFa	Conselho Federal de Fonoaudiologia
CIED	Research Centre on Education
DMO	Distúrbio Miofuncional Orofacial
EUA	Estados Unidos da América

FMRP	Faculdade de Medicina de Ribeirão Preto
FOB	Faculdade de Odontologia de Bauru
IAOM	International Association of Orofacial Myology
IJOM	International Journal of Orofacial Myology and Myofunctional Therapy
MEDLINE	Medical Literature Analysis and Retrieval System Online
MO	Motricidade Orofacial
OM	Orofacial Myology
OMD	Orofacial Myofunctional Disorder
OMT	Orofacial Myofunctional Therapy
PPGSCH	Programa de Pós-Graduação em Saúde da Comunicação Humana
RCSLT	Royal College of Speech and Language Therapists
SBFa	Sociedade Brasileira de Fonoaudiologia
SciELO	Scientific Electronic Library Online
SLP	Speech–Language Pathologist
SMOF	Squilibrio Muscolare Orofacciale
TMOF	Terapia Miofuncional Orofacial
UAA	Universidad Autónoma de Asunción
UFPB	Universidade Federal da Paraíba
UFPE	Universidade Federal de Pernambuco
UNCuyo	Universidad Nacional de Cuyo
UNFV	Universidad Nacional Federico Villarreal
Unipamplona	Universidad de Pamplona
USP	Universidade de São Paulo
WoS	Web of Science

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Perspective

Integrative Breathing Therapy: A Multidimensional Framework for Unified Airway Function and Its Application to Orofacial Myology and Obstructive Sleep Apnea

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Abstract

Background/Objectives: Breathing efficiency and stability depend on the integrated function of biochemical, biomechanical, and psychophysiological processes across the unified upper and lower airway. Clinical interventions often address these domains in isolation, which may limit treatment outcomes. The primary objective of this article is to present Integrative Breathing Therapy (IBT) as a clinically applicable, multidimensional framework for training unified airway function. A secondary objective is to illustrate how this framework can inform clinical reasoning in orofacial myology and behavioural management of obstructive sleep apnea. **Method:** This article presents a clinical synthesis of physiological theory, neuroplasticity research, and applied breathing therapy to describe the theoretical and clinical foundations underpinning the Integrative Breathing Therapy (IBT) framework. Multidimensional phenotyping is used to organise dominant biochemical, biomechanical, and psychophysiological contributors to breathing inefficiency, with obstructive sleep apnea presented as a clinical example. **Results:** This synthesis outlines a unified airway model linking multidimensional phenotyping to targeted intervention selection. The IBT framework provides a structured approach for integrating biomechanical coordination, ventilatory control, and psychophysiological regulation within clinical practice. The obstructive sleep apnea exemplar demonstrates how phenotype-informed mapping can support clinical reasoning and guide individualised intervention strategies within OM and related behavioural approaches. **Conclusions:** Integrative Breathing Therapy offers a clinically grounded, multidimensional model for functional breathing optimisation that aligns unified airway training with principles of neural adaptation and systems-based clinical reasoning. This framework supports phenotype-guided clinical decision-making and provides a coherent structure for addressing breathing inefficiency and airway instability across a range of clinical populations, including those treated with orofacial myology and behavioural OSA therapies.

Keywords: Integrative Breathing Therapy; functional breathing disorders; neuroplasticity; upper and lower airway; autonomic regulation; multidimensional phenotyping; respiratory rehabilitation

1. Introduction

Breathing and airway dysfunction are increasingly recognised as multidimensional problems that may require multidisciplinary and comprehensive interventions. Despite advances in orofacial myofunctional therapy (OMT) and related approaches, clinicians often lack an integrated framework that connects nasal function, tongue and upper-airway

behaviour, breathing pattern regulation, and the training processes required for sustainable change, particularly in more complex patients.

This article outlines the IBT approach to breathing and airway rehabilitation, organised around three core concepts: the unified breathing system; the multidimensional nature of breathing; and the application of neuroplasticity principles to the retraining of dysfunctional patterns. This perspective aligns with current directions in OMT while extending them, offering additional conceptual tools for understanding and addressing nasal breathing difficulties, upper-airway impairment, and conditions such as sleep-disordered breathing.

2. The Evolving Landscape of Orofacial Myofunctional Therapy

Orofacial Myofunctional Therapy (OMT) has traditionally focused on the tongue, lips, jaw, and related oral behaviors, using targeted exercises to improve muscle coordination, optimize oral postures, and eliminate dysfunctional habits. Most foundational protocols define OMT within this local orofacial scope, though more recent models have begun to integrate broader airway and systemic considerations, including nasal breathing, craniofacial growth, and sleep-disordered breathing [1].

While the importance of nasal breathing has long been acknowledged within OMT, correction of mouth breathing has traditionally focused on establishing normalized tongue and lip posture, improving orofacial muscle function, and addressing maladaptive oral habits. More recently, emerging protocols have placed greater emphasis on nasal breathing function itself, including airflow mechanics, breathing pattern regulation, and the integration of respiratory and postural control, particularly in the context of sleep-disordered breathing and craniofacial development. This evolution provides an important bridge to the broader, multidimensional focus of IBT described in this article [2–4].

A parallel trend within OMT is the growing emphasis on neurological re-education as the foundation for restoring orofacial and nasal breathing function. This shift has expanded OMT beyond mechanical exercise drills toward more comprehensive, system-aware protocols [5].

3. Integrative Breathing Therapy (IBT): A Systems-Based Complement to OMT

Building on these developments within OMT, Integrative Breathing Therapy (IBT) is described here as a systems-based framework that situates orofacial function within the regulation of the unified breathing system as a whole.

While myofunctional interventions primarily focus on tongue, lip, and facial muscle function to support nasal breathing and oral posture, IBT applies these principles across broader physiological, neurological, and behavioural contributors to habitual breathing patterns and airway stability.

IBT conceptualises breathing both as a therapeutic regulator and as a function requiring retraining—using breathing practices to influence autonomic and physiological regulation while simultaneously rehabilitating dysfunctional breathing mechanics and patterns. IBT explicitly assumes that all effective training depends on neuroplastic change in neural circuits supporting breathing, but for clinical reasoning it differentiates three overlapping targets: (1) sensory retraining (e.g., interoceptive and exteroceptive awareness of breathing and orofacial function), (2) autonomic state regulation (e.g., modulating arousal and autonomic balance through specific breathing styles), and (3) behavioural habit retraining of breathing and orofacial patterns. Drawing on neuroplasticity principles, IBT treats breathing as an integrated behavioural process shaped by biomechanical, biochemi-

cal, and psychophysiological influences. This systems perspective is particularly relevant in conditions involving upper-airway compromise, including sleep-disordered breathing.

Within this framework, IBT is organized around three core principles:

1. The unified breathing system—acknowledging functional continuity from the nasal and orofacial structures through the pharynx, thorax and pelvic floor, such that changes in one region may influence function across the system. This perspective is consistent with osteopathic descriptions of five interconnected ‘diaphragms’—the tentorium cerebelli, tongue, thoracic inlet, respiratory diaphragm and pelvic floor—which together form co-dependent planes involved in respiration, circulation and postural support [6].
2. A multidimensional model of breathing—assessing breathing-related dysfunction across biomechanical, biochemical, and psychophysiological dimensions, each contributing to breathing efficiency, airway stability, and adaptive capacity.
3. Sensory–autonomic–behavioral retraining—employing graded and varied breathing practice, sensory training for interoceptive accuracy, attentional modulation, behavioural reinforcement, and nervous system regulation to influence habitual breathing patterns and to promote longer-term functional adaptation. These interventions are designed with the expectation of neuroplastic change, but are described in terms of their primary clinical targets for clarity.

Together, these principles situate orofacial interventions within a broader systems framework that considers airway mechanics, respiratory physiology, and neural regulation.

4. Unified Breathing System

In systems-oriented approaches to breathing rehabilitation, it is useful to view the airway as a single connected functional unit. The respiratory tract, from the nose to the lungs, shares mechanical, inflammatory, and neural pathways, such that dysfunction in one region can influence function in others.

The concept of the unified airway describes the functional integration of the upper airway (nose, oral cavity, pharynx, tongue, larynx) and lower airway (trachea, bronchi, lungs). These regions are linked through shared inflammatory mechanisms, similar tissue responses, and coordinated neural control [7]. In the following paragraphs, I outline key shared inflammatory and neuromuscular features of the unified airway. Table 1 then summarises these components and their primary functions as a synthesis of the preceding text.

4.1. Linked Inflammatory Responses

The respiratory tract functions as a continuous biological system, such that inflammation in the nasal or sinus tissues (e.g., allergic rhinitis) can affect the lower airway, including asthma and OSA [8]. Shared inflammatory mediators and structural changes help explain the frequent coexistence of upper- and lower-airway conditions, supporting the clinical relevance of whole-airway perspectives [9].

4.2. Integrated Neuromuscular Control

Effective breathing depends on coordinated activity between the tongue, pharyngeal muscles, diaphragm, and rib cage. These structures function as an integrated system rather than as isolated components, with continuous sensory–motor feedback shaping airway patency and ventilation [10]. During inspiration, for example, reflex activation of the tongue increases the aperture of the upper airway and contributes to airway stabilisation, while coordinated engagement of the diaphragm and intercostal muscles supports airflow and ventilation demands [11,12].

Disruption of this coordination, through chronic stress, inflammation, oxidative stress, dysfunctional breathing or sleep-related breathing disorders, can impair the timing and magnitude of upper-airway muscle activation [13]. In obstructive sleep apnoea, reduced and poorly co-ordinated tongue-muscle activity during sleep is commonly observed and contributes to airway collapse and increased apnea–hypopnea index (AHI) [14].

4.3. Relevance for Breathing Retraining Approaches

The concept of the unified airway provides a useful framework for breathing retraining approaches such as Integrative Breathing Therapy (IBT). Training diaphragmatic activity and lower respiratory mechanics can alter airflow regulation and respiratory muscle coordination across the airway, including the upper airway. Likewise, improvements in nasal and upper airway obstruction may reduce respiratory effort and support restoration of a more functional breathing pattern. This bidirectional interaction suggests that breathing-based interventions may influence both airway function and breathing pattern through integrated mechanical and neural pathways.

In individuals with functional breathing disorders, disruption at one level of the airway, whether mechanical, inflammatory, or neural, may therefore contribute to maladaptive breathing patterns across the system, reinforcing symptoms despite the absence of structural pathology.

Table 1. Structures and Features of the Unified Airway.

Component	Includes	Primary Functions	Shared Features
Upper Airway (Extrathoracic)	Nose, mouth, nasopharynx, oropharynx, laryngopharynx, tongue, larynx	- Conditions, filters, and humidifies incoming air - Regulates airflow through modulation of upper airway resistance, including vocal-fold and supraglottic contributions - Supports phonation and speech - Protects lower airway	- Similar epithelial and inflammatory responses - Integrated neuromuscular control with muscles of lower airway. - Shares neural pathways with lower airway. - Dysfunction can influence lower airway behavior.
Lower Airway (Thoracic)	Trachea, bronchi, bronchioles, alveoli	- Conducts air to the lungs - Gas exchange (alveolar)	- Linked inflammatory mechanisms with upper airway disease. - Shares sensory and autonomic innervation with upper airway. - Dysfunction can influence upper airways.
Primary Muscles of Breathing	Diaphragm, intercostals	- Generate pressure gradients by changing thoracic volume - Main drivers of quiet breathing	- Work synergistically with both upper, thoracic and pelvic structures to regulate airflow and support ventilation within an integrated pressure system.
Secondary (Accessory) Muscles of Breathing	Sternocleidomastoid, scalenes, upper trapezius, pectoralis minor, abdominal muscles	- Provide additional thoracic and abdominal expansion or compression during increased demand or dysfunction	- Often recruited when airway or breathing control is compromised; their activity reflects system-wide respiratory and postural integration, including intra abdominal and pelvic pressure regulation.

Primary functions and shared features are summarised from current descriptions of upper and lower airway physiology and unified airway models [15–17].

5. The Multidimensional Nature of Breathing

Breathing is a complex, adaptive behaviour that emerges from interactions across multiple physiological and psychological domains. In frameworks such as Integrative Breathing Therapy (IBT), breathing is conceptualised as multidimensional, shaped primarily by three interrelated systems: the biochemical, biomechanical, and psychophysiological dimensions [18]. Each dimension influences the others, and dysfunction in any domain can affect overall respiratory function. Recognising these interconnections provides a framework for assessment and intervention that goes beyond approaches focused on isolated aspects of breathing.

5.1. Biochemical Dimension

This dimension encompasses gas exchange, chemosensitivity to carbon dioxide, acid–base regulation, and metabolic demand. Alterations in CO₂ sensitivity, chronic over-breathing, or breath-holding habits can influence respiratory drive and contribute to sympathetic arousal, airway instability, and symptoms such as dyspnoea or dizziness. Breathing exercises targeting biochemical function include controlled nasal breathing, slow relaxed breathing, and CO₂ tolerance exercises, which may be performed with or without biofeedback [19].

5.2. Biomechanical Dimension

The biomechanical dimension refers to structural and movement-based aspects of breathing, including ribcage mobility, diaphragmatic function, postural alignment, upper-airway mechanics, and orofacial contributions to airflow. Restrictions or inefficiencies in these systems can lead to compensatory patterns such as upper-chest breathing, excessive accessory muscle use, or oral breathing, which may disrupt airflow and autonomic regulation. Interventions may include manual therapy, postural and motor retraining, upper-airway and nasal muscle rehabilitation, and breathing exercises designed to restore relaxed, flexible, and functional breathing patterns.

5.3. Psychophysiological Dimension

This dimension reflects the influence of emotional state, autonomic regulation, stress reactivity, attentional patterns such as hypervigilance, and fear-conditioned responses to breathing. Factors such as chronic stress, heightened threat sensitivity, perfectionism, or trauma can reinforce high-effort breathing strategies, including bracing, rapid shallow breathing, or highly irregular breathing with involuntary breath-holding during cognitive load. Addressing this dimension may involve autonomic downregulation strategies, interoceptive training, cognitive reframing, and neuroplasticity-informed habit change to support more adaptable respiratory patterns.

While each dimension contributes uniquely to overall function, these domains are inseparable in practice. Biochemical dysregulation can drive mechanical rigidity, mechanical inefficiencies can increase psychophysiological load, and stress physiology can influence both chemistry and movement. Considering all three dimensions may therefore support more precise assessment and the development of personalised therapeutic pathways.

Finally, the multidimensional model interfaces directly with neuroplastic mechanisms: each domain—biochemical, biomechanical, and psychophysiological—modulates both sensory (afferent) and motor (efferent) control of the unified airway, providing a foundation for integrated, adaptive interventions.

6. Mechanisms of Neuroplasticity: The Whole-System Approach

The following subsections summarise key neuroplastic mechanisms through which breathing and airway function may adapt to training. Neuroplasticity—the nervous system’s capacity to reorganise neural connectivity and function in response to experience—is central to effective breathing and airway rehabilitation [20]. These adaptive processes involve interacting biomechanical, biochemical, and neural pathways and exhibit learning and memory effects shaped by prior patterns of stimulation [21].

6.1. Breathing Brain Connections

Breathing rhythms influence neural activity across multiple brain regions and can support adaptive change. Respiratory cycles coordinate oscillatory activity in areas including the olfactory bulb, parietal cortex, amygdala, and medial prefrontal cortex (mPFC). Inhalation and exhalation modulate neuronal timing involved in interoception, emotional processing, and action preparation, generating respiration-modulated brain oscillations (RMBO) [22].

Nasal and oral breathing engage partially distinct neural pathways [23,24]. While both influence baroreflex-related brain rhythms—particularly at slower breathing rates around 0.1 Hz—nasal airflow uniquely entrains activity via olfactory pathways. Projections from the olfactory bulb reach limbic and cortical regions involved in emotion, memory, and learning, including the amygdala, piriform cortex, and mPFC [25]. These pathways provide a plausible neurophysiological basis through which nasal breathing retraining may influence emotional regulation, anxiety, and cognitive clarity.

Consistent with this view, subjective nasal obstruction is associated with elevated anxiety even in the absence of clear structural pathology [26]. Rhinitis has also been linked to increased risk of depression, and olfactory impairment is associated with depressive symptoms, memory deficits, and cognitive decline [27,28]. While these associations do not establish causality, they highlight the close relationship between nasal sensory input, breathing, and brain function.

Attending to sensations of smell, nasal airflow, body movement, and sound increases respiration-linked sensory input and may enhance afferent signalling through olfactory and trigeminal pathways. Training olfactory awareness and mindful attention to nasal sensation may therefore support mood regulation and cognitive function, particularly in individuals with reduced nasal sensory engagement. Within IBT, conscious smelling and mindful nasal attention are incorporated as components of functional nasal rehabilitation, informed by evidence of sensory deafferentation associated with reduced nasal use [4].

6.2. Sensory and Motor Pathways of Neuroplasticity

Adaptive plasticity of the unified airway depends on sensory (afferent) signals from the nose, upper and lower airways, and chemoreceptors that project to the brain’s respiratory control centers. These inputs coordinate motor (efferent) output through the hypoglossal, phrenic, and intercostal nerves, enabling the tongue, pharynx, diaphragm, and chest wall to function as a single unit [29].

Afferent information related to O₂, CO₂, pH, and mechanical stretch is conveyed primarily via the vagus (X) and glossopharyngeal (IX) nerves to the nucleus tractus solitarius (NTS). Trigeminal (V) inputs from nasal and facial receptors signal airflow and resistance, influencing breathing patterns and upper-airway muscle drive [30].

Motor pathways to the upper airway run predominantly through the hypoglossal nerve (XII), while the phrenic and intercostal nerves supply the diaphragm and rib cage. The respiratory central pattern generator (rCPG) provides an important source of respiratory-related drive to these motor pools, contributing to coordination between tongue,

diaphragm and chest-wall behaviour. However, studies of hypoglossal motoneurons show that tongue muscle activity is shaped by a complex convergence of respiratory premotor inputs, chemosensory and mechanosensory feedback, and sleep–wake-dependent neuromodulation, rather than by a simple uniform rhythmic signal. IBT therefore treats the tongue and upper airway muscles as respiratory effectors whose function reflects this multi-level central control [7,12].

From a neuroplasticity perspective, breathing retraining can be understood as modulation of afferent sensory input to influence central respiratory control and downstream motor output. Specific breathing modifications preferentially engage different sensory pathways: attention to nasal airflow enhances trigeminal input; changes in lung volume, breathing rate, or inspiratory–expiratory ratios influence vagal mechanoreceptors; and breath-holding or controlled hypoventilation engages chemoreceptor-based afferent systems. Respiratory muscle training further alters afferent feedback and motor drive through phrenic and intercostal pathways.

Together, these strategies enable graded, task-specific engagement of sensory–motor circuits and support adaptive neuroplastic change within the unified breathing system.

6.3. Adaptive Long-Term Facilitation

A key mechanism of neuroplastic change in breathing is long-term facilitation (LTF), a form of serotonin- and adenosine-dependent synaptic plasticity that enhances baseline activation of phrenic and hypoglossal motoneurons, increasing respiratory pump and upper-airway muscle tone [31,32]. Fluctuations in oxygen, carbon dioxide, and mechanical load modulate this response and shape motor output to both upper and lower airway muscles [33].

LTF may be adaptive or destabilising depending on chemoreceptor sensitivity, ventilatory drive, and background CO₂ levels [34]. Mild intermittent hypoxia within a controlled range can enhance airway stability when ventilatory drive is not excessive and CO₂ is maintained within normal physiological limits [35]. In contrast, hypocapnia reduces neural drive—particularly to upper-airway muscles—while excessive hypoxia or hypercapnia, as seen in severe OSA, may impair coordination and plasticity [36].

Mild intermittent hypoxia has therefore been explored as a therapeutic stimulus in conditions such as sleep apnoea and asthma [20]. This can be delivered through controlled breath-holding practices or Intermittent Hypoxia Training (IHT) using specialised devices. When carefully titrated, IHT may promote adaptive LTF and normalise chemosensitivity, potentially improving upper-airway muscle responsiveness [37,38]. However, these effects are highly protocol-dependent, and inappropriate dosing may increase loop gain or respiratory instability, particularly in individuals with severe OSA or motor control disorders [39].

In addition to hypoxic stimuli, increased respiratory load—such as higher inspiratory pressure or lung volume—can strengthen hypoglossal motor output and support airway patency, as occurs during exercise or with inspiratory resistance training [40,41].

Overall, carefully dosed modulation of hypoxia, CO₂, and mechanical load can induce adaptive neuroplastic changes in breathing and upper-airway control. While these mechanisms provide a plausible foundation for therapeutic intervention, clinical application—particularly in OSA—remains an emerging field requiring individualised protocols and further research [35,42].

7. Clinical Application of IBT's Multidimensional Neuroplasticity Approach: Sleep Apnea

In this section, the general IBT framework described above is applied to obstructive sleep apnea (OSA) as an example of how unified airway concepts, multidimensional phenotyping, and neuroplasticity-informed training can guide clinical reasoning. Dysfunctional breathing in sleep apnea can act as both a contributor to, and a consequence of, the condition. Biomechanical, biochemical, and psychophysiological drivers often overlap and interact, leading to the persistence of disordered breathing patterns and related symptoms [43,44]. These patterns reflect a combination of adaptive and maladaptive changes across both the upper and lower airways [45]. While adaptive neuroplastic changes support airway stability and efficient coordination, maladaptive patterns may reinforce airway collapsibility, ventilatory instability, and symptom expression. Sleep apnea therefore provides a clear illustration of the unified airway and multidimensional framework underpinning breathing rehabilitation, highlighting the need for individualized interventions that reinforce adaptive neuroplastic change across the respiratory system.

Taken together, these concepts support a phenotype-guided approach to breathing rehabilitation in sleep apnea. Within this approach, sleep apnea is understood through the lens of a unified airway, assessed using a multidimensional framework, and addressed through interventions designed to reinforce adaptive neuroplastic change. The sections that follow outline how unified airway function, multidimensional phenotyping, and phenotype-specific intervention pathways can be integrated to guide targeted breathing rehabilitation.

7.1. Unified Airway and Functional Coordination

The unified airway model recognises the nose, pharynx, larynx, and lower airway as an integrated functional system. Anatomical, neural, and inflammatory interdependence means that dysfunction in one region can destabilise others, contributing to airway collapsibility and ventilatory inefficiency. For this reason, IBT treats nasal function as foundational, supporting airflow regulation, sensory feedback, and neuromotor coordination. Upper airway retraining is embedded within respiratory timing, diaphragmatic mechanics, and posture, ensuring that airway support is trained as a coordinated, cycle-linked function rather than as isolated muscle strength work.

7.2. Neuroplasticity-Informed Training

Respiratory and upper airway control networks are activity-dependent and highly plastic. IBT incorporates phase-locked breathing interventions designed to reinforce adaptive coordination across the upper and lower airway. Tongue, soft palate, and pharyngeal activation are specifically trained in synchrony with both inspiratory and respiratory phases, with the aim of enhancing integration between hypoglossal, phrenic, and intercostal motor output. Mindful attention to sensory input, carbon dioxide modulation, and carefully titrated hypoxic exposure are also employed to further support long-term facilitation and stabilization of airway motor control.

7.3. Multidimensional Phenotyping and Intervention Pathways

Assessment considers the relative contribution of three interacting dimensions—biochemical, biomechanical, and psychophysiological—mapped to the key physiological traits described in obstructive sleep apnea, including ventilatory control instability (high loop gain), impaired responsiveness of upper airway dilator muscles, and a low arousal threshold [46].

Biochemical factors include ventilatory control instability and heightened carbon dioxide sensitivity, which may contribute to oscillatory breathing and ventilatory overshoot. Biomechanical factors encompass ribcage and diaphragmatic mechanics, tongue posture, pharyngeal compliance, and habitual oral breathing, influencing passive airway collapsibility and the effectiveness of upper airway muscle recruitment. Psychophysiological factors include autonomic tone, arousal threshold, and threat sensitivity, which modulate respiratory control, sleep continuity, and arousal propensity. These dimensions rarely occur in isolation; rather, their interaction reflects the trait overlap and heterogeneity commonly observed in obstructive sleep apnea.

Once nasal breathing has been established and baseline breathing patterns stabilised (as outlined in the unified airway and neuroplasticity-informed training sections), IBT interventions are guided by the dominant physiological trait profile. In presentations characterised by elevated loop gain or carbon dioxide intolerance, intervention prioritises stabilisation of ventilatory control through breathing pattern retraining and CO₂ tolerance work, consistent with approaches aimed at reducing ventilatory instability; mild intermittent hypoxia may be introduced cautiously once baseline regulation improves. Where impaired responsiveness of upper airway dilator muscles predominates, training emphasises biomechanical and neuromuscular retraining of the tongue and pharyngeal musculature in synchrony with the breathing cycle, supporting improved airway muscle recruitment during vulnerable phases of respiration. In mixed presentations involving heightened arousal propensity and ventilatory dysregulation, intervention integrates slow, cycle-linked breathing, autonomic downregulation, and interoceptive training, consistent with trait-based strategies aimed at increasing arousal threshold, alongside airway retraining to support respiratory stability.

Across phenotypes, nasal breathing rehabilitation and stabilisation of baseline breathing patterns remain a consistent foundation, supporting unified airway function and facilitating adaptive coordination across the respiratory system.

Table 2 summarises the IBT phenotype-guided rehabilitation framework for sleep apnea, illustrating how unified airway concepts, trait-informed phenotyping, and neuroplasticity-informed training principles are integrated to guide targeted breathing rehabilitation.

Table 2. Trait-Informed Multidimensional Phenotyping and IBT-Guided Intervention Pathways in Sleep Apnea.

Dominant Phenotype	Primary Dimension	Key Features	IBT Informed Intervention Focus
Elevated loop gain/ventilatory control instability	Biochemical (with psychophysiological interaction)	Heightened CO ₂ sensitivity, ventilatory overshoot, oscillatory breathing patterns, frequent respiratory arousals	Breathing pattern retraining to support ventilatory stability; CO ₂ tolerance work as described in neuroplasticity-informed training; cautious introduction of mild intermittent hypoxia once baseline breathing regulation improves
Impaired responsiveness of upper airway dilator muscles	Biomechanical (with neural drive interaction)	Reduced or poorly timed tongue and pharyngeal muscle activation, increased airway collapsibility, oral breathing tendency	Phase-locked retraining of tongue, soft palate, and pharyngeal musculature synchronised with the breathing cycle, consistent with unified airway and airway neuromuscular training sections; resistance-based respiratory loading where appropriate
Low arousal threshold with ventilatory dysregulation	Psychophysiological with ventilatory dysregulation (with biochemical and biomechanical overlap)	Heightened autonomic tone, increased arousal propensity, sleep fragmentation, variable breathing patterns	Slow, cycle-linked breathing; autonomic downregulation and interoceptive training as outlined in psychophysiological regulation sections; airway retraining to support respiratory stability

Traits are adapted from established physiological models of obstructive sleep apnea, including ventilatory control instability (loop gain), upper airway muscle responsiveness, and arousal threshold. Suggested IBT intervention foci are extrapolated from existing literature on breathing retraining, intermittent hypoxia, and orofacial myofunctional and airway-focused therapies [42,46].

7.4. Integration with Conventional Therapies

IBT is not positioned as a replacement for continuous positive airway pressure (CPAP), oral appliances, neuromodulation devices, or orofacial myofunctional therapy (OMT), but as a complementary, phenotype-informed approach. By addressing nasal function, ventilatory control stability, and behavioural and autonomic regulation, IBT may support tolerance to conventional therapies, reduce residual ventilatory instability, and assist functional adaptation beyond periods of device dependence.

Framed within established physiological trait models of obstructive sleep apnea, IBT aims to complement device-based and mechanical interventions by targeting modifiable contributors to breathing instability that may not be fully addressed by structural support alone.

7.5. Clinical Implications for Orofacial Myofunctional Therapy Practice

From an orofacial myofunctional therapy perspective, the IBT framework provides a broader explanatory context for variability in patient response to conventional protocols. Traditional OMT approaches emphasise strengthening and coordination of the tongue, lips, and orofacial musculature to support nasal breathing and airway patency. However, residual symptoms or unstable gains may persist when breathing pattern regulation, ventilatory control instability, or heightened psychophysiological arousal are not concurrently addressed.

A multidimensional, trait-informed approach encourages clinicians to consider whether apparent non-compliance, fatigue, or plateauing reflects underlying physiological contributors such as elevated loop gain, impaired timing or responsiveness of upper airway dilator muscles, or psychophysiological factors including hypervigilance and low arousal threshold. In such cases, excessive emphasis on isolated or high-load muscle activation may

inadvertently increase respiratory effort or sympathetic activation, potentially undermining airway stability.

Within the IBT framework, myofunctional retraining is reframed as a task of coordination and timing embedded within the breathing cycle rather than as isolated strength-based exercise. Integrating nasal breathing rehabilitation, respiratory pacing, and autonomic regulation strategies may improve tolerance to orofacial exercises and enhance carryover into sleep and daily function. This perspective also supports flexible dosing, sequencing, and progression of exercises based on individual regulatory capacity and dominant physiological trait profile.

For OMT practitioners, incorporating unified airway assessment and multidimensional screening may refine clinical reasoning, improve matching of patients to specific intervention strategies, and reduce variability in outcomes. Rather than replacing established myofunctional techniques, IBT offers a complementary framework that situates them within whole-system breathing regulation and training-informed adaptation.

7.6. Limitations and Future Directions

This article presents a clinically informed synthesis rather than a definitive treatment protocol. Although the framework draws on established research in respiratory physiology, airway control, autonomic regulation, and training-related neuroplasticity, evidence specific to IBT as an integrated intervention in sleep apnea remains emergent and is largely extrapolated from related fields.

Future research should include controlled studies of phenotype-guided breathing interventions, mechanistic investigations linking breathing pattern modification to airway stability during sleep, and comparative evaluations alongside conventional orofacial myofunctional therapy and device-based treatments. As this evidence base develops, phenotype-guided IBT frameworks may offer clinicians a structured, evidence-informed approach to tailoring breathing rehabilitation in sleep apnea.

8. Conclusions

Integrative Breathing Therapy (IBT) offers a clinically grounded, multidimensional framework that brings together unified airway concepts, breathing biomechanics, ventilatory control, autonomic regulation, and orofacial function within a single systems-based model for practice. By organising assessment and intervention around biochemical, biomechanical, and psychophysiological dimensions, and then applying this structure in a phenotype-guided way—as illustrated with obstructive sleep apnea—IBT supports more targeted selection and sequencing of sensory, autonomic, and behavioural breathing interventions. For orofacial myofunctional therapists, this perspective reframes tongue and orofacial retraining as coordination- and timing-focused tasks embedded within the breathing cycle and supported by nasal rehabilitation and autonomic regulation, rather than as isolated strength exercises. Positioned alongside CPAP, oral appliances, neuromodulation, and conventional OMT, IBT is proposed not as a replacement but as a complementary clinical reasoning framework that may help explain variability in treatment response, facilitate integration of therapies, and guide future research on personalised, whole-system breathing rehabilitation in sleep-disordered and dysfunctional breathing populations.

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Article

Orofacial Myofunctional Therapy for Patients with Obstructive Sleep Apnea—A Mixed Methods Study of Facilitators and Barriers to Treatment Adherence

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Abstract: Orofacial myofunctional therapy (OMT) for obstructive sleep apnea (OSA) is a promising, new treatment. We aimed to study patients' experiences and adherence to OMT. Twelve patients with OSA were included in the study, and they engaged in OMT exercises three times daily for 12 weeks. Participants tracked their sleep and OMT exercise activities in an electronic diary. Exercise techniques were guided by a certified therapist. Patients' experiences with OMT were assessed through semi-structured individual interviews conducted after a 12-week intervention, and the transcripts were analyzed using thematic analysis. The findings revealed an overarching theme that captured both facilitators of and barriers to OMT, organized into three subthemes: (1) motivation, (2) perceived support, and (3) perceived effects. Motivation was driven by a desire to improve general health and avoid continuous positive airway pressure treatment, and was supported by a sense of mastery and perceived effectiveness. Key facilitators included a trusting patient–therapist relationship, as well as developing routines and a sense of control. Barriers involved managing the comprehensive treatment protocol, insecurities around exercise execution and the potential impact of OMT, sickness burden, and previous negative healthcare experiences. These themes were supported by quantitative findings, which demonstrated high treatment adherence, while sleep data indicated modest individual improvements in subjective sleep quality and efficiency. By recognizing facilitators and barriers and addressing the individual differences among OSA patients, healthcare providers can better tailor their approach to meet diverse patient needs. This personalized approach, supported by emerging sleep improvements, may enhance patient engagement and improve adherence to OMT.

Keywords: obstructive sleep apnea; orofacial myofunctional therapy; adherence; trust; facilitators; barriers

1. Introduction

Obstructive sleep apnea (OSA) affects nearly 1 billion people globally [1] and involves recurrent upper airway obstruction during sleep, leading to excessive daytime sleepiness,

cognitive impairment, mental health issues, cardiovascular disease, and metabolic dysregulation [2]. Continuous positive airway pressure (CPAP) therapy is considered the gold standard and effectively reduces apneic events and health risks [3], although long-term adherence remains a challenge [4,5]. Complementary, less efficient treatment modalities for OSA include lifestyle change [6], positional therapy [7], mandibular advancement devices (MAD) [8], and surgery [9]. Exploring alternative and adjunctive treatments is essential to address the varied needs of OSA patients [3].

Orofacial myofunctional therapy (OMT) is an emerging alternative treatment for OSA [6,10,11]. It focuses on exercises to strengthen pharyngeal, velar, tongue, and facial muscles to improve airway function and enhance nasal breathing, aiming to reduce apneic events and improve sleep quality [12,13]. Systematic reviews and meta-analyses indicate that OMT can reduce AHI and improve oxygen saturation levels, especially in cases of mild to moderate OSA [8–10]. Despite emerging evidence for the effect, we are not aware of any study of the OSA patients' experience with OMT treatment.

This pilot study was conducted within the Sleep Revolution project, a Horizon 2020-funded initiative by the European Union that aims to transform the clinical management of sleep-disordered breathing (SDB) through innovative diagnostic tools and digital treatment strategies [14]. As a preparatory step toward a larger randomized controlled trial (RCT) evaluating the effect of OMT on OSA, this study was conducted to adjust and refine the design of the forthcoming RCT.

The aim of this study was to understand patients' experiences and adherence to OMT.

2. Materials and Methods

2.1. Study Design and Ethics

This mixed-methods study was designed to gain an in-depth understanding of patients' experiences with OMT. We designed a qualitative study and used quantitative data on treatment adherence and self-reported sleep outcomes collected via a digital diary to complement our findings. The primary component was qualitative, based on individual semi-structured interviews following the completion of a 12-week OMT program. These interviews were conducted face-to-face by the first author, who also served as the participants' OMT therapist.

To mitigate potential bias stemming from this dual role of therapist as interviewer, three measures were implemented. First, the interview guide (Appendix A) was developed collaboratively through an iterative process. An initial draft was prepared by the last author and subsequently reviewed and revised independently by all co-authors. The guide was then refined through a series of discussions, ensuring relevance with the study's objectives. Our method followed the approach outlined by Brinkmann and Kvale [15] and was thoughtfully designed to include key themes, sub-questions, and open-ended prompts. The guide was tested with a convenience sample of seven volunteers. Their feedback was used to review and finalize the interview guide. Second, during the interviews, efforts were made to establish a safe and non-judgmental environment by emphasizing that both positive and negative feedback were equally valuable and appreciated. Third, the interpretation of the interview data followed a collaborative process by the author group to ensure a balanced and credible qualitative analysis.

In addition, baseline and post-intervention clinical assessments were conducted using standardized orofacial measurements. These were included for examiner training and calibration purposes in preparation for the forthcoming RCT, and results were not included in this study.

The study protocol was approved by the Regional Committee for Medical and Health Research Ethics South East Norway (reference number: 377317) and adhered to Good

Clinical Practice rules according to the Declaration of Helsinki. All participants provided written informed consent.

2.2. Participants

Twelve motivated individuals who contacted the project leader following media coverage about the project were considered for participation. The inclusion criteria included (1) a verified OSA diagnosis according to the current International Classification of Sleep Disorders version 3 criteria [16,17], (2) written informed consent, (3) an age ≥ 18 years, (4) willingness to complete baseline and follow-up tests, (5) interest in trying OMT exercises, and (6) the ability to use and own a smartphone.

The exclusion criteria included (1) a BMI ≥ 40 , (2) congenital craniofacial malformations, (3) active malignant disease, (4) blindness or hearing loss, (5) unstable cardiometabolic disease, (6) substance abuse, and (7) medical issues interfering with the study protocol, as judged by project leader.

Twelve participants were included in the study: eight females and four males aged between 37 and 68 years (median 59 years). Two participants withdrew shortly after the baseline evaluation due to low capacity to participate in the study. Most were employed full-time in high-responsibility roles, with four needing a varying degree of reduced workload due to long-term sick leave. All patients had tried CPAP treatment, but only six were CPAP-adherent. One participant was MAD non-adherent, and in addition, two of the participants used MAD devices but did not view this as a good treatment option. Participants' BMI values ranged from 19.3 to 37.6 (median 27.4), and their AHI values varied from 6.9 to 81.4 (median 30.9). Participants reported sleep-related issues that had lasted from 1.5 to 31 years (median 10.8 years).

Participants exhibited a range of comorbidities in addition to OSA, including rheumatoid arthritis, Meniere's disease, chronic obstructive pulmonary disease, migraines, hypertension, gastroesophageal reflux disease, celiac disease, irritable bowel syndrome, hormonal disturbances, psoriasis, attention-deficit hyperactivity disorder, burnout, asthma, depression, allergies, and congenital heart disease. Participants' characteristics are presented in Table 1.

Table 1. Participants' characteristics.

Research ID	Age	Employment Fraction (%)	Treatment	BMI	AHI	Duration of Sleep Difficulties (Years)
P1	61–65	100	CPAP non-adherent	27.4	13.9	1.7
P2	56–60	100	CPAP	23.7	32.6	17.5
P3	56–60	<50	CPAP	19.3	29.2	12.5
P4	61–65	100	CPAP, MAD	23.8	46.3	6.0
P5	51–55	<50	CPAP	29.8	55.1	15.0
P6	56–60	100	CPAP non-adherent, MAD	24.4	9.0	30.0
P7	46–50	<50	CPAP non-adherent, MAD non-adherent	28.4	22.2	20.0
P8	61–65	100	CPAP	24.4	6.9	31.0

Table 1. Cont.

Research ID	Age	Employment Fraction (%)	Treatment	BMI	AHI	Duration of Sleep Difficulties (Years)
P9	36–40	100	CPAP	30.3	39.3	9.0
P10	66–70	100	CPAP non-adherent	28.7	38.7	5.0
W1	36–40	100	CPAP	27.5	23.0	4.5
W2	56–60	<50	none	37.6	81.4	1.5

Employment fraction (%) refers to the participants' professional workload. P1–P10: Patients completing project and interview. W1–W2: Individuals who withdrew from the project early. CPAP: Continuous positive airway pressure. MAD: Mandibular advancement device. BMI: Body mass index. AHI: Apnea hypopnea index.

2.3. Intervention

Participants engaged in a standardized OMT intervention package designed to address both the physical and behavioral aspects of OMT. The program featured a structured exercise regimen that consisted of a revised version of exercises described by Guimarães [12] that target the pharyngeal, soft palate, tongue, and facial muscles. These exercises were performed over a twelve-week period. The intervention also included self-monitoring through the use of a digital sleep diary [18] that incorporated an exercise log. By combining targeted OMT exercises, ongoing therapist support, and integrated self-monitoring, the intervention aimed to promote adherence and achieve the broader therapeutic goals of OMT, such as enhanced physical function and improved sleep health. This approach sought to assess the feasibility of implementing a structured and multifaceted program for patients undergoing OMT.

The therapist, who is a dentist by primary training and was certified as an orofacial myofunctional therapist by the Academy of Orofacial Myofunctional Therapy (AOMT), instructed participants in proper exercise techniques following the baseline evaluation. The OMT module included seven exercises: (1) brushing the tongue while holding it in different positions, (2) sliding the tongue against the hard palate behind the upper front teeth, (3) performing a tongue-to-palate vacuum hold, (4) pressing the back of the tongue down while touching the lower front teeth with the tip of the tongue, (5) raising the soft palate and uvula while saying “ah” both intermittently (“a-a-a”) and continuously (“aaa”), (6) blowing balloons or performing forced lip blowing, and (7) performing cheek resistance exercises. Participants performed these exercises at home three times daily for a total of 30–40 min per day over 12 weeks. Instructional videos describing the exercises were made by our research group and were provided through a YouTube link [19]. Telemedicine consultations were made available as needed over the 12-week period. Participants registered their sleep and exercise activity in an electronic diary. Follow-up video consultations with the OMT therapist, which lasted 15 to 54 min, provided support for continued training, with most consultations occurring every two to three weeks.

2.4. Materials and Measurements

Semi-structured interviews were conducted to explore participants' experiences, including their thoughts on receiving a sleep apnea diagnosis, their perceptions of sleep before and after the intervention, their experiences with the OMT exercises, and the digital sleep diary. Additionally, we asked them about the role of their partners throughout the study, as well as participants' interactions with healthcare professionals.

Quantitative data were collected via a digital sleep diary (Appendix B), which participants completed once daily throughout the 12-week intervention period. The digital sleep diary used in this study was adapted from the Consensus Sleep Diary [18]. The diary included a text box where participants recorded their OMT exercises to document

adherence to the prescribed regimen of three sessions per day. Adherence was categorized based on the number of sessions completed: 0/3, 1/3, 2/3, or 3/3. Additional information was gathered through video consultations and interviews, when relevant.

The participants also registered their sleep in the diary, in which they calculated and reported total sleep time, sleep efficiency (SE), and sleep quality (SQ). SE was calculated as total sleep time divided by the duration of the sleep episode, following the method proposed by Reed and Sacco 2016 [20]. Participants' perceived SQ was reported using a 5-point Likert scale (1 = very poor; 5 = very good). This sleep data was visualized in the diary.

Baseline and outcome assessments, using the Extended Orofacial Myofunctional Evaluation with Scores (OMES-E), the Iowa Oral Performance Instrument (IOPI), and the Tongue Range of Motion Ratio (TRMR), were conducted for therapist training purposes prior to the forthcoming RCT. Accordingly, data collected from these assessments were not included in the analysis of the present study.

2.5. Data Analysis

Data analysis was conducted using an inductive thematic approach described by Braun and Clarke [21]. The interviews were audio-recorded and transcribed using NVivo software version 14 by the first and second authors. The transcription process included repeated reading and comparison of the recordings to ensure accuracy, aligning with Braun and Clarke's [21] recommendation of familiarization through immersion in the data (step 1).

The initial coding (step 2) began with all authors independently reading the transcripts to develop initial impressions. Preliminary codes were then suggested and discussed during group meetings until a consensus on codes and categories was reached. The first author refined and organized the codes based on these discussions, ensuring consistency and relevance to the data. Subthemes and overarching themes were identified through the combination and grouping of related codes (step 3).

Throughout the process, themes were continually refined by revisiting the transcripts and ensuring that there was sufficient supporting data for each theme. The authors collaborated to finalize the themes, creating a clear and comprehensive representation of the data through discussions and visual mapping of themes and subthemes (step 4).

The final themes were defined and named collectively and illustrated with direct quotes from the interviews (step 5). A selection of relevant literature was used as an interpretive base for the defined themes. Following this, the drafting of the article took place to document the findings and the systematic approach used throughout the study (step 6).

Exercise adherence was defined as the completion of more than 80% of the 252 planned exercise sets over the 12-week intervention period. Sleep diary data analysis began on the first Monday following each participant's registration, marking the start of Week 1. From this point, data from the following 12 consecutive weeks were included in the analysis. Missing entries for the daily number of exercises were interpreted as the training not being performed, unless participants indicated otherwise during interviews or video consultations. If one or more diary entries were missing within a given week, the averages for SE and SQ were calculated based on the available entries.

3. Results

A total of 10 patients (P1–P10) were interviewed. Interviews lasted approximately 30–80 min. The analysis revealed an overarching theme centered on the barriers and facilitators influencing adherence to OMT, organized into three main themes: (1) motivation, (2) perceived support, and (3) perceived effect. This overarching theme captured participants' experiences throughout the 12-week OMT program, shedding light on the complexity

of the factors that impacted their commitment and engagement with the OMT intervention process. Detailed overview of facilitators and barriers to OMT is presented in Figure 1.

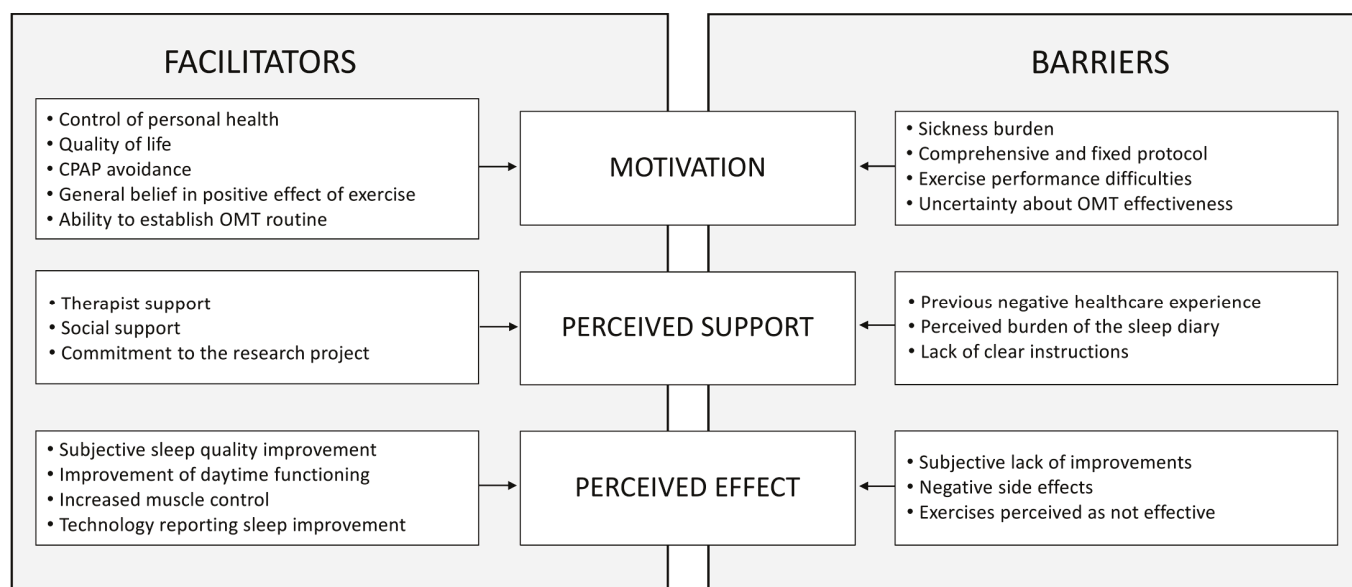


Figure 1. Factors influencing adherence to orofacial myofunctional therapy. CPAP: Continuous airway pressure. OMT: Orofacial myofunctional therapy. The figure displays an overview of the overarching theme and subthemes developed in the thematic analysis.

3.1. Motivation Facilitators

3.1.1. Control of Personal Health

Ten out of ten patients expressed a strong desire to take control of their own health, which served as a central motivation for joining the study. As one participant stated:

“Give me something I can work on by myself. I’ll do anything... as long as I can influence it.” (P5)

For three patients, the limited availability of alternative treatment options further fueled participants’ interest in OMT. These participants aspired to achieve better sleep and enhanced daytime functioning, believing that this could reduce related health risks.

“I don’t mind snoring; that doesn’t bother me. But those breathing pauses—I definitely don’t want those.” (P6)

3.1.2. Quality of Life

While half of the patients reported a desire to actively improve their quality of life, all consistently described how sleep apnea had diminished their quality of life, citing challenges such as low energy, persistent daytime drowsiness, and poor overall sleep quality. Four participants highlighted the strain that sleep apnea had placed on their relationships, which often led to sleeping in separate rooms.

“This has done something with the nights. It has done something with my relationship... It has actually been very damaging.” (P1)

3.1.3. CPAP Avoidance

The avoidance of CPAP therapy emerged as a key motivator for adherence to OMT, driven by both physical and psychological challenges. All participants reported discomfort with CPAP, including mask irritation, stomach pain, and chest discomfort, making the therapy difficult to tolerate: *“I’m constantly adjusting it, and either it’s too tight or too loose” (P2).*

All of the six participants who used CPAP in the project described CPAP as a “necessary inconvenience,” something they adapted to, but found far from ideal. For four patients, however, psychological barriers like panic and claustrophobia made CPAP completely unmanageable. As one participant explained,

“I didn’t try it any nights because I didn’t dare to lie down. . . I basically panicked just from thinking about having the mask on while lying down.” (P1)

3.1.4. General Belief in the Positive Effect of Exercise

Eight out of ten participants expressed a strong belief in the positive impact of exercise on their health, which influenced their engagement with the OMT program. As one participant noted,

“I exercise my body, I go for walks, and I do mouth exercises, because these three things are so important for me.” (P5)

Nine out of ten participants expressed a desire to continue their exercises beyond the project’s duration, despite variations in perceived effectiveness.

3.1.5. Ability to Establish OMT Routines

Six out of ten participants established routines to fit the time-consuming OMT exercises into their busy schedules. Most found specific times that “naturally fit,” emphasizing that without a routine, “You suddenly just drop out of it, forget it and then get distracted by something else” (P9). Three patients incorporated exercises into commutes, while two patients ensured that they completed sessions within a set timeframe to avoid feeling like they were exercising all day.

3.2. Motivation Barriers

3.2.1. Sickness Burden

Eight out of ten participants had comorbid illnesses, and six of them described how additional diagnoses exacerbated their overall sickness burden, complicating OMT and daily life. Comorbidities often hindered adherence to the OMT regimen. One patient described the following scenario:

“I had intense headache. I couldn’t handle light. I couldn’t handle sound. . . I was just in pain, nothing worked, and nothing helped.” (P1)

The two patients who did not have comorbid illnesses described their overall health as good.

3.2.2. Comprehensive and Fixed Protocol

Seven out of ten participants found the comprehensive and fixed OMT training protocol challenging, particularly the requirement to exercise three times a day. One patient shared,

“What I found most challenging was actually doing the exercises. . . Just getting them done three times a day, that has been very difficult for me.” (P2)

Key challenges included fitting the exercises into midday schedules and the mental burden of maintaining the regimen.

“It was mentally exhausting. . . it was tiresome to do, but also constantly feeling like: Now I have to do exercises, now I have to do exercises.” (P7)

3.2.3. Exercise Performance Difficulties

Half of the participants found three exercises—caves, soft palate lift, and tongue down—particularly difficult to master. One participant noted,

“I couldn’t do that [lifting soft palate exercise. . . That was the heaviest and most difficult one.” (P7)

Three patients also emphasized the importance of mental focus. This corresponded with the therapist’s observation that participants took several weeks to effectively master certain exercises, with some struggling throughout the 12-week program.

“During the first week the exercises were difficult. . . it was frustrating. . . I had to focus immensely to perform the exercises.” (P5)

3.2.4. Uncertainty About OMT Effectiveness

During interviews, one participant questioned the quality of the Guimarães study [12], expressing doubts about the reported adherence: *“No way that they have exercised three times a day for 12 weeks” (P8)*. Two additional participants also expressed uncertainty about the effectiveness of OMT for others. Despite these doubts, there was curiosity and anticipation about the project’s potential outcomes.

3.3. Perceived Support Facilitators

3.3.1. Therapist Support

All participants experienced therapist support as a positive part of the process, valuing the opportunity to ask questions and receive clear answers.

“I feel like I can talk about all sorts of things. Also in a professional sense, you [the therapist] can answer so many questions about sleep apnea. . . I’ve really appreciated that.” (P2)

Video consultations were described as warm and inviting, and eight out of ten participants looked forward to these meetings. Half of the group highlighted their relationship with the therapist as a key motivator for performing the exercises.

“It turns into a conversation. . . it’s been really nice. And maybe that’s also made me more committed, you know, because you feel like you have a relationship.” (P5)

Five out of ten participants also emphasized the importance of consultation frequency, seeking enough contact for support but not so much that it became overwhelming. Additionally, two participants found that frequent consultations served as a helpful reminder to stay committed to the program. Lastly, four participants mentioned feeling a sense of obligation to the therapist, which further motivated their adherence to treatment.

“When I’m part of a project like this, I’d really like to see an effect, you know. . . and it’s partly out of respect for you.” (P4)

3.3.2. Social Support

Eight out of ten participants were in relationships, and all eight felt that their partners were positive about the intervention, although they mainly credited their commitment to their own motivation. One participant stated,

“He’s been involved, but not actively. This has to come from within myself. . . for my own benefit.” (P6)

Two of the partners had concerns about the general negative health effects of sleep apnea and motivated their spouses to seek medical treatment and commit to the OMT protocol. One of these eight participants expressed a desire for more support from their

partner but admitted that they had not communicated this need clearly. Two participants also suggested that group-based OMT sessions could provide a valuable support system and motivation through shared experiences.

"I kind of wish there was a group where we could share experiences. . . When you're in a group, you motivate each other. . . I think that would have been really, really useful." (P10)

3.3.3. Commitment to the Research Project

For three patients, the fact that this process was part of a research project provided additional support. They felt that being part of a research project motivated them to adhere to the OMT regimen.

"I want to stick with the exercises because I'm involved in this study, and I want to see it through." (P5)

These participants also expressed a desire to contribute positively to the study, and similar sentiments were observed by the therapist during video consultations.

3.4. Perceived Support Barriers

3.4.1. Previous Negative Healthcare Experience

Eight out of ten participants reported years of interaction with the healthcare system for sleep-related issues, often feeling abandoned, frustrated, and dissatisfied due to delayed diagnoses and inadequate treatment. Six of these eight patients also described a lack of trust in the system, with one participant stating,

"I've totally stopped going to the doctor. . . I don't share anything because I don't trust the system anymore." (P5)

Despite this, these six participants trusted specific healthcare practitioners who provided thorough follow-up and demonstrated expertise.

"There's a lot of variation in general practitioners . . . I don't have very good experience [laughs]. I go there as rarely as I can, and when I leave, I regret that I went. . . A GP. . . is supposed to be a bit of an expert on everything, but at the same time maybe nothing [laughs]. I have much more trust in someone who has spent time specifically on one subject." (P2)

The two participants who did not report negative experiences, both of whom had no additional health issues, described a high level of trust in the healthcare system.

3.4.2. Perceived Burden of the Sleep Diary

Nine out of ten participants recorded their sleep using the electronic diary, while one participant (P4) chose not to. All participants found the sleep diary more or less irrelevant, but two participants appreciated the initial sleep efficiency statistics. Five of the patients reported the sleep diary as a barrier to the intervention, three of whom emphasized that regular entries were disruptive and stressful.

"It became very tiring to have to register everything. . . I hardly had time to sleep when I had to register all the times I was awake. . . it became very stressful." (P1)

The last two patients expressed frustration with unclear phrases and the rigid input system, especially the wake-up time limitations.

3.4.3. Lack of Clear Instructions

Patients received OMT guidance from the therapist, supported by video and written instructions. Two out of ten patients expressed confusion due to perceived discrepancies between the information provided by the videos and the written instructions. These

patients expressed uncertainty about how to properly perform the exercises that needed to be addressed during video consultations.

"I couldn't quite get the video and the descriptions to add up." (P2)

3.5. Perceived Effect Facilitators

3.5.1. Subjective Sleep Quality Improvement

Eight out of ten participants reported fewer awakenings and improved sleep quality after 12 weeks of OMT training, with some even sleeping through the night. One participant shared, *"I feel like I sleep more continuously. . . I feel that I sleep better"* (P3). Two of these participants experienced such improvement that they discontinued CPAP use and sleep medication.

"Now I sleep through the night without waking up, and I don't need to take Oxazepam. I have nights where I don't use melatonin either, but rather drink milk with honey in it. I also don't need to sleep in the middle of the day anymore. . . but I don't know. . . it could be related to my sick leave." (P8)

3.5.2. Improvements in Daytime Functioning

Seven out of ten patients reported feeling more energized, less tired, and better able to manage daily activities. One participant noted, *"I am [. . .] much more well-rested. . . I don't pass out in the chair as much"* (P4). Two patients also described improvements in general well-being and more effective rest.

3.5.3. Increased Muscle Control

Five out of ten participants noted increased muscle control and strength during the program.

"I have much better control over my tongue, and I control my muscles much better. And I feel the muscles better. . . I also think that they are much stronger now." (P9)

This improvement encouraged continued adherence to the exercise regime. Three patients also reported general improvement in oral motor function.

"My motivation got better when the facial palsy [long time diagnosis] disappeared." (P8)

3.5.4. Technology Reporting Sleep Improvement

Five of the ten participants reported increased motivation in response to objectively measured improvements captured by different technologies. These included the project-specific electronic sleep diary, medical treatment devices, such as CPAP (used independently of the study), and personally owned consumer technologies (e.g., snoring apps and Garmin watches), as illustrated by patient 5:

"It's clear that I have had an improvement in the end of this [project] and that is a motivation. . . I actually haven't had such low numbers [data from CPAP] since I got that machine." (P5)

3.6. Perceived Effect Barriers

3.6.1. Subjective Lack of Improvements

Patients differentiated between a lack of improvement in daytime functioning and sleep. Eight out of ten experienced some improvements in at least one category. Two of these patients were uncertain whether these changes were related to OMT exercises.

"I'm sleeping well. How much this program has contributed to this change, I don't really know. So, if it stays like this, I'll be very happy, but from what I know about my illness, I think it will probably fluctuate." (P5)

The remaining two participants, both of whom reported good sleep quality at baseline, perceived no changes following OMT. They attributed this to already functioning well and difficulties in recognizing subtle improvements, particularly in relation to their energy levels and daily functioning. Participants who reported fewer or no subjective improvements expressed the need for objective measurements to assess OMT effectiveness, while those with noticeable improvements relied more on personal experiences to sustain motivation.

3.6.2. Negative Side Effects

Six out of ten participants experienced no negative side effects during the 12-week OMT program.

"[When asked about negative side effects] No, no not at all [laughing]." (P4)

Three patients reported mild side effects, such as transient muscle soreness and tooth sensitivity. One patient with a history of headaches reported worsening symptoms after ten weeks, leading to discontinuation of the exercises.

3.6.3. Exercises Perceived as Not Effective

Therapist observations during video consultations revealed that most participants found certain exercises to be less effective, although only two out of ten patients mentioned this in interviews. Patients occasionally skipped or omitted the exercises they felt were ineffective. One patient shared their experience as follows:

"Blowing up a balloon was so easy that I felt it had no effect, or why am I doing this? So that it got a bit forgotten... and that tongue exercise was also so easy to perform that I didn't feel it had any effect either." (P7)

3.7. Distribution of Participants Across Identified Subthemes

To highlight reported responses, Table 2 provides a structured summary of the qualitative findings. The table shows the identified facilitators and barriers to OMT adherence, along with the number of participants who reported each subtheme.

Table 2. Facilitators and barriers to orofacial myofunctional adherence: number of participants per subtheme.

Overarching Theme	Theme	Subtheme	Number of Participants	Participant Count Visualization
Facilitators	Motivation	Control of personal health	10	
		Quality of life	5	
		CPAP avoidance	10	
		General belief in positive effect of exercise	8	
		Ability to establish OMT routine	6	
	Perceived Support	Therapist support	10	
		Social support	8	
		Commitment to the research project	3	
	Perceived Effect	Subjective sleep quality improvement	8	
		Improvement of daytime functioning	7	
		Increased muscle control	5	
		Technology reporting sleep improvement	5	

Table 2. Cont.

Overarching Theme	Theme	Subtheme	Number of Participants	Participant Count Visualization
Barriers	Motivation	Sickness burden	6	
		Comprehensive and fixed protocol	7	
		Exercise performance difficulties	5	
		Uncertainty about OMT effectiveness	3	
	Perceived Support	Previous negative healthcare experience	8	
		Perceived burden of the sleep diary	5	
		Lack of clear instructions	2	
	Perceived effect	Subjective lack of improvements	4	
		Negative side effects	4	
		Exercises perceived as not effective	2	

Bar lengths in the “Participant count visualization” column are proportional to the number of participants reporting each subtheme, with a maximum of 10 participants. The darkest colored bars represent subthemes mentioned by 8 or more patients.

3.8. Exercise Adherence

Logs from the electronic sleep diary, supported by feedback from video consultations and interviews, showed that the majority of participants maintained high adherence to the OMT program.

Of the ten participants who completed the study, eight exceeded the defined 80% adherence threshold. Two participants were considered non-adherent: One participant (P7) discontinued OMT and stopped reporting after week 10 due to worsening of a pre-existing chronic headache, which the patient attributed to OMT. The other participant (P2) explained during video consultations that significant work-related stress made it difficult to consistently perform the exercises three times per day. Figure 2 illustrates the reported adherence to OMT.

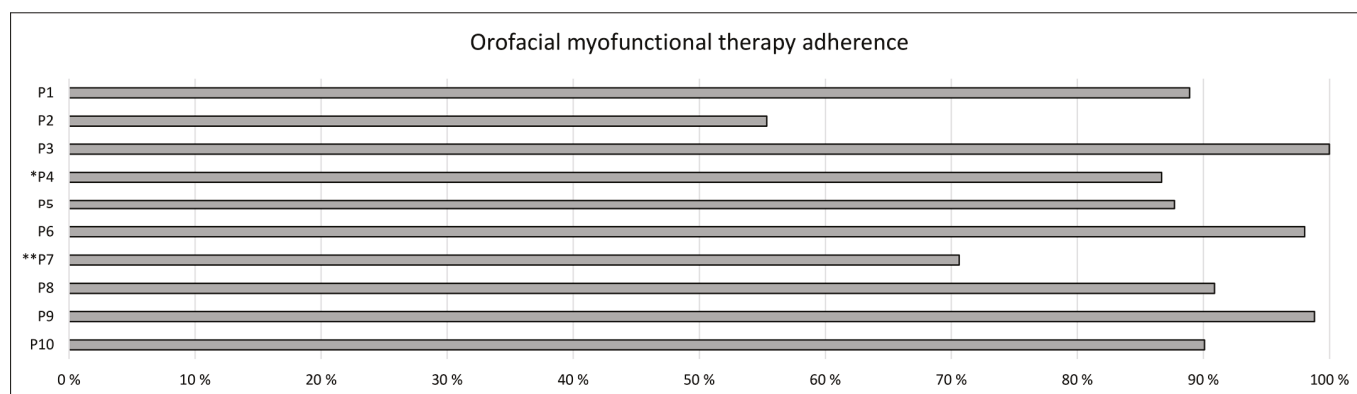


Figure 2. Adherence to orofacial myofunctional therapy (OMT) over 12 weeks. Each bar represents self-reported adherence as recorded in the digital sleep diary. P1–P10: Patients completing the project and interviews. * P4 did not use the sleep diary; adherence was estimated based on information provided during the interviews. ** P7 stopped OMT and sleep diary entries after week 10 due to side effects.

3.9. Sleep Efficiency and Sleep Quality

Seven of the eight exercise-adherent participants completed sleep diary registrations throughout the 12-week intervention period (P4 did not). Additionally, one exercise non-adherent participant (P2) provided complete sleep data. Based on calculated values from the sleep diary, six of the eight participants showed stable or slightly improved SE,

while two exhibited a marked decrease. For SQ, the calculated scores indicated modest improvements in six participants, whereas two patients showed a decline. In total, three patients showed declines in SE, SQ, or both measures. Individual patient data are presented visually in Figure 3.

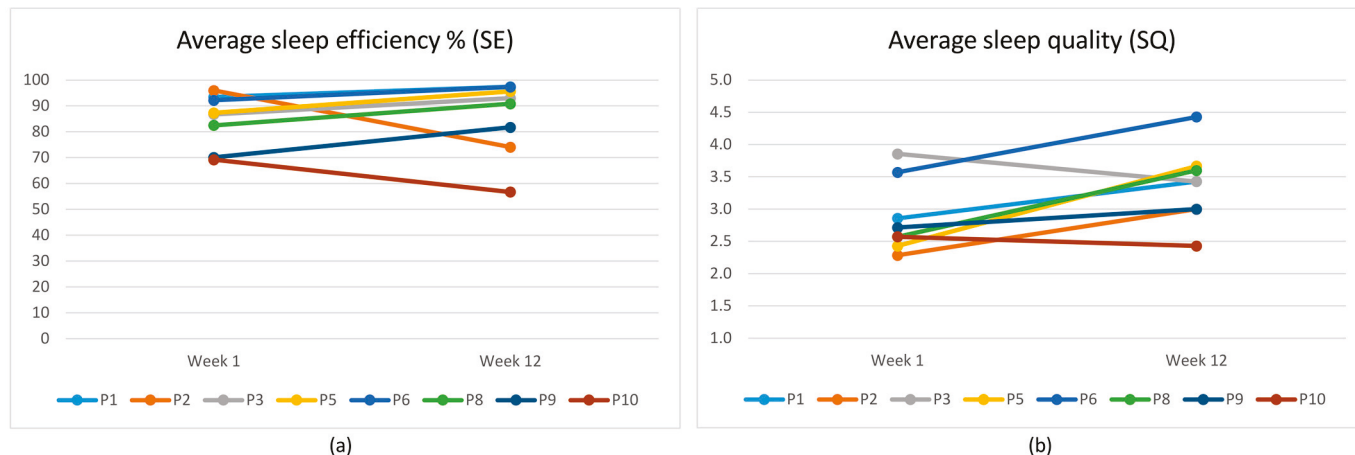


Figure 3. P1–P10: Patients completing the project and interviews (P4 did not use the sleep diary, and P7 stopped using the diary during week 10). Self-reported sleep diary data has been calculated per week, comparing week 1 to week 12 after twelve weeks of orofacial myofunctional therapy. (a) Individual changes in average sleep efficiency (SE). Group average change from week 1 to week 12 for SE = 1.6% (standard deviation (SD) = 13.2%; range from −22.8% to 16.6%); (b) Individual changes in average sleep quality (SQ) (1 = very poor; 5 = very good). Group average change from week 1 to week 12 for SQ = 20.0% (SD = 20.0%; range from −11.1% to 51.0%).

4. Discussion

The aim of the study was to understand patients' experiences and adherence to OMT.

Our main finding was that the overarching theme of facilitators and barriers to OMT adherence can be described according to the three main themes: motivation, perceived support, and perceived effect. Although patients receiving OMT were influenced by many of the same factors, there were marked individual differences in how these were interpreted, prioritized, and acted upon. In the following subsections, we discuss each of these themes in depth, highlighting commonalities, as well as differences in individual perspectives and experiences. The high level of OMT adherence observed among our participants provides a strong foundation, lending credibility and depth to the insights derived from their interview answers.

4.1. Motivation

Although this study did not employ a predefined theoretical framework, through our qualitative analysis, the Self-Determination Theory (SDT) emerged as a framework that can provide valuable insights into adherence to OMT. The SDT emphasizes autonomy, competence, and relatedness as critical drivers of intrinsic motivation [22], which may explain the participants' ability to persist in this demanding intervention. We will illustrate how this framework guided our understanding of patient facilitators and barriers to adherence in this study.

Our participants described both intrinsic and extrinsic motivational factors that contributed to their decision to enroll in the study. Regaining control over their personal health was the clearest internal motivator, alongside a belief in the positive effects of general exercise. This fostered confidence in OMT's potential effectiveness. For many of our patients, OMT represented not just a therapy to alleviate the OSA burden but also an empowering

opportunity to take an active role in their treatment. This aligns with the SDT emphasis of autonomy [22], as they are driven by their belief in the therapy's relevance to their personal health goals in choosing OMT as their preferred treatment option. Aversion to CPAP due to physical discomfort and psychological strain was identified as an external motivator that also contributed to OMT commitment. Many described CPAP avoidance as a powerful motivator to enroll in the study, that outweighed concerns about the effort required to complete the twelve-week structured exercise regimen. While extrinsic motivators like CPAP avoidance can be effective initially, SDT highlights the importance of fostering intrinsic motivation, such as a sense of competence and autonomy, to sustain long-term adherence [22]. Over time, CPAP avoidance may be replaced by a deeper sense of meaningful accomplishment as participants take active control of their OSA management.

Barriers to motivation were also evident, with the rigid and demanding nature of the OMT protocol emerging as the primary challenge. This was especially true for the patients who were managing comorbid illnesses or juggling already pressured daily routines. These findings emphasize the importance of tailoring interventions to accommodate individual health constraints and diverse schedules. In contrast, participants who successfully integrated the OMT program into their daily routines reported greater motivation and positivity and were more likely to continue exercising beyond the study period. The patients also reported that exercise-related insecurities added to the feeling of being overwhelmed during the first weeks, but that this feeling faded over time. According to the SDT, these barriers reflect the importance of fostering autonomy, building competence, and alleviating stress related to exercise performance to enhance adherence [23,24].

4.2. Perceived Support and Trust

We found that the concept of “perceived support” was closely linked to trust relationships, where trust toward the research project and the therapist was crucial. Trust was characterized by patients' belief that the therapist administering the OMT intervention would act benevolently, honor commitments, and refrain from causing harm [25]. This trust allowed patients to entrust their health to the therapist, even without control over the therapist's knowledge or motivation, regarding therapeutic recommendations [25–27]. Participants had to accept vulnerability, both in processing the overwhelming information about OMT and in navigating uncertainties due to limited research on this treatment. Interestingly, some patients viewed their participation in the research project as a positive motivator, driven by the opportunity to contribute to stronger evidence for the OSA patient community.

The therapist worked specifically to create a safe and positive environment, adapting the frequency and duration of telemedicine consultations to the participants' needs. These meetings aimed to monitor OMT progress and address patients' questions or concerns related to their OSA diagnosis. Participants also had email access to the therapist throughout the study. Our findings suggest that the patients' perception of being supported during the intervention strongly influenced both their trust in the therapist and their ability to stay committed to the program. Particularly, the patient–therapist relationship was emphasized as a catalyst for sustained motivation. All patients described their therapist relationship as open and trusting. Skirbekk et al. [27] has described such relationships as characterized by mutual and open mandates of trust, where the therapist is perceived as both professional and relatable by the patient. Open mandates of trust are necessary for interventions and treatments where uncertainties are common. Preferences for therapist support varied; while some valued direct encouragement, others preferred knowing that support was available when needed [28].

While partner support was anticipated to affect adherence, it did not appear critical for this study group, likely due to their strong internal motivation. All partners played passive but positive roles, and any potentially negative attitudes from partners were hypothetical rather than observed. However, participants noted that social stigma from sleeping separately due to OSA symptoms and snoring motivated their pursuit of treatment. This stigma might have influenced their engagement with OMT, although partner perspectives on this issue were not explored. In the context of the SDT, a partner's acceptance could significantly affect the sense of relatedness, which is an essential driver of motivation [28].

The primary barrier to perceived support stemmed from previous negative healthcare experiences, which had significantly undermined trust in the healthcare system and healthcare practitioners. The lack of trust in the relationship between an OMT therapist and a patient presented a risk that the patient would be unlikely to follow the advice given, and as a result would not adhere to treatment [27]. In our study, the necessary elements, described by Skirbekk et al. [27], to create an open trust relationship were observed in both evaluation consultations and video consultations. Many reported disappointments in accessing quality healthcare, and specific healthcare providers, often their GP, had failed to become an ally in their healthcare. Many participants reported long struggles with OSA symptoms and frustration with delays in receiving a diagnosis. Patients with negative experiences might be more reluctant and need more time before being able to give their therapist an open mandate of trust [27]. However, when these patients got to know the therapist, they reported appreciation for the open dialogue the most. One of the most crucial aspects of this dialogue was providing honest responses, whether answers to specific questions were available or not. Taking the time to follow up on unanswered questions and later updating the patient fostered a sense of being heard and valued, ultimately building a greater sense of trust. In the context of the SDT [29], we noticed that some of these patients described an increased need for autonomy to compensate for the lack of trust in medical decisions. This became apparent in some of our interviews when they stated that specific exercises that felt ineffective for them were omitted from their daily routine.

4.3. Perceived Effect

We expected the electronic diary to serve as a supportive motivational tool; however, all participants perceived it as irrelevant, and half even described it as bothersome or a source of stress. Although the diary has previously been used successfully in enhancing awareness and improving sleep quality in patients with insomnia [30], it was not interpreted as helpful for patients in our group, likely due to small nightly variations in sleep quality. However, the two patients with the greatest variation in sleep quality found it more beneficial. According to the SDT, the need for feedback on treatment effects is related to competence building, which helps sustain motivation. Our findings suggest that most participants valued some form of objective measurements, although preferences for specific tools varied.

Most participants reported subjective improvements in sleep quality and daytime functioning. These perceived benefits supported high adherence to OMT. However, a minority reported a lack of noticeable improvement. The group showed modest improvements in both SE and SQ. However, these trends were not consistent across all participants, underscoring variability in individual responses. All three patients who displayed worsening in SE or SQ reported unusual stress or illness, which could account for worsening sleep outcomes despite strong adherence in two of the three. While higher OMT adherence may have facilitated better sleep for this group, there are multiple complex factors that contribute to changes in perceived sleep quality.

Our findings are consistent with those reported in the existing literature [10], suggesting that OMT can positively influence subjective sleep. At the same time, the variability observed within the group highlights the importance of considering individual contexts and responses when evaluating the effectiveness of such interventions. Further exploration may help clarify the mechanisms behind these effects and shed light on factors that influence how different individuals respond to OMT in relation to sleep.

Improved muscle control, which was reported by half of the participants as the first notable change, suggests that OMT can enhance oral motor precision relatively fast, which in turn may motivate continued adherence to the program. A few participants also reported unexpected positive outcomes, such as enhanced facial appearance, which was regarded as a welcome effect, highlighting the potential impact of OMT exercises beyond their primary therapeutic goals.

We observed a greater motivation to continue OMT training after the project among participants who felt that the intervention had increased their competence by confirming the expectation of a positive OMT treatment effect. In contrast, those who remained uncertain about the benefits of OMT showed lower motivation to continue. Instead, they expressed a need to further build competence by continuing to evaluate their sleep in relation to whether or not they perform the exercises in the time ahead.

4.4. Instructions and Follow-Up

The OMT exercises used in the intervention were compiled to activate the stomatognathic muscles related to upper airway function [12]. The fact that all study participants needed some time to master the defined exercises illustrates a significant challenge in OMT, which is related to the fact that oral muscles in everyday life are mostly automatically rather than consciously controlled in functions like talking, eating, swallowing, and breathing. This automaticity means that most individuals have low proprioceptive awareness of their oral muscles, which can make it difficult to master new muscle patterns during therapy [31]. A few of our participants expressed that the video instructions that were available for home training were unclear, even if they had tested all exercises in a physical meeting with the therapist at the start of the intervention. According to the SDT, this kind of uncertainty would be a barrier that affects motivation negatively, as the sense of mastery and control is reduced [22]. Even if only a few patients mentioned this issue in their interviews, the therapist reported that all patients in the study had questions regarding correct muscle technique for several weeks during video consultations. It is unclear if this observation could indicate that more of the patients found the video instructions to be unclear at the start of the intervention, before the exercises were internalized. Another interpretation is that patients may require time to build the sensory awareness, muscle control, and strength necessary to accurately perform the exercises.

Although research on the adverse effects of OMT is limited, potential side effects may arise similarly to other muscle-training interventions [32]. This would, in our opinion, particularly be the case for individuals with pre-existing conditions that affect the head, neck, shoulder, or oropharyngeal muscles, or if harmful compensatory techniques or excessive exertion are used. In our study, one patient who had a history of long-lasting headaches reported exacerbation due to OMT. Even though the patient discontinued OMT, the patient expressed motivation to resume treatment with a modified program to avoid triggering these headaches.

The reported changes in sleep quality and daytime functioning following OMT show the variability in subjective experiences among participants. Most of our patients reported fewer awakenings and more continuous sleep, with some even discontinuing CPAP or medication use, suggesting significant therapeutic benefits for certain individuals. How-

ever, for a few, attributing unchanged symptoms to limited observational skills might reflect an effort to rationalize the experience, particularly among patients with minimal pre-treatment complaints who may struggle to notice changes when trying a new treatment. Interestingly, these patients expressed a stronger need for objective measurements to evaluate OMT effectiveness, pointing to the potential need for tools to better detect such changes. We also reflected on the possibility that this self-attribution could represent an attempt to protect the feelings of the interviewer, who also served as the therapist [33,34], and how the therapeutic relationship may influence patient-reported outcomes, consciously or subconsciously. From an SDT perspective, strong personal experiences can outweigh the need for objective medical assessment by building the necessary perceived competence to sustain motivation.

Our discussion has revolved around the foundational elements of motivation influencing OMT adherence, framed by the SDT [29]. Mutual trust in the patient–therapist relationship emerged as a potentially impactful facilitator to intervention compliance. The SDT, in combination with a practical tool like the “Behavior Change Wheel” (BCW), could support OMT therapists in creating structured personalized interventions by fostering long-term adherence through collaborative, patient-centered care. The BCW is designed as a wheel with three layers that focuses on core sources of behavior in the inner layer, intervention functions to facilitate behavior change in the middle layer, and overarching aspects of health care systems as the outer layer [35]. Although the BCW was not used to design the intervention, we see in hindsight that many of the therapist’s actions aligned with components from the model’s two inner layers: the core (capability, opportunity, and motivation as core drivers of behavior) and the associated intervention functions (such as education, training, enablement, and environmental restructuring). These components appear to capture important aspects of how the therapist’s actions may have supported the high adherence observed in our sample, where eight out of ten participants completed over 80% of the prescribed OMT program. The outer policy layer of the BCW was not relevant in this context, as OMT is not yet an established or system-level treatment for OSA. Figure 4 provides a summary of how the BCW framework may help structure and understand OMT-supportive strategies in clinical practice.

We also find that the concept of shared decision-making (SDM) could potentially be a valuable tool to further enhance intervention effectiveness. SDM empowers patients to actively participate in their treatment planning, aligning therapeutic goals with their personal values, preferences, and life circumstances [36]. In the context of OSA treatment, first-line options like CPAP and MAD require substantial adaptation and consistent use, with significant variation in patient satisfaction and adherence [37]. By incorporating SDM, therapists can work with patients to evaluate these treatment options alongside OMT, fostering realistic expectations and tailored strategies that better address individual needs. This collaborative process ensures that patients are supported not only in selecting a treatment that aligns with their preferences but also in managing the challenges inherent to any intervention, ultimately promoting adherence and long-term health outcomes [38].



Figure 4. Behavior Change Wheel adaptation to illustrate therapist strategies used to support orofacial myofunctional therapy (OMT) adherence in obstructive sleep apnea (OSA) patients. This figure highlights the inner two layers of the model: sources of behavior and intervention functions.

4.5. Clinical Implications

The variability in symptoms and adherence capacity among OSA patients suggests tailored intervention strategies. While our participants met the program's demands, individuals with more severe symptoms or lower motivation may struggle, emphasizing the importance of accessible and supportive therapy designs. Our findings highlight the pivotal role of the therapist, emphasizing the need for personalized, empathetic, and adaptable approaches in clinical practice to better support patients and enhance intervention success. Interviews further revealed the interplay between patients' unique conditions and the therapist's influence in shaping the intervention process. Despite high motivation, several participants required more support than we anticipated. We found no previous research on patient experiences or the therapist's role in OMT interventions. Given the complexity of the physical and behavioral factors affecting adherence to OMT that were revealed in our study, we recommend that future OMT treatment programs consider using the BCW framework to assist in intervention design. The BCW offers a comprehensive approach to identifying key drivers of behavior and guides the selection of effective strategies to support patients, making it well-suited to address the multifaceted challenges of OMT adherence [35]. We view the BCW, the SDT, and SDM as complementary, and when used together, these theories can provide a cohesive and comprehensive approach to designing patient-centered OMT interventions that can improve accessibility, adherence, and outcomes across diverse OSA populations.

4.6. Strengths and Limitations

This study demonstrated high adherence to a rigorous OMT protocol among a highly motivated group, showcasing the feasibility of this intervention. This study also benefited from a rich qualitative analysis, with multiple authors revisiting the data over time to

enhance the robustness of the findings. Moreover, integrating both patient and therapist perspectives offered valuable insights into the dynamics of adherence and intervention processes.

However, the study has notable limitations. Our participant group is small, and compared to the broader OSA population, it exhibited a large proportion of females. Our goal in the recruitment of patients was an even distribution of genders, but we found that fewer males were motivated to participate. Our study group was highly motivated for OMT training, either due to a lack of other treatment options or a desire to avoid CPAP treatment. This high motivation might not be representative of the average OSA patient. Six participants in this study were undergoing active CPAP treatment and reported fewer of the classical OSA symptoms [39,40]. The remaining four participants were CPAP-non-adherent and reported more of the expected symptoms.

The differences between our sample and a typical OSA population likely influenced their experiences and adherence to the intervention. For instance, their high motivation for OMT could stem from a strong desire to maintain or continue performing in high-responsibility jobs, reflecting a greater commitment to positive outcomes. However, despite their motivation, participants faced significant challenges associated with adhering to the demanding OMT protocol, reporting muscle soreness, difficulty maintaining focus, and the time commitment required for the exercises. These barriers, which are consistent with those found in other intensive interventions [41], may be even more pronounced for patients with lower motivation, greater symptom severity, or additional physical and psychological burdens [42]. It is our understanding that this adds to the importance of identifying patient-specific facilitators and barriers for each individual patient.

The dual role of the interviewer as therapist introduced a potential source of bias, possibly leading to an over-reporting of positive experiences due to social desirability. The interpretation of patient replies could also be filtered through the lens of the therapist's understanding of the situation. To mitigate these risks, we used a semi-structured interview guide designed to avoid leading questions, fostered an open and trustful interview environment, and conducted the analysis collaboratively within the author group. During the analyses, we particularly searched for minority views that were negative toward the therapist [43]. While these measures reduced the potential for bias, we acknowledge that not all risks can be fully eliminated. Furthermore, the limited existing research on patient experiences and therapist roles in OMT interventions has restricted our ability to compare findings more broadly.

While comparing objective metrics, such as OSA severity measurements or anatomical features, would have provided valuable insights, it was not the focus of this study. Consequently, pre- and post-treatment polygraphies were not conducted. Although some objective measurements were collected, they primarily served as calibration tools to align assessments between the therapist and researcher in preparation for our upcoming RCT, where evaluating the effects of OMT will be the primary outcome. It remains uncertain whether including more objective measurements in this study would have influenced our findings. However, a comprehensive assessment of these factors was beyond the scope of this study. Future research, particularly the planned trial, will further explore the effects of OMT while incorporating more rigorous objective evaluations to address this gap.

5. Conclusions

This study provides new insight into how patients experience OMT during the treatment of OSA, as well as the facilitators and barriers that influence their adherence during 12 weeks of intervention. The main motivating factors were the desire to take control of personal health and improve quality of life. One of the most important motivating factors

for CPAP users was the possibility of discontinuing CPAP therapy. The most significant barriers were the rigid structure of the 12-week OMT protocol, sickness burden, and previous negative healthcare experiences. Emerging subjective improvements in sleep quality and muscle control, which were supported by the relationship between the patient and the therapist, were especially important for sustained motivation.

Patients exhibited substantial variation in anatomical features, muscle function, personality traits, and life circumstances. While participants identified some common influencing factors to OMT adherence, there was significant variation in individual experiences and needs. We found that theoretical frameworks like the BCW, the SDT, and SDM could be useful tools for understanding the complex interplay of physical, psychological, and social factors in designing OMT interventions. By applying these frameworks, therapists can effectively identify patient-specific facilitators and barriers, address diverse needs, and provide tailored support to help patients succeed with OMT therapy.

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Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

Data Availability Statement: Due to ethical reasons linked to patient privacy, the data presented in this study are only available upon request from the corresponding author.

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Abbreviations

The following abbreviations are used in this manuscript:

OSA	Obstructive sleep apnea
CPAP	Continuous positive airway pressure
MAD	Mandibular advancement devices
OMT	Orofacial myofunctional therapy
SDB	Sleep-disordered breathing
AOMT	Academy of Orofacial Myofunctional Therapy
P1–P10	Patients 1 to 10
SDT	Self-Determination Theory

BCW	Behavior Change Wheel
SDM	Shared decision-making
RCT	Randomized controlled trial

Appendix A

A.1. Interview Guide

[General Introduction] We need to learn more about what you know about sleep apnea and how you have experienced the treatment you have received. We are interested in your experiences. There are no right or wrong answers. This is important to help us offer the best possible treatment in the future.

1. Background
 - a. Gender
 - b. Age
 - c. Family
 - d. Occupation
 - e. Marital status
2. How did you first hear about this project?
3. How did you experience receiving the sleep apnea diagnosis?
 - a. What was it like to start CPAP treatment?
 - b. Are you aware of any health risks related to sleep apnea? Could you elaborate?
 - i. Has this information affected your motivation to participate in this project?
4. Tell us a bit about your sleep three months ago.
 - a. What did you do on your own to improve your sleep before the project started?
 - b. To what extent did your sleep problems affect your daily functioning?
 - c. Have you thought about your breathing patterns?
5. Tell us a bit about your sleep now.
 - a. Has the OMT treatment contributed to any changes in your sleep?
 - i. In what way has the OMT treatment improved or worsened your sleep?
 - b. If you have noticed any changes in daily functioning, could you elaborate?
 - c. Have you thought about your current breathing patterns?
6. Tell us about the exercise routines.
 - a. What was difficult, and what was easy?
 - i. Did you complete all the exercises every time?
 - b. What motivated you the most to keep performing the exercises?
 - i. How has your motivation changed during the training period?
 - c. What are your thoughts on continuing the exercises after the project?
7. Tell us about your experiences with the sleep diary and tracking the exercises.
 - a. Has the sleep and exercise diary contributed to changes in your sleep?
 - i. What was most useful?
 - ii. What were the disadvantages?
 - b. How often did you fill out the sleep diary and record your exercises?
 - i. How much time did it take to log the information?
 - c. Is there anything you feel is missing in the sleep diary?
 - d. Did you keep track of your sleep before the project?

8. [Only if the participant has a partner] Describe your partner's role in the treatment over these 12 weeks.
 - a. Can you describe if and how your partner supported you during this project?
 - i. Could your partner have supported or motivated you more?
 - b. Would you have liked your partner to have received information about the OMT treatment from us before the project began?
 - i. If yes, how would you have preferred this information to be shared?
9. Tell us about your encounters with healthcare personnel.
 - a. How did you experience the first meeting with the OMT therapist?
 - i. Can you think of anything that was missing or should have been explained during that meeting?
 - b. How did you experience the video consultations with the OMT therapist?
 - i. What were the pros and cons of those meetings?
 - c. How would you describe your collaboration with the OMT therapist regarding the treatment? Is there anything that could have been different?
 - d. Do you have any thoughts on how sleep guidance could have been provided before, during, or after the project?
 - e. Have you used any other sources of information about OSA and sleep during the project?
 - f. Let us shift slightly and ask a few questions about general health: Who or what do you trust most when it comes to health information?
 - i. Why?
10. Back to the project: How has it been to participate in the project?
 - a. Is there anything important you would like to add that we have not asked about?

Appendix B

B.1. Sleep Diary

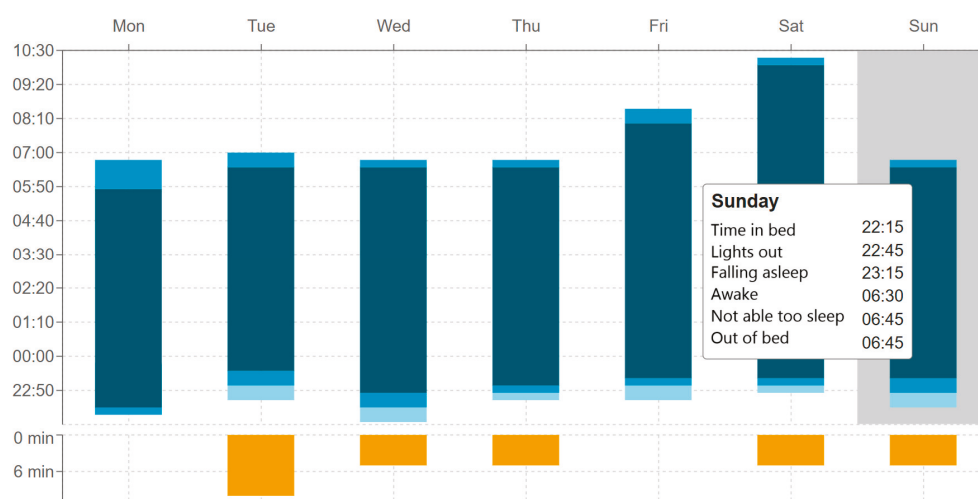


Figure A1. Overview of one week of registrations by a test patient presented in the sleep diary. Each column represents one night. When the cursor is hovered over one column, the text box with sleep details appears. Yellow color represents time awake (minutes); light blue represents time between going to bed and trying to sleep; medium blue represents time from trying to sleep to falling asleep; dark blue represents duration of sleep.

Descriptions	Close						
	Mon	Tue	Wed	Thu	Fri	Sat	Sun
Total sleep efficiency	85.7%	85.4%	90.2%	92.7%	92.1%	94.8%	89.6%
How was your daytime function yesterday?	Good	Neither good nor bad	Good	Good	Neither good nor bad	Good	Good
What was bad about your function?							
Measures taken to improve function			Went to bed early without scrolling in bed			Went to bed early without scrolling in bed	Went to bed early without scrolling in bed
Sleep pills and/or other substances							
Sleep quality	OK	Good	Good	Good	OK	Good	Good

Figure A2. Overview of one week of test patient answers to sleep diary questions.

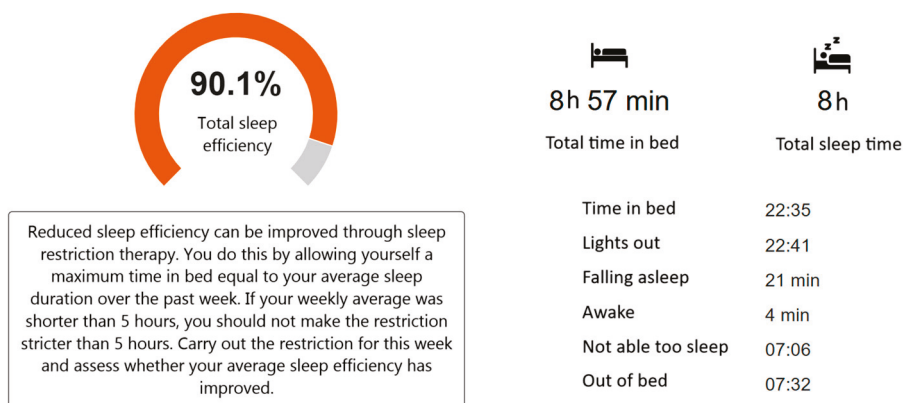


Figure A3. Calculated average of sleep efficiency in %, total time in bed, and total sleep time for one week. The calculation of sleep efficiency requires a minimum of three entries per week.

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Article

Knowledge, Attitudes, and Practices Among Lebanese Pediatric Dentists Regarding Obstructive Sleep Apnea and Myofunctional Therapy in Children

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Abstract: (1) Background/Objectives: Obstructive Sleep Apnea (OSA) in childhood is a significant health concern with potential adverse effects on daytime function, behavior, education, and overall development. Early intervention is crucial to ease these consequences. Myofunctional therapy (MT) has emerged as a treatment modality, particularly in young children, to address OSA. This highlights the importance of early detection and intervention by pediatric dentists and other healthcare providers who frequently interact with the pediatric oral and facial structures. This study aimed to investigate the knowledge, attitudes, and practices of Lebanese pediatric dentists regarding pediatric OSA and MT. (2) Methods: A cross-sectional survey was distributed to 103 Lebanese Pediatric dentists registered with the Lebanese Society of Pediatric Dentistry (LSPD). The survey assessed familiarity with OSA, diagnostic practices, treatment approaches, and utilization of MT. (3) Results: Out of 103 pediatric dentists, 62 responded (60.2%). Most respondents were familiar with OSA (86.8%). However, the number of diagnostic symptoms used varied. MT was not pediatric dentists' primary choice in treating OSA. (4) Conclusions: Lebanese pediatric dentists demonstrate a good understanding of OSA, but there is potential for improvement in diagnostic comprehensiveness and exploration of MT as a treatment option.

Keywords: childhood obstructive sleep apnea; myofunctional therapy; pediatric dentists

1. Introduction

Sleep disorders in children are a growing global concern, with Obstructive Sleep Apnea (OSA) emerging as a prevalent and potentially serious condition [1–3]. OSA is characterized by recurring partial or complete upper airway obstruction during sleep, leading to breathing disruptions, oxygen desaturation, and sleep fragmentation [2,3]. Untreated sleep disorders can have detrimental consequences on a child's physical, cognitive, and behavioral development, including growth impairment, cardiovascular problems, learning difficulties, and behavioral issues [1,3].

Pediatric dentists' role is critical in early detection and management of pediatric OSA. They are usually the first to check on the oral sphere after the pediatric physician [3–5]. As primary oral healthcare providers during a child's formative years, they are uniquely positioned to recognize subtle signs and symptoms of OSA that may be overlooked by

parents or other physicians. Lebanese dentists receive training on respiratory disorders and their diagnosis and treatment in children during their fourth year of undergraduate studies. Pediatric dentistry specialists receive even more in-depth training in this specific field, further enhancing their ability to recognize OSA. This expertise allows for crucial early identification, leading to timely intervention and minimizing the long-term effects of untreated OSA [3,4].

However, accurately diagnosing OSA in children presents unique challenges due to subtle and varied symptom presentations. Unlike adults, excessive daytime sleepiness may not be a prominent symptom in children [3,6]. Instead, they might present with behavioral issues or learning difficulties [1,3].

Therefore, when screening for pediatric OSA, pediatric dentists should consider a comprehensive list of potential signs and symptoms, including the nocturnal signs such as habitual snoring (often loud and disruptive), witnessed pauses in breathing, labored or noisy breathing, restless sleep, unusual sleep positions, frequent awakenings, night sweats, and bedwetting. Additionally, daytime sleepiness (less common in children), behavioral problems (hyperactivity, inattentiveness, aggression), learning difficulties, morning headaches, and mouth breathing are also noticeable [3,6,7].

Moreover, a definitive diagnosis of OSA in children necessitates a thorough evaluation process. First, a detailed history-taking by engaging parents as active informants is essential, as they are primary observers of their child's sleep behaviors [3,6]. Additionally, a comprehensive physical examination encompassing oral cavity inspection, tonsil size assessment using a standardized grading scale, observation for craniofacial anomalies (e.g., retrognathia, micrognathia), tongue size and nasal patency evaluation are critical [7,8]. On the other hand, a polysomnography (PSG) which is the gold standard for OSA diagnosis should be performed if a clinical diagnosis was not conclusive. Nevertheless, access can be limited due to its performance in a hospital setting that requires patient stay overnight [3,6]. Alternative methods like home sleep apnea testing or nocturnal oximetry may be considered [3].

Myofunctional Therapy (MT) has emerged since the 1900s as a promising non-invasive treatment for addressing underlying factors contributing to pediatric OSA [9,10]. Focusing on muscle function to correct malocclusion, it was first described in 1918 by Alfred Rodgers. It was not until 1980 that prefabricated functional appliances were introduced [10]. The effect of oropharyngeal exercises has been demonstrated in improving orofacial muscle function, promoting proper tongue posture and swallowing patterns, and facilitating nasal breathing, ultimately enhancing airway patency during sleep [4,9–13]. Two types of MT are being used: the active therapy relies on specific exercises (tongue push-ups, cheek puffs and lip seal exercises) groups to strengthen the muscle groups whereas the passive approach utilizes specialized appliances that stimulate tongue activity and promote proper posture during sleep [14].

Although MT is not the first line treatment in patients with OSA, considering applying it could lead to tangible clinical benefits [15,16]. Whether the treatment proves successful or not, no possible harm is associated with the implementation of MT. Besides its numerous positive effects, this therapy is still not widely used, especially in Lebanon.

Hence, this study investigates the knowledge, attitudes, and practices of Lebanese Pediatric dentists regarding pediatric OSA and the use of MT. A survey was conducted to assess their familiarity with the condition, diagnostic approaches, and treatment preferences, particularly focusing on the role of MT in their clinical practice.

2. Materials and Methods

This cross-sectional survey assessed Lebanese pediatric dentists' experiences and perspectives on pediatric OSA and MT. The research team consisted of an associate professor specialized in pediatric dentistry, a dentistry student, and two medical students. This diversity of backgrounds and perspectives gave different dimensions to the design, data collection, and analysis processes of the study. The survey was tailored based on the input of a professor and specialist in pediatric dentistry. A pilot survey was distributed to two pediatric dentistry educators and one public health specialist and modified based on their feedback to ensure clarity and that questions were interpreted as intended.

The study included 103 dental faculty and practitioners specializing in pediatric dentistry registered with the Lebanese Society of Pediatric Dentistry (LSPD). Contact information was obtained from the LSPD membership directory. The survey was electronically distributed via Google Forms (Google LLC; Mountain View, CA, USA) between March and April 2024. The 12-item online survey, provided in Appendix A, addressed: demographics, familiarity with OSA, diagnostic practices, treatment approaches, MT use, multidisciplinary collaborations, and challenges in diagnosis and treatment. The questions were written according to the American Academy of Pediatric Dentistry clinical practice guidelines [16].

Data were analyzed using IBM SPSS Statistics for Windows, version 29.0 (IBM Corp.; Armonk, NY, USA). Descriptive statistics summarized the data: frequencies and percentages for categorical variables (specialty, familiarity with OSA, treatment approaches), and means, medians, standard deviations, and ranges for continuous variables (years of experience, number of OSA diagnoses per year). Additionally, Pearson correlation coefficients (r) were used to assess relationships between numerical variables. Meaningful correlations, which will be presented in the results, were defined as: $|r| > 0.3$ (moderate or stronger correlation) and $p < 0.05$. A correlation matrix was generated to visualize significant relationships. Histograms, bar charts, and scatter plots visually presented the data.

3. Results

3.1. Sample Characteristics

Out of 103 contacted dentists, 62 responded to the survey. Table 1 summarizes practice characteristics of participating Pediatric dentists.

Table 1. Practice Characteristics of Participating Dentists ($n = 62$).

Variable	Mean	Median	Standard Deviation	Range
Average Number of OSA Diagnoses per Year	22.58	10	23.24	10–90
Percentage Treated with Myofunctional Therapy (Among Those Using Therapy)	32.73	20	37.35	0–100%

As shown in Table 2, the majority of respondents were Pediatric dentists (95.2%) familiar with OSA in children (86.8%). Most dentists have not considered Myofunctional Therapy as a standalone treatment (77.4%). However, among those who have used Myofunctional therapy, 55% reported patient improvement.

Table 2. Dentists' Use and Perceptions of Myofunctional Therapy in OSA Treatment.

Variable	Category	Count	Percentage
Specialty	Pediatric dentistry	59	95.2%
	General Dentist	3	4.8%

Table 2. Cont.

Variable	Category	Count	Percentage
Considered Myofunctional Therapy as Standalone Treatment	Yes	14	22.6%
	No	48	77.4%
Patient Symptoms Improved After Myofunctional Therapy (Among Those Using)	Yes	11	55%
	No	4	20%
	Not applicable (Never prescribed Myofunctional Therapy)	5	25%

3.2. Familiarity and Diagnostic Practices

The number of diagnostic symptoms for diagnosis used varied. A positive correlation was observed between familiarity with OSA and the number of diagnostic symptoms considered ($r = 0.330$, $p = 0.034$). Dentists not familiar with OSA detected on average 3.6 symptoms among 9 listed in the survey. On the other hand, those familiar with OSA detected on average 6 symptoms.

Figure 1 shows that the highest percentage of familiarity with OSA was observed in the least experienced group (less than 5 years) at 29.00%, while the lowest was in the 10–15 years of experience group at 12.90%. The percentage of dentists not familiar with OSA ranged from 3.20% to 8.10% across all experience levels.

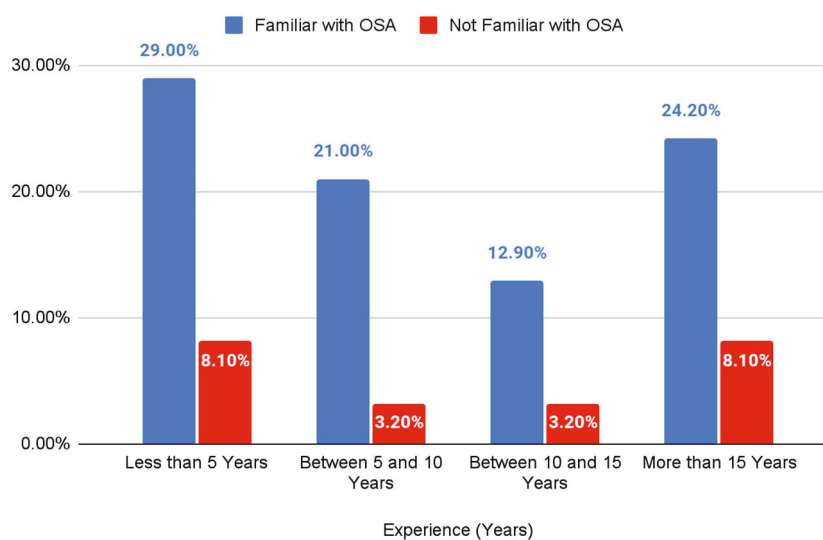


Figure 1. Comparison of Familiarity with Pediatric Obstructive Sleep Apnea (OSA) Based on Years of Professional Experience.

3.3. Treatment Approaches and Myofunctional Therapy Use

Figure 2 demonstrated that across all experience levels, the majority of dentists choose to abstain and refer, with this approach being most prevalent among those with less than 5 years of experience (84.20%) and least common among those with more than 15 years of experience (62.50%). The use of myofunctional therapy and orthodontic treatment varies across experience levels, with more experienced dentists generally showing a higher likelihood of using these approaches compared to their less experienced counterparts.

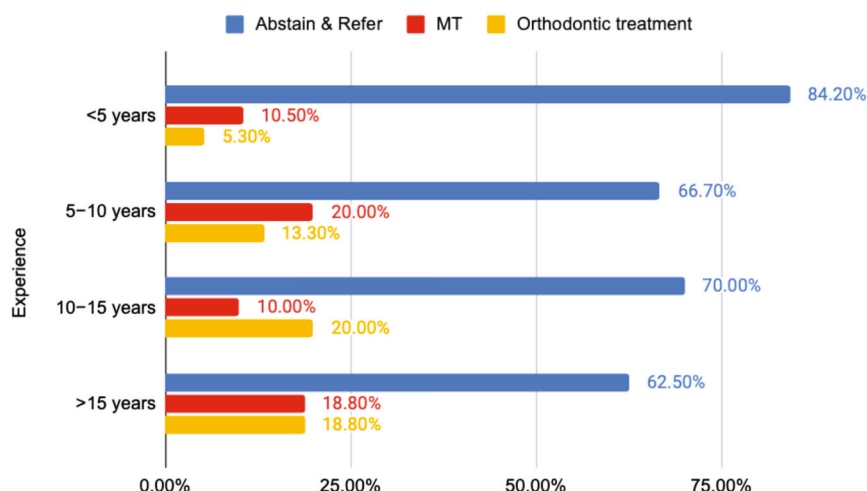


Figure 2. Choice of Management Approaches for Pediatric Obstructive Sleep Apnea (OSA) by Dentist Experience Level.

3.4. Collaboration and Challenges

The survey results, presented in Table 3, revealed that ENT physicians were the most common referral specialists (80.9%), followed by orthodontists (50.0%). Pediatric physicians were also referred to by a substantial proportion of dentists (23.5%). A smaller number of referrals were made to pediatric dentists with specific myofunctional therapy training (8.0%), speech therapists (4.8%), sleep medicine specialists (1.6%), and physiotherapists (3.2%). It is important to note that some dentists listed multiple specialists, indicating a collaborative approach to managing pediatric OSA.

Table 3. Referral Patterns of Dentists for Pediatric Obstructive Sleep Apnea (OSA) Treatment.

Speciality	Frequency (n)	Percentage (%)
ENT Physician	51	82.3
Orthodontist	32	51.6
Pediatric Physician	15	24.2
Pediatric dentist with Myofunctional Therapy experience	5	8.0
Speech Therapist	3	4.8
Sleep Medicine	1	1.6
Physiotherapist	2	3.2

4. Discussion

The scope of dental practice has significantly broadened over the years. Dentists, especially Pediatric dentists, play a crucial role in detecting underlying medical conditions in patients seeking dental care [2–4]. Specifically, OSA in children has been associated with a high risk of morbidity and mortality. Studies have demonstrated a prevalence of 1 to 4%, emphasizing the need for awareness among pediatric dentists [5,6]. Sleep disorders that go untreated can significantly impact a child's overall development, including stunted physical growth, potential heart problems, challenges with learning, and behavioral difficulties [1,3]. Specifically, a study on a Lebanese population investigated the prevalence of sleep-disordered breathing (SDB) among Lebanese children aged 3–12 years and its effects on their growth parameters. The results showed that 16.11% of children were at high risk of SDB, and there was a significant correlation between SDB and impaired growth parameters [17]. Given these serious consequences, early diagnosis of sleep disorders in children is crucial.

Besides performing a polysomnography test, which is the gold standard for diagnosing OSA, pediatric dentists should be able to detect the various clinical symptoms that can help lead to a clinical diagnosis. The patient can present with enlarged tonsil size, a high Mallampati score, micrognathia, retrognathia, high arch palate, obesity, and snoring [3,18].

Results show an experienced cohort of dentists averaging between 10 and 15 years of practice. As shown in Table 2, the majority of respondents were Pediatric dentists (95.2%) familiar with OSA in children (86.8%). Most dentists have not considered MT as a standalone treatment (77.4%), likely due to insufficient academic training on these kinds of therapies, positioning MT as a non-traditional approach with the pediatric dentistry curriculum. Hence, a pronounced heterogeneity can be seen among dentists in their treating approach (Figure 2). The survey answers showed that the majority of dentists did not treat their OSA patients and preferred to refer them to other specialists. However, among those who have used MT, 55% reported patient improvement. This finding stands as a strong counter-evidence, highlighting the efficacy of MT as a standalone therapy for OSA. This observation further aligns with systematic reviews and meta-analysis that have demonstrated a decrease in the apnea-hypopnea index (AHI) in children who were treated with MT [9,17]. Therefore, the following analysis emphasizes the importance of strengthening dentists' knowledge and expertise in proven non-invasive therapeutic options such as MT for OSA treatment.

The significant positive correlation between familiarity with OSA and the number of diagnostic symptoms used indicates that dentists who are less knowledgeable about the condition are less likely to consider a broader range of signs and symptoms [17]. As a matter of fact, dentists unfamiliar with OSA detected on average 3.6 symptoms. On the other hand, those familiar with OSA detected on average 6 symptoms. The latter suggests that dentists unfamiliar with OSA's symptoms are more likely to miss diagnoses and contribute to an increase in the morbidity in Lebanese children leading to growth impairment and learning challenges.

Although not statistically significant at the standard level, the possible association between higher Pediatric dentists' experience and increased consideration of myofunctional therapy is interesting. It suggests that dentists who are more experienced might be more open to exploring various treatment options, including myofunctional therapy as shown in Figure 2.

The level of OSA knowledge was associated with professionals' treatment confidence and their willingness to refer patients [9]. The results showed a wide clinical referral behavior suggesting the need for a multidisciplinary approach to treat OSA. More than 80% of responders referred their patients to an ENT physician for surgery. Others suggested referring to an orthodontist (51.6%), pediatric physicians (23.5%), pediatric dentists with specific myofunctional therapy training (8.0%), speech therapists (4.8%), sleep medicine specialists (1.6%), and physiotherapists (3.2%) [1]. There is a discrepancy in referral preferences between ENT and sleep medicine. However, the multidisciplinary approach in treating OSA encourages the higher integration of sleep medicine specialists to confirm diagnoses through polysomnography and building together the comprehensive management plan.

Several studies conducted in different countries have assessed the level of OSA knowledge among different healthcare providers. For example, an Indian study showed a moderate knowledge level of OSA among their pediatric dentists with a need for more training regarding the treatment options [19]. Another study conducted in China and targeting orthodontics professionals emphasize on the same results that professionals should gain more knowledge on the different modalities of treatment [20]. A study of dentists in Jeddah, Saudi Arabia, revealed a limited understanding and negative perception of

OSA [21]. However, the literature has shown a positive correlation between knowledge levels and attitude, indicating that dental practitioners with higher knowledge scores tended to have a more favorable outlook on their ability to better diagnose, refer and treat OSA.

Furthermore, pediatric dentists with higher experience decided to treat their patients rather than referring. These results suggest the importance of specific training not only in proper sleep disorder diagnosis and treatment approaches but also in referral options.

Most dental experts acknowledged the necessity of identifying patients with OSA and expanding their knowledge of associated issues. Hence, there is a need for enhanced education and training specifically focused on pediatric OSA and myofunctional therapy, irrespective of professional experience [9,10,17]. These formations should be further included in the curricula of dental faculties because the majority of pediatric dentists are being trained on how to use myofunctional therapy during conferences and private courses or workshops.

This study has limitations inherent to its cross-sectional design and reliance on self-reported data. The small sample size and survey distribution within a single country limit the generalizability of the findings. Further research with larger and more diverse samples is needed to confirm and expand upon these results.

5. Conclusions

The results offer valuable insights into the knowledge, attitudes, and practices of Lebanese pediatric dentists regarding pediatric OSA. Our findings underscore the need for heightened awareness, a more comprehensive consideration of diagnostic symptoms, and further exploration of MT as a treatment option. Continued research is vital to investigate the long-term effectiveness of MT in Lebanese children, identify ideal patient profiles, and gain a deeper understanding of the perspectives of both parents and pediatric dentists concerning this approach.

This study encourages Lebanese pediatric dentists to embrace MT as a potential treatment modality for pediatric OSA and to collaborate actively with other healthcare professionals to provide the best possible care for children affected by this condition. Although it has its limitations and needs specific training, MT has its indications and should be a complementary approach in pediatric dentistry.

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Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

Data Availability Statement: The datasets generated and analyzed during the current study are available from the corresponding author upon reasonable request.

Conflicts of Interest: The authors declare no conflicts of interest.

Abbreviations

The following abbreviations are used in this manuscript:

MT Myofunctional therapy
OSA Obstructive sleep apnea

Appendix A

1. What is your specialty?
 - General Dentist
 - Pediatric dentistry
2. Specify your experience:
 - Less than 5 years
 - Between 5 and 10 years
 - Between 10 and 15 years
 - More than 15 years
3. Are you familiar with Obstructive Sleep Apnea (OSA) in children?
 - Yes
 - No
4. Based on which symptoms do you diagnose OSA? (Select all that apply)
 - Snoring
 - Hyperactivity
 - Mouth breathing
 - Sleep disruption
 - Daytime sleepiness and fatigue
 - Nocturnal enuresis (Bed wetting)
 - Nocturnal sweating
 - Agitated sleep
 - Poor academic performance
5. Based on which signs do you treat or refer? (Select all that apply)
 - Size of the tongue compared to airway opening
 - Tonsillar hypertrophy
 - Adenoid facies
 - Micrognathia
 - Retrognathia
 - High-arched palate
 - Obesity
6. What is the average number of patients you diagnose with OSA per year?
 - 0–20
 - 21–40
 - 41–60
 - 61–80
 - More than 80
7. What type of therapy are you more likely to prescribe to your patients? (Select all that apply)
 - Myofunctional therapy (strengthening exercises + appliance)
 - Mandibular advancement (Herbst, Twin Block, Bionator, Frankel)
 - Rapid Maxillary Expansion
 - Weight loss (diet, etc.)

- Abstain treatment and refer to a specialist
- 8. To which specialist do you refer pediatric OSA patients? (Select all that apply)
 - ENT physician
 - Pediatric physician
 - Orthodontist
 - Physiotherapist
 - Other: _____
- 9. Did you ever consider using myofunctional therapy alone as a treatment?
 - Yes
 - No
- 10. What is the percentage of sleep disorders patients that you treated with myofunctional therapy?
- 11. Did the patients' symptoms improve after the use of myofunctional therapy?
 - Yes
 - No
 - Not applicable, I never prescribe myofunctional therapy
- 12. In your opinion, why did myofunctional therapy not work in certain patients? Or why may it not work? (Select all that apply)
 - Treatment interruption
 - Complexity of the condition
 - Ineffective method
 - Other treatments are better and more effective

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Article

Multidisciplinary Approaches to Tongue Thrust Management in Australia: An Exploratory Study

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Abstract: Background/Objectives: Tongue thrust (TT) occurs when abnormal tongue movements cause anterior tongue placement with pressure and contact against or between the teeth, potentially affecting the oral phase of swallowing, impacting eating, breathing and speaking. There is limited literature on the diagnostic and treatment approaches for TT, as well as involvement of health practitioners in its management. This study aims to examine the current knowledge and practices related to TT diagnosis and treatment among health professionals in Australia. **Methods:** A two-phase explanatory sequential mixed methods approach was adopted, comprising an online survey that collected participants' demographic information and details on assessment, diagnosis, management, referral practices, and relevant experience and training. Phase one involved 47 health professionals from various disciplines in Australia who completed an online survey in its entirety. Phase two included in-depth interviews with seven speech-language pathologists (SLPs) to gain further insights into their experiences in managing TT. Survey data were analysed descriptively, and interview data was analysed thematically. **Results:** Most participants diagnosed TT using clinical assessments, such as general observation and oral motor examinations. Treatment approaches commonly included orofacial myofunctional therapy and the use of myofunctional devices. Interviews with SLPs identified four key themes: tongue thrust as a symptom rather than a diagnosis, facilitators to effective treatment, multidisciplinary approaches to management, and training and education gaps in clinical practice. **Conclusions:** This study provides valuable insights into how TT is identified, assessed, diagnosed, and managed by health professionals in Australia. It highlights the perspectives of SLPs on treatment approaches, as well as their views on the availability and adequacy of training and education in this field. The findings suggest the need for a broader understanding of TT management, emphasising the importance of multidisciplinary collaboration and professional development. These insights are globally relevant, as they stress the shared challenges and the value of international collaboration in improving TT diagnosis and treatment practices.

Keywords: tongue thrust; swallow; Australia; tongue; management

1. Introduction

Tongue thrust (TT) is defined as an atypical movement pattern that involves the individual placing the tongue against or between their teeth during swallowing and speech production [1]. TT can be categorised as one of the conditions that fall under the umbrella term of orofacial myofunctional disorders and is also referred to as a reversed swallow, anterior swallow, infantile swallowing pattern, deviated swallow, deviated deglutition, or

abnormal swallow in the oral phase; it has been described as a type of swallowing pattern that infants use in the very early developmental stages of life [2]. Many of these terms are drawn from legacy descriptions and do not reflect current physiological understanding and contemporary perspectives. If the tongue function and infantile swallow pattern does not develop into a more mature swallow over time, it can turn into a persistent habit [2,3]. The tongue plays a vital role in several bodily functions, such as safe breathing, swallowing, chewing, and speech. Adults report that functional improvements in oral behaviours may contribute to perceived quality of life changes and improved quality of life [2–6]. Therefore, adverse effects associated with TT include dental deformities from the tongue consistently placing pressure on the teeth, breathing difficulties, anterior open bite and articulation inaccuracies.

The prevalence of TT varies by age and gender [7]. A study from India reported a prevalence rate of 4.9% in children aged six to ten years with TT, and this rate typically decreases between 10 and 12 years of age [7]. TT is most common in children aged eight to ten years old and is also more common in females compared to males [8]. TT can persist in later childhood, adolescence and adulthood; however, prevalence rates are lacking for older patients [9]. Overall, there is a significant lack in the literature surrounding the prevalence and developmental nature of TT, particularly in Australia.

Research suggests that there are multiple contributing factors to the aetiology of TT. Airway obstruction and habitual mouth breathing, enlarged tonsils, anterior malocclusion, marked lip movement during swallowing, and digit and dummy sucking have all been found to be associated with TT [10–12]. Referral to allergists and ENT specialists is recommended for patients with mouth breathing to assess for enlarged adenoids and other nasal or pharyngeal obstructions that may contribute to tongue thrusting. It remains unclear whether TT affects speech or if a speech or articulation impairment increases the likelihood of TT. However, individuals with TT often experience speech issues to some extent [11].

A multidisciplinary team is reported to be advantageous with assessment and differential diagnosis of TT due to the complex nature of diagnosis and contributing factors [13,14]. The practitioners typically involved in the diagnosis and treatment of TT or interdental tongue placement during the oral phase of swallowing includes dentists, orthodontists, SLPs, ear nose and throat specialists (ENT), orofacial myofunctional therapists, paediatricians and general practitioners [13–16]. Several methods for diagnosing and assessing the severity of TT have been reported; however, the literature is ambiguous around which methods are most efficacious. Ultrasound measures and devices or appliances, such as intraoral sensory instruments, have been reported as effective diagnostic methods [7,9,17–22]. Rating scales including the Expanded Orofacial Myofunctional Evaluation with Scores (OMES-E) Scale [23] and the Tongue Thrust Rating Scale (TTRS) [24] have also been highlighted as useful diagnostic tools for identifying the presence and severity of TT.

Whilst TT itself may not directly cause significant health complications, its persistence can contribute to functional issues; therefore, timely identification and intervention may help mitigate these outcomes, particularly when TT is part of a broader orofacial myofunctional disorder. However, it is important to note that successful treatment outcomes are also achievable in older children, adolescents, and adults. Research and clinical experience suggest that while early intervention may support developmental alignment and habit correction, therapy initiated at later stages can still be effective, especially when tailored to individual needs and motivation levels. Different treatment methods to remediate and/or minimise TT and related orofacial myofunctional disorders include orofacial myofunctional therapy (OMT), use of myofunctional devices [20] and orthodontic treatment including tongue cribs [20,25]. The aim of these treatment approaches is to improve oral functions and remediate the TT by correction or repositioning tongue placement during swallowing

and speech production [26]. The use of appliances like tongue cribs in TT treatment remains controversial. The IAOM opposes such devices, noting they may disrupt oral rest posture and freeway space, potentially worsening TT [27]. Additionally, many clinicians question the effectiveness of removable myofunctional devices. Foundational research by Proffit suggests tongue pressure during function is insufficient to move teeth, highlighting the greater impact of anterior tongue rest posture on dentoalveolar changes [28]. It is important to distinguish between tongue thrust during function and anterior interdental tongue rest posture. Anterior interdental tongue rest posture is more strongly implicated in dentoalveolar changes due to prolonged, low-force pressure. While tongue thrust is often visible and more readily observed, it is the resting posture that can have more persistent effects on craniofacial development and malocclusion [29]. Additionally, aesthetic concerns, such as visible tongue positioning during speech or rest, may also motivate individuals or parents to seek treatment. Despite increasing clinical interest, there is still limited knowledge about other interventions used by health professionals managing TT in practice.

Health professionals involved in the assessment, differential diagnosis, and treatment of TT require a comprehensive understanding of TT to provide effective patient care [2]. For instance, if TT is not recognised as a contributing factor—or if an underlying orofacial myofunctional disorder is missed in a client with an articulation disorder—treatment outcomes may be suboptimal, as the root cause may not be adequately addressed [30]. There is a notable overlap in the scope of practice among orthodontists, SLPs, and ENTs in the identification and management of TT [15]. Additionally, a lack of consensus exists regarding the processes and methods used in TT management, highlighting a significant gap in the knowledge, education, and practices of health professionals managing TT in Australia.

Aim

The aim of this study was to explore current approaches to TT assessment, diagnosis and treatment, experience and training by health professionals, particularly in SLPs managing TT in Australia.

Objectives

To investigate the current practices of Australian health professionals with the identification, assessment, diagnosis and management of TT.

To explore Australian health professionals' perceptions and experiences of training and education in TT management.

2. Materials and Methods

2.1. Research Design

This study incorporated a two-phase explanatory sequential mixed methods approach [31]. Phase one was an online survey, which included quantitative and qualitative components. The second qualitative phase, informed by phase one, involved online semi-structured interviews [32].

2.2. Participants

Phase One—Online Survey: Health practitioners based in Australia involved in the assessment, diagnosis and treatment of TT were eligible to participate in the online survey. This included SLPs, orthodontists, dentists and orofacial myofunctional therapists. A total of 58 participants commenced the online survey, but 11 health professionals did not complete the survey in its entirety, resulting in a sample of 47 participants who completed the survey in full. Results will be reported for the maximum sample sizes who completed each question in the survey

Phase Two—Clinician Interviews: A total of 17 SLPs who completed the survey expressed interest in participating in an online interview and were then invited to participate in an online interview. Seven responded to the invitation and participated in online interviews. Though our goal was to recruit 12 to 15 participants, consistent with recommendations for achieving thematic saturation in qualitative research [32], we were only able to secure seven interviews.

2.3. Materials

Phase One—Online Survey: Survey questions were developed to gather demographic information on participants and details on assessment, diagnosis, management, referral, experience and training in TT. Survey questions were entered into the Qualtrics online software to create and distribute the online surveys to participants.

Phase Two—Clinician Interviews: Interview questions were generated based on survey responses, to expand on survey answers and provide more in-depth explanations of SLPs experiences with TT. Data was coded using NVivo 15 software prior to analysis.

2.4. Procedures

Phase One—Online Survey: A recruitment flyer was prepared which included a link to an online survey in Qualtrics. The flyer was distributed to special interest groups on Facebook, which were identified as significant for targeting potential participants. Survey links were also disseminated via professional organisations including the Australian Association of Orofacial Myology, Australian Dental Association, Australian Society of Orthodontics and Speech Pathology Australia. Participants were advised to click ‘next’ if they consented to proceed to participate in the survey. This concluded the section of research that gathered data allowing the comparison of assessment and treatment methods between the different health professionals. At conclusion of the online survey, only SLPs were invited to provide contact details if they were interested in participating in a follow-up individual online interview. The online survey was open from February to April 2024.

Phase Two—Clinician interviews: Seventeen (17) SLPs provided contact details to participate in a follow-up interview. Since the research team consisted of SLPs, this discipline specific knowledge and experience was used by the SLP interviewers to gather more in-depth information regarding SLP management of TT. Consenting interview participants were emailed a participant information sheet to take part in an online interview and return an electronic consent form. They were then contacted by a member of the research team by email or phone to schedule a suitable interview date and time. No prior relationship was established between the interviewers and interviewees. Online interviews were conducted by two of the study supervisors who are highly experienced female SLPs with extensive knowledge and experience in TT assessment and management. The nature of the semi-structured interview guide was open-ended to reduce interviewer bias. These were pilot tested with the researchers prior to the interviews commencing. All interviews were video recorded with a backup audio recording on an iPhone and de-identified field notes were taken. No interviews were conducted more than once. The transcripts were then checked for accuracy and de-identified by the project team. Interview transcripts were emailed to each participant for cross-checking, and they were given the opportunity to make amendments, to which two of the seven participants made brief changes. Interview transcripts were then coded by four researchers using NVivo 15 software.

2.5. Data Analysis

Online survey responses were analysed to describe demographic information and data on knowledge and approaches to TT management. NVivo 15 was used to code the qualitative data from the clinician interviews, which highlighted the most frequently discussed

topics across the interviews. Due to the nature of the semi-structured interviews, data was then analysed using Braun and Clarke's six phases of reflexive thematic analysis, i.e., familiarising the data, generation of initial codes, searching for themes, review of themes, defining and naming themes and producing the report [33]. The research team met on several occasions to search, review, define and rename themes, which was accomplished by placing prevalent codes into tables, looking for similarities, differences and most significant areas among these, and defining/naming. Once themes were identified and defined, themes were organised with indicative quotes from participant transcripts.

2.6. Ethical Considerations

This study was conducted in accordance with the Declaration of Helsinki and approved by the Curtin University Human Research Ethics Committee prior to commencing the study (HRE2023-0225 on the 9 May 2023). All survey data was de-identified prior to analysis. Interview participants were identifiable and were provided with a participant number. All electronic documents and data with participant details were stored electronically in a password-protected folder on a secure network.

3. Results

3.1. Phase One—Online Survey

3.1.1. Participant Demographics

Table 1 presents the university qualifications and additional training of the 47 participants in this study. The majority of participants were located Western Australia ($n = 22$) followed by New South Wales ($n = 11$; 20%), and Queensland and Victoria, each contributing seven participants (13%).

Table 1. University qualifications and other training of participants ($n = 47$).

Qualifications	Frequency
Speech Pathology	
• Bachelor of Speech Pathology/Speech and Hearing/Human Communication Science/with or without Honours	42
• Masters in Speech Pathology	
Clinical Doctorate in Speech Pathology	1
Doctor of Philosophy (PhD) in Speech-Language Pathology	3
Master of Audiology	1
Dental Surgery	
• Bachelor of Dental Surgery	8
• Master of Dental Surgery	
Bachelor of Applied Science (Oral Health)	3
Postgraduate Orthodontics	1
Bachelor of Science (Psychology)	1

Table 1. *Cont.*

Qualifications	Frequency
Bachelor of Health Science	1
Bachelor of Biomedical Science	1
Graduate Certificate in Education	1
Other Training	
Orofacial Myofunctional Therapy (OMT) Training	2
Diploma in Breastfeeding Management	1
Associate of Dental Therapy	1

Note: Some participants had obtained more than one qualification.

3.1.2. Assessment and Diagnosis of Tongue Thrust

Clinical assessments were employed by 37 survey participants for a total of 63 responses to clinical assessments to evaluate and diagnose TT. The most frequently used clinical assessments were swallow assessments and observations, oral motor evaluations, speech observations and analyses, and observations of malocclusion or facial structure (Figure 1).

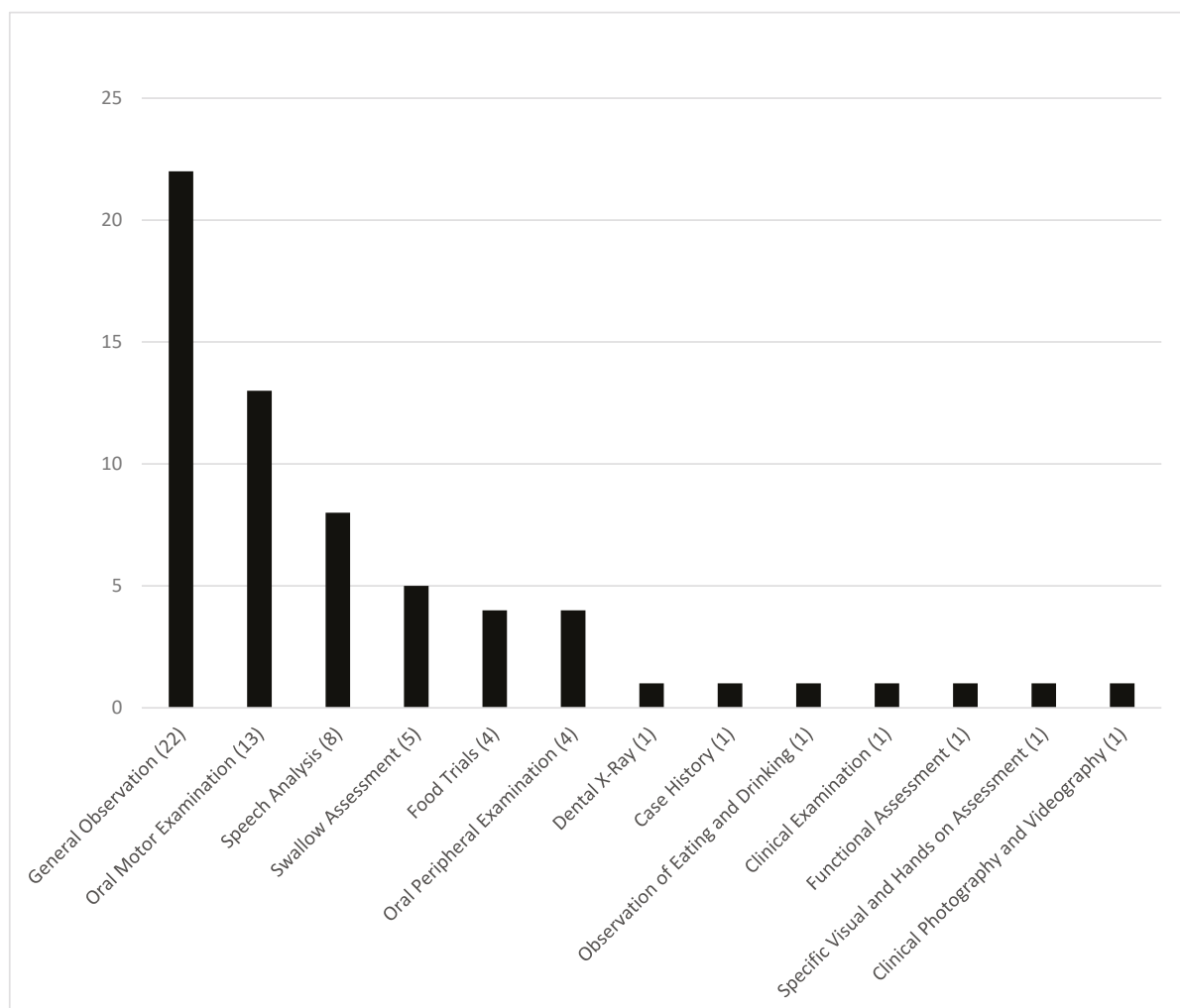


Figure 1. Clinical assessments used to diagnose and assess tongue thrust ($n = 63$).

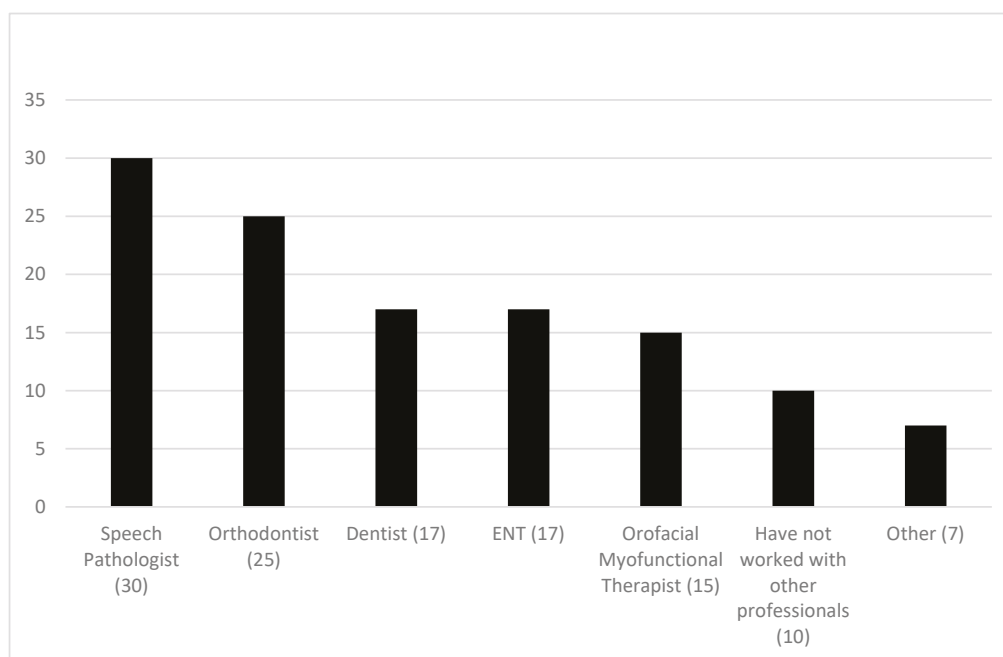
Across 37 participants, a total of 59 types of clinical assessments were reported. Table 2 provides a breakdown by profession.

Table 2. Total number of clinical assessments used to diagnose and assess tongue thrust by profession ($n = 37$).

Profession	Feeding and Swallowing Observation	Oral Motor Examination	Speech Analysis	Malocclusion Observation	Total
Speech-language pathologist	21	17	8	2	
Dentist	1			2	
Orofacial myofunctional therapist	1	2			
Orthodontist	1		1	1	
Other		2			
Total	24	21	9	5	59

The top three clinical assessments used by SLPs to assess TT were swallowing assessments and observations, oral motor evaluations and speech analysis and observation. The most frequently used clinical evaluations used by dentists and orthodontists were malocclusion and swallowing observations with one orthodontist reporting also using speech observations as evidence of TT. OMTs reported using mainly oral motor evaluations and swallowing observations in TT assessments.

Collaboration with other health professionals regarding assessment and diagnosis of TT was reported by participants in the survey. Interdisciplinary liaising in TT management was prominent ($n = 121$) with participants collaborating with SLPs (23%), orthodontists (20%), dentists (13%), ENT's (13%), and orofacial myofunctional therapists (12%). An additional 5% reported consulting with other professionals, including naturopaths, chiropractors, craniosacral therapists and osteopaths. While these professions may not have formal expertise in TT, their inclusion reflects participant-reported practices. Notably, 10 respondents—all of whom were SLPs—reported not collaborating with other professionals. This likely reflects their confidence and autonomy in diagnosing TT within their scope of practice (see Figure 2).

**Figure 2.** Health professionals involved in diagnosing and assessing tongue thrust ($n = 121$).

3.1.3. Confidence in the Assessment and Diagnosis of Tongue Thrust

Participants rated their confidence in the assessment and diagnosis of TT on a scale from zero (not confident at all) to 10 (very confident). The overall average score was 7.81 (SD = 2.41). Orofacial myofunctional therapists ($n = 3$) had the highest confidence ($M = 10$, SD = 0), followed by orthodontics ($n = 3$) ($M = 9$, SD = 1). The average confidence scores of SLPs ($n = 40$) were 7.63 (SD = 2.34), followed by dentists ($n = 4$) with an average confidence of six (SD = 4). Two other health professionals, including an oral health therapist and dual qualified SLP and orofacial myofunctional therapist ($n = 2$) reported an average confidence of 8.5 (SD = 2.12).

3.1.4. Treatment of Tongue Thrust

Participants ($n = 39$) reported three main treatment methods for TT, including orofacial myofunctional therapy (59%), myofunctional devices (20%), and orthodontic treatment (18%). One participant (3%) selected 'other' and conducted tongue surgery. This is likely to be one of the dental practitioners surveyed. Of the eight participants who reported using myofunctional devices, eight used the MyoMunchee, one used Myospots and another a different band. Orthodontic treatment methods used ($n = 7$) included three reports of palate expansion, and one participant report each for fixed appliances, tongue crib brace, orthognathic surgery and stoma adhesives. Of participants who reported using OMT ($n = 22$), the most common ($n = 8$) was tongue exercises. Alternative OMT exercises are provided in Figure 3.

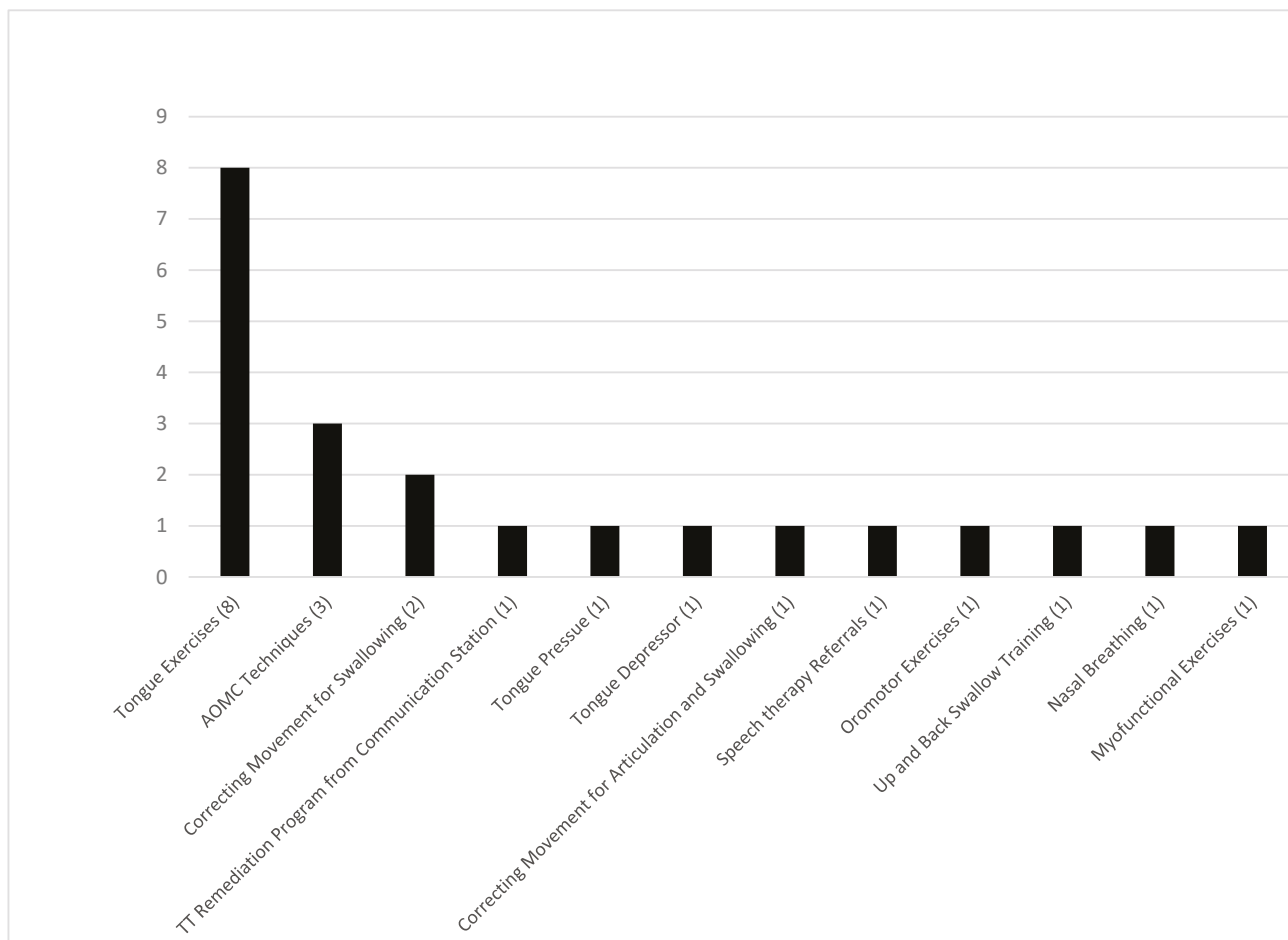


Figure 3. Orofacial myofunctional therapy methods used for treatment ($n = 22$).

Participants were asked to report how they measured the effectiveness of intervention with free text. Of the 40 participant who responded to this item, a total of 67 responses were reported and ranked from highest to lowest. Frequency reportedly used; observations (25%), assessment of current swallowing ability (21%), N/A or no method reported (16%), reassessment using same methods (13%), client/caregiver/stakeholder reports (9%), pre-treatment and post-treatment picture or video comparison (7%), accuracy of speech sounds in conversation (4%) comparison in efficacy of exercise performance pre-treatment and post-treatment (3%), and Payne paste (2%).

3.1.5. Education and Training in the Assessment and Treatment of Tongue Thrust

Participants ($n = 21$) reported their exposure to TT assessment and diagnosis whilst studying at university. Most reported no exposure (86%) at university and of three participants who reported exposure, one participant reported learning about clinical diagnosis and assessment (orthodontist), one within the university curriculum (SLP), and one from observations of the swallowing pattern (SLP).

Participants reported whether they had received further training to diagnose and assess TT ($n = 54$). Most received additional training (41%). Participants ($n = 31$) rated the level of adequacy of their further training from mostly and very adequate (46%), to mostly inadequate or not adequate at all (16%), with 19% reporting neutral responses.

Of the 47 participants, 51% reported having received further training to treat TT. Participants who had attended training ($n = 24$) reported attending formal training, (58%) informal training, (29%) or both informal and formal training (13%). Formal training ($n = 23$) included orofacial myofunctional therapy (87%), training in dental therapy (4%), research (4%) and training within an orthopaedic course (4%). Informal training ($n = 15$) included research (53%) and training from peers (47%).

SLPs ($n = 46$) reported whether they had received further training to diagnose and assess TT ($n = 25$). Other professionals including orthodontists, dentists, orofacial myofunctional therapists, dental therapists, dental hygienists, oral health therapists and orofacial myofunctional therapist/SLP ($n = 14$) also reported whether they had received further training to diagnose and assess TT ($n = 7$). Of the SLPs ($n = 25$) received formal training ($n = 11$), informal training ($n = 5$) or both formal and informal training ($n = 8$). One SLP gave no response on the type of further training they received. The most common further training for diagnosis and assessment methods among SLPs included partaking in orofacial myology courses (formal) ($n = 17$), reading literature/journal articles (informal) ($n = 7$) and mentoring/supervision (informal) ($n = 4$). Other professionals ($n = 7$) also reported receiving formal training ($n = 4$), informal training ($n = 1$) or both formal and informal training ($n = 2$). The most common further training method for TT diagnosis and assessment among other professionals included partaking in orofacial myofunctional therapy courses (both formal and informal) ($n = 2$).

SLPs ($n = 46$) reported whether they had received further training to *treat* TT ($n = 18$). Other professionals including orthodontists, dentists, orofacial myofunctional therapists, dental therapists, dental hygienists, oral health therapists and orofacial myofunctional therapist/SLP ($n = 6$) also reported whether they had received further training ($n = 6$). Of the SLPs ($n = 18$) who reported receiving formal training ($n = 10$), informal training ($n = 3$) or both formal and informal training ($n = 5$). The most common further training methods for treatment of TT among SLPs also included partaking in orofacial myology courses (formal) ($n = 11$), reading literature/journal articles (informal) ($n = 4$) and mentoring/supervision (informal) ($n = 3$). Other professionals ($n = 6$) also reported receiving formal training ($n = 4$) or both formal and informal training ($n = 2$). The most common further training method

for treatment of TT among other professionals included partaking in a variety of courses such as orthodontic and orthopaedic (formal) ($n = 4$).

Participants rated their level of adequacy of their further training in TT on a scale from zero (not adequate at all) to 10 (very adequate). The overall average adequacy rating was 7.71 (SD = 2.02). The single orthodontist and orofacial myofunctional therapist/SLP reported the highest adequacy of training with scores of 10, followed by orofacial myofunctional therapists ($n = 2$) and dental hygienists ($n = 2$) both with a score of 8.5 and standard deviations of 2.12. The average adequacy of training scores of SLPs ($n = 24$) was 7.42 (SD = 2.06), followed by a sole dentist ($M = 7$).

3.2. Phase Two—Clinician Interviews

Key themes were generated based on the 45-minute-long interviews with SLPs who shared their detailed experiences assessing, diagnosing and treating tongue thrust. The overarching themes generated were: (1) Tongue thrust is a symptom, not a diagnosis, (2) barriers to effective treatment, (3) multidisciplinary approaches to management, and (4) training and education gaps in clinical practice.

Table 3 provides details for the number of interviewees who referenced each theme and sub-theme, offering quantitative support for the thematic analysis presented in the manuscript.

Table 3. Number of interviewees who mentioned each theme identified in the qualitative analysis ($n = 7$).

Main Theme	Sub-Theme	Number of Participants	Number of Times Referenced
Tongue thrust is a symptom, not a diagnosis	It's part of a bigger picture	4	10
	The hidden realities of TT	5	12
Facilitators to effective treatment	Motivation makes a difference	6	15
	What's it going to cost?	4	4
	Partnerships with parents and clients: A key to success	4	6
	Confidence and support from health professionals	4	5
	Relationships with other health professionals	2	2
Multidisciplinary approaches to management	Same same, but different: Variation in management approaches	2	2
	Strength in collaboration	2	3
Training and education gaps in clinical practice	Polarising views	4	5
	Hesitation and fear	3	4

A detailed overview of the themes and sub-themes identified through thematic analysis, along with illustrative quotes from participants is outlined in Table 4.

Table 4. Themes generated from interviews with speech-language pathologists on their experiences assessing, diagnosing and treating tongue thrust. ($n = 7$).

Main Theme	Sub-Theme	Indicative Quotes
Tongue thrust is a symptom, not a diagnosis	It's part of a bigger picture	"An anterior tongue thrust is a symptom for the tongues overall posture, strength, where it sits in the mouth, restriction etc. It usually comes along with articulation difficulties and even mouth breathing. So it's often not just the tongue thrust that we actually treat at the end of the day." (P1) "Frequently when I see children with tongue thrust they actually present with a lot of other things." (P3) "I don't think that is a diagnosis. A tongue thrust...is really just a part of a much bigger picture." (P7) "I think it, I mean, I remember from uni, where we had different lectures and they were always saying, you know, 'if you're not, if you're gonna work on speech, work on speech like you can't improve speech unless you're speaking' type of thing. Which to some degree is true, but and if there's underlying, something underlying that's causing the speech issue, if we're not addressing that, then we're going to be practising speech for a long time and not getting very far." (P4)
	The hidden realities of TT	"I think that tongue thrust within the umbrella of oral facial myofunctional disorders should be treated as a topic as equal to speech as equal to language. OK, because it underlines a child's ability for language and a child's for speech. So it has to have equal weighting and without it having equal weighting, we're never going to get this holistic view of what, of how we're treating the client. And it comes in voice. I mean, if we look at it, it affects voice as well. It affects oral phase swallowing. I mean, it affects every area except for AAC I would argue." (P1) "And I guess in a way, sometimes when I identify the tongue thrust swallow, that's not the priority of the parents, or the parents haven't noticed it and its not until I do the assessment and I've been like "have you noticed it?," they'll be like "oh," and so it might not be a priority for them in therapy to target that whereas the speech or the breathing might be a priority for them so it also really depends on I guess what's important for the family" (P3)
Facilitators to effective treatment	Motivation makes a difference	"The awareness of the child and their motivation makes a difference." (P4) ". . . . home practice and definitely the child and how self-aware they are." (P3) "I wouldn't try and do it any younger than eight. They've got to have the right kind of maturity and motivation," (P5) "He wasn't interested. He didn't care, 'cause really, if no one's telling them in their peers, they really don't get motivated. I'm now seeing him again at 14 because he's got an interest in girls. So now his tongue thrust is a real issue because he's got an interest in girls and they go 'Why do you speak like that?' as well as he's also got a tongue tie, which he's like, 'Now I need to fix my tongue thrust, I need to fix my tongue tie. I know I've got to do the pre therapy', so he's super motivated." (P1)
	What's it going to cost?	"Obviously being in private practice, finance is a big consideration for families." (P7) "And also the cost of coming to see us." (P2) "I do choose some clients that if they can't continue therapy financially, then I will give them some pro bono sessions 'cause I'm like, 'let's get this done because he's motivated'." (P1)

Table 4. Cont.

Main Theme	Sub-Theme	Indicative Quotes
Facilitators to effective treatment	Partnerships with parents and clients: A key to success	“The biggest barrier is the availability of the parent to work with the child.” (P1) “And then it just comes down to the motivation of the child and the child which is the child parent relationship ‘cause I’m very much about pushing the child through what they can do, whereas the parents will often go, you know, if you don’t do this, you won’t get that. If you don’t do this and if we’re just hearing that repeatedly and there’s no consequence, then the child knows that. But I don’t want that kind of, you know, therapy. I want the therapy to be ‘We’re going to do this because it’s going to help this.’” (P1)
	Confidence and support from health professionals	“...support from other professionals” (P7) “I suppose attitude and just not having the full team around to get the best outcomes, and finances, would be the biggest issues that I experience.” (P7) “I had a supervisor who said to me, when I went back to her I said ‘what are we going to do?’ She said, ‘well, you’re the third speechie so you’ve just got to hope that they move on and go elsewhere and they’re no longer your problem’. And I didn’t get it as a mature aged student to go ‘We can’t actually’” (P1)
Multidisciplinary approaches to management	Relationships with other health professionals	“We have a really strong relationship with an orthodontist in our area and they refer all their tongue thrust, a lot of their tongue thrust clients to us” (P3) “I used to mostly get the referrals after the treatment, the orthodontic treatment had finished. And so they would send me, when I requested it, they would send me their records with their pre and post photos and the measurements and stuff that they had done. And often the reason that they were referring at that point was because there was some dental relapse because obviously the tongue was just pushing everything back to where it had been. After treatment, they would obviously go back to the orthodontist and often then have the finishing touches of their treatment finalised,” (P7) “We do also often refer people to specialist dentists with crossbites and other things going on with their teeth as well, which is, you know, likely caused from the tongue not being in the correct place as well.” (P2) “a lot of our referrals come from a paediatric dentist, who, she works in the area of tongue, she gets a lot of tongue tie referrals because she does releases. Then we have at least two other paediatric dentists who refer to us as well.” (P4) “So my referrals, predominantly within the hospital will come from a GP and or a paediatrician and or Perth Children’s Hospital. The referrals that I will send... maybe ENT. Majority have already got a medic involved, because that’s where our referral comes from. It may be a dietician if there are issues around intake and nutrition and or hydration. Within the health service, we’re not allowed to specify or recommend, it’s parents choice as far as where they seek their providers from, so I will give them a choice for them to select. So say for example they had I wanted to refer to ENT. They would kind of select who if it would be for a tongue tie revision, it may be a paediatric surgeon, it may be a dentist. And I’m aware that some of the dentists that the parents go to may request a craniofacial.” There could also be dentist if I’m concerned around malocclusion issues because, I feel these are the ones that are at risk of you needing your orthodontic work kind of later down the line. If we don’t intervene early enough.” (P6)

Table 4. Cont.

Main Theme	Sub-Theme	Indicative Quotes
Multidisciplinary approaches to management	Same same, but different: Variation in management approaches	“I think [orofacial myology is] kind of like I said, it’s the foundations of, you know, our assessment and our treatment. So I think it’s definitely, there are still gaps there and I find when we get community therapists in to work because I work within a hospital base, I’m doing a lot of that kind of, gap filling because the impression that I get is we, there’s still kind of not enough knowledge and awareness of this area.” (P6) “When I reflect on my own career, I think about how many years I treated children with speech difficulties without ever looking in their mouth. And this whole idea that you wouldn’t even think about the, you know, what’s going on in their mouth when that is the organ that is responsible for speech. And I still see so many kids who come from, who’ve been transferred from other therapists who are much younger than me and who’ve had more recent training at uni who are still not looking in people’s mouths. I find that sometimes just looking in there, you will see something that will, if you deal with it, it will make all of the difference.” (P7)
	Strength in collaboration	“I’ve got enough sort of knowledge to manage more, but I wanna keep it to what I do so I can then, ‘cause I’m lucky in Melbourne, I can say ‘go see my colleague who does oral motor and oral phase feeding’. So, we can kind of share the clients across then. So that’s a little bit of something that we get in the big cities. I suppose it’s a little bit easier. We don’t have to be the all in one person.” (P1) “I get a lot of dental referrals... So, a lot of my clients will come from dental referrals, or they’ll come from other speech-language pathologists who actually say they have gone as far as they can with, say, an interdental lisp or a tongue thrust. And then they’ll say, ‘OK, we’ve been working with you for, say, three months or six months or two years. Let’s, see if we can send you to somebody else just to look at it from a different perspective’.” (P1)
Training and education gaps in clinical practice	Polarising views	“When I’ve spoken to other people about TT before it can be quite a polar conversation, you’re either for or against it. I think my standing is like it’s really nice to just be in the middle—to not fully agree, not fully disagree, but find like a nice balance, middle ground” (P3) “I am beyond delighted that there’s research being done in this area. I know how I live everyday, the controversy around myofunctional work and the impact that it can have on speech and feeding... I don’t understand why this space is so controversial” (P7) “It gets really exhausting just constantly reading when people are asking questions in this space around how there’s not enough evidence, and so therefore we shouldn’t be doing this.” (P7)
	Hesitation and fear	“I just am terrified that I won’t be able to hold my own if somebody who just is not really interested in listening, asks me a question that I don’t feel like I’m quite know the answer to.” (P7) “Basically parents are Googling, trying to find someone who can do this therapy, and there’s kind of slim pickings. So it’s yeah, not just any speech therapist who is able to or willing to work on that. Even though it is within our scope of practise, but people are a bit hesitant to work on the tongue thrusts because they’re scared of the whole non speech oromotor exercise area, and... even just the idea of using a tongue depressor for some speechies. I think they’re even too scared to have one in the room.” (P4) “I guess people are a little bit hesitant and scared to venture into the world of non-therapy where you’re not actually working on speech.” (P4)

3.2.1. Tongue Thrust Is a Symptom, Not a Diagnosis

A common theme was that tongue thrust (TT) cannot be diagnosed alone, since it is usually an indicator of an underlying issue, with participants referring to it as a 'symptom' or 'part of a bigger picture'.

"I think it's really important to understand I see tongue thrust as a symptom, not a diagnosis." P1

Participants explained the importance of considering the underlying issues when planning assessment and treatment, since treating a speech issue alone may be inefficient if the underlying cause, for example, low-lying tongue posture or limited tongue movement, is not addressed first within therapy.

Participants emphasised that it is critical to take a holistic approach to assessment and treatment, so that underlying problems can be prioritised and resolved rather than looking at only TT in isolation. Several participants shared similar opinions that TT should be viewed with equal importance as an orofacial myofunctional dysfunction as other areas of speech pathology due to the potential significant impacts if not addressed.

3.2.2. Facilitators to Effective Treatment

Participants discussed barriers and facilitators experienced when treating clients with tongue thrust, and how these restricted the capacity for the provision of effective management. Some participants reported that client attitudes impacted therapy, such as if a child is not engaged or motivated, they are unlikely to put the work in that is required to progress. One participant shared their experiences with a client who had previously received treatment when they were younger and later returned to resume therapy, motivated by external factors when they were at an older age (P1).

Another theme generated was finances as a barrier to effective treatment as some clients could not afford therapy. However, some participants reported providing pro-bono sessions to exceptionally motivated clients. The motivation and availability of parents or guardians to engage with treatment was also a barrier to effective therapy. As participants' tongue thrust caseloads mainly consist of younger children, they report that it is critical for parents to have the capacity to prioritise therapy in order to see results for their child.

"When they go home, the parents are in charge of facilitating the practice and providing the feedback, so if the parents aren't motivated to help the child, in that respect then it's probably a later goal." P3

Another recurring barrier reportedly experienced by participants was confidence levels and general support from other professionals. Participants discussed how having limited input or guidance from the multidisciplinary team (MDT) or professionals around them can hinder positive outcomes, whilst some expressed doubts with self-confidence.

"But I guess another barrier is my own confidence in doing the therapy, I've been doing it for ages, but I sometimes stop and I'm like 'Is this actually working?' because it's really hard to see sometimes, I think sometimes I get those moments." P3

3.2.3. Multidisciplinary Approaches to Management

Another theme across interviews was the importance of working in a multidisciplinary team, and the involvement of other health professionals, such as ENTs, dentists, orthodontists, GPs, paediatricians and the variation in management approaches.

Participants reported receiving referrals from other health professionals for issues such as speech and feeding difficulties. Participants also gave referrals to other health professionals for issues such as bite issues, snoring, tight muscles, breathing, tongue tie

releases, and others. Other comments by participants involved the variation in management approaches between the multidisciplinary team, as well as between different SLPs. Participants reported that the difference in education and training is a possible link to the variation in management approaches, and the limited number of speech-language pathologists who look inside the mouth for a TT.

3.2.4. Training and Education Gaps in Clinical Practice

A recurring theme amongst participants was the significant lack of research, evidence and education in the management of TT. Participants commented on the strength in collaboration amongst health professionals, and different perspectives. One participant reported the benefit of living in a bigger city, and the availability of health professionals who specialise in TT.

There was a polarity of arguments, for and against OMT due to a perception of limited evidence in this area. Further research into the role of SLPs and the impact of orofacial myofunctional therapy on speech and feeding was suggested by all participants.

There was a sense of hesitation and fear by SLPs to talk about, or practice in orofacial myofunctional therapy, and more specifically, TT. Participants reported that the lack of research and the fierce controversy surrounding the functional impact of OMT made them hesitant to share their experiences with other health professionals and to advocate for therapy approaches in this area.

"I'm actually terrified at the thought of offering something more formal in terms of training because of that whole controversy and how firmly people who are not on the tongue thrust oromyofunctional train are not on it." P7

Although therapies aligned with OMT for developing feeding and speech skills for underlying orofacial myofunctional disorders are within the scope of practice of SLPs, some practitioners reported lacking confidence to work in the area of TT to the limited education and evidence. Participants felt strongly about the need to include teaching of OMT in the undergraduate curriculum at university for Speech Pathology students.

"I think it's really irresponsible, bordering on unethical, of us to be treating kids for years and years and years without actually looking at the full gamut of things that might be impacting that communication impairment. So yes, please, please get it in to the undergrad classes." P7

4. Discussion

The current study was exploratory to investigate approaches to the assessment, diagnosis and management of TT in Australia, and health professionals' perceptions and training experiences in TT. In the first phase, the key findings were that health professionals used a range of methods to assess, diagnose and treat TT and each possess a variety of training qualifications and experiences in the field. In the second phase (clinician interviews), four key themes were generated from interview data (1) Tongue thrust is a Symptom, not a Diagnosis, (2) Facilitators to Effective Treatment, (3) Multidisciplinary Approaches to Management, and (4) Training and Education Gaps in Clinical Practice. Each theme contributes to client-centred care in TT, highlighting that there are several factors influencing an individuals' accessibility to assessment and treatment of their TT.

Effective approaches to assessing TT are an important consideration in this area. Across this study's interviews, a range of assessment methods including oral motor examinations, speech analysis, observations of eating and drinking, swallowing during meals, speech during conversations, and oral structure and function (i.e., tongue movement and positioning of teeth) were reported to be used. An investigation of the literature shows that

ultrasound [7,18–20] and TT rating scales [24,25] are used within TT assessment, which, as above, is contradictory with the most used assessment methods reported by Australian SLPs in the current study. This may be a geographical limitation due to a variety of research taking place in the United States, when the present study took place in Australia. Furthermore, this contradiction may support the theme that is present in existing research, suggesting that practitioners use a vast array of tools to assess their clients [21,34].

Participants in the online survey indicated OMT approaches to be commonly used for TT treatment, which aligns with previous literature [2]. Myofunctional devices and orthodontic treatment including tongue cribs are also reported and were discussed by several interview participants in the present study [21,27]. However, there is still limited research surrounding efficacy of assessment and treatment methods for TT. During interviews, participants were asked about barriers they experienced when managing TT so that factors impacting effective assessment and treatment could be identified and understood. The main barriers found in this study were financial burdens of the client, client motivation and engagement, parent engagement, confidence of the SLP, and clinical support from other health professionals. There is some existing literature further supporting this theme, although further investigation into this area from a broader range and larger number of professionals would be beneficial to increase both clinician and client awareness of challenges they may face when managing TT [21].

Working with other health professionals was reported to promote treatment efficacy for patients with TT. While there is insufficient research on the effects of multidisciplinary team approach on TT management, it is well-known that the collaboration of efforts from different professionals improves patient management, compared to global treatment delivered by a sole professional [35]. Maspero et al. [36] highlighted that orthodontic treatment alone is not sufficient to treat an atypical swallow, and a multidisciplinary approach such as orthodontic and myofunctional rehabilitation has the potential to lead to optimal long-term outcomes. The results from the survey and the interviews with professional practitioners support the notion that there is strength in collaboration.

A lack of knowledge and awareness in the management of TT eventually results in controversy and hesitation around the implementation of OMT for TT. Most participants in the current study did not have further training to diagnose and assess TT, and only some reported the adequacy of their training. Many clinicians may not be equipped with the training to confidently recognise a TT, which can impact on the efficacy of intervention provided to clients. This lack of definitive supporting evidence on the functional impact of OMT explains the polarity of views on OMT interventions between health care professionals and explains SLPs' fears of practicing in OMT [37]. The scarcity of conclusive information on the efficacy of OMT in improving oral and tongue strength in patients with TT is noted both in the literature and within the current study [26,38]. While tongue strength alone may not be the sole determinant of functional outcomes, emerging research highlights the potential significance of orofacial myofunctional patterns—particularly tongue posture in relation to sleep-disordered breathing (SDB) in children. These findings suggest a need to consider a more comprehensive view of tongue function beyond isolated strength metrics. For example, Villa et al. [38] demonstrated that myofunctional therapy can reduce symptoms in children with SDB and improve measurable aspects of tongue function, such as strength, endurance and resting posture. Homem et al. [39] found there to be a significant lack of consistent scientific evidence demonstrating the efficacy of OMT on dentofacial and orofacial disorders, which impacts the treatment provided to clients, and the overall outcomes as a result. If the underlying issue of TT is left unrecognized, it may influence the efficacy or timing of other treatments, potentially delaying optimal outcomes. However, it is important to acknowledge that many individuals who begin treatment

in later childhood, adolescence, or adulthood can still achieve successful results. Early identification may support more efficient care pathways, but positive outcomes are not limited to early intervention alone.

4.1. Clinical Implications

This study underscores the variability in management approaches among healthcare professionals assessing and treating clients with TT, identifying key barriers and highlighting the need for more standardised and enhanced education in this field. Given the limited existing literature, this study provides valuable data to support evidence-based practice, particularly for SLPs in Australia. However, discrepancies exist between the current literature and the real-world perspectives of professionals working in this area. The insights gained from this study—formulated from clinical perspectives—contribute to improved management outcomes for a diverse range of clients, including those with undiagnosed TT or related conditions.

The study's findings are multifaceted, reflecting the diverse survey and interview responses from various professional groups with varying levels of experience. Notably, younger or less experienced professionals often differ in their approach compared to more experienced professionals. These differences are influenced by variations in education and training, which in turn affect clinical practice in the management of TT.

4.2. Limitations and Future Research

There are several acknowledged limitations with the present study, including a small sample size. While 58 participants commenced the online survey in phase one, only 47 completed the survey in its entirety, and seven participants were involved in the interviews during phase two. A larger sample size of 12 to 15 participants for the clinician interviews in phase two is necessary for increasing the depth of the results and allowing for improved generalisability [40,41]. Furthermore, interviewing health professionals beyond SLPs would have contributed to deeper insights and diverse perspectives, especially considering that one of the main themes found was 'MDT approaches to management'. Strengths of the study included using a mixed-methods approach, allowing for quantitative and qualitative data to be integrated. This allowed for a comprehensive understanding of the topic from a range of health professionals as part of the online survey, and detailed exploration of perspectives and experiences from SLPs within clinician interviews. This enabled a thorough understanding as the survey results informed the interview questions. Furthermore, the diverse recruitment process through social media and professional bodies allowed for the targeting of a larger and wider audience involved in the field of TT.

The findings from the current study and existing literature highlight variability in the approaches of assessment and treatment Australian health professionals use to manage TT. The lack of comprehensive TT training for SLPs in Australia despite the identified clinical need to address TT in practice was an overwhelming finding in the study. This gap in research presents an opportunity for not only the role of SLPs in TT management to be explored, but also for other health professionals involved in TT. Future research should consider conducting interviews with all health professionals involved in TT, including internationally, so a deeper understanding of how disciplines differ in their approaches to TT management can be gained. Future research should also evaluate the effectiveness of commonly used OMT practices in SLP treatment and the alignment to clinical practice. This research will enhance the treatment provided to individuals experiencing TT and contribute to improvements in their quality of life.

5. Conclusions

This study describes the varied approaches to the management of tongue thrust among Australian health professionals, with a particular focus on the perspectives and practices of speech-language pathologists (SLPs). The themes generated provide valuable insights into the experiences of SLPs, highlighting key barriers to treatment such as limited efficacy data, the need for a broader clinical perspective on the underlying causes of TT, and the importance of an MDT involvement.

Importantly, the findings support a growing recognition that TT may not be a standalone diagnosis but rather a symptom of more complex orofacial and airway-related conditions, such as a potential clinical indicator of posterior airway obstruction or allergic responses, underscoring the need for timely referral to ENT or allergy specialists when appropriate.

A strong consensus among SLPs is that TT remains an area with limited awareness and education. This gap may serve as a catalyst for expanding education, training and research opportunities for both practicing and student SLPs, ultimately enhancing clinical confidence and patient care.

While this study focuses on the Australian context, the identified themes—barriers to treatment, the need for interdisciplinary collaboration, and the limited awareness surrounding TT—are likely relevant across global healthcare systems.

Future research could explore whether these challenges and perspectives are shared in other countries. Ultimately, this study's findings may contribute to more comprehensive and effective global management strategies for TT, improving patient outcomes across diverse environments.

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Article

Lingual Frenuloplasty with Myofunctional Therapy: Improving Outcomes for the Treatment of Ankyloglossia (Tongue-Tie) with Refined Techniques and Endpoints

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Abstract: Purpose: Ankyloglossia (tongue-tie) can lead to oromyofascial dysfunction which affects breathing, swallowing, speech, and posture. This study presents the evolution and outcomes of a refined lingual frenuloplasty protocol that integrates individualized myofunctional therapy to address compensatory patterns. Methods: A prospective cohort of 445 patients (≥ 4 years) was treated between 2021 and 2023 using a fascia-preserving CO₂ laser protocol with structured pre- and postoperative myofunctional therapy. Patients were stratified as pediatric (<12 years) or adolescent/adult (≥ 12 years). Key refinements included fascia-sparing dissection, reduced suture tension with cyanoacrylate adhesive, defined functional endpoints, structured myofunctional therapy, and standardized wound-healing strategies. Results: Among 379 patients (85% response) with >2 months follow-up, the 2025 protocol achieved an 86% satisfaction rate and significantly fewer complications compared with 2019 (pain 3.7% vs. 15.8%; bleeding 1% vs. 13%; revision 2.1% vs. 6.6%). Deeper genioglossus dissection increased swelling risk (OR = 4.0, $p < 0.0001$) but did not affect satisfaction. Conclusions: The refined 2025 protocol represents an outcome-tracked advancement in ankyloglossia management. By emphasizing fascia preservation, functional diagnostics, and integrated myofunctional therapy, the approach improves safety, efficacy, and patient-centered outcomes.

Keywords: ankyloglossia; lingual frenuloplasty; myofunctional therapy; fascia preservation; TRMR; functional endpoints; WHIMS

1. Introduction

Ankyloglossia (tongue-tie) is a condition of limited tongue mobility due to restrictive tissues connecting the tongue to the floor of the mouth. [1] Orofacial myofunctional disorders (OMDs) encompass various dysfunctions related to the muscles and functions of the face and mouth, impacting breathing, swallowing, speech, orthodontic issues, grinding, neck tension, jaw pain, and postural stability [2–4]. Orofacial myofunctional therapy (OMT or myofunctional therapy, as it is referenced in this paper) includes awareness, individualized exercises, neuromuscular repatterning, and retraining aimed at addressing the root causes of dysfunctional compensations and maladaptive habits [4–7]. Ankyloglossia is frequently observed in patients with orofacial dysfunction [8,9].

Lingual frenuloplasty, a surgical procedure to release restrictive lingual tissue, can facilitate improved tongue mobility and function [10–12]. However, the clinical effectiveness of frenuloplasty has been debated, particularly regarding its impact on speech and developmental outcomes [13–15]. These uncertainties highlight the multifactorial nature of OMDs and the importance of treatment approaches that go beyond anatomical correction including addressing learned behaviors and compensatory mechanisms (see Figure S1). Meanwhile, other studies indicate that frenuloplasty can lead to improvements in speech articulation and tongue mobility, supporting its use in clinical practice for children with speech difficulties attributed to tongue-tie [16–18]. These studies underscore the need to address not just the mechanical limitations of tongue-tie but also the broader myofunctional, postural, and compensatory mechanisms [11].

In addition to its impact on feeding, speech, and oral hygiene, ankyloglossia can interfere with the normal development and integration of primitive reflexes. Studies have shown that retained primitive reflexes, such as the rooting and sucking reflexes, can be indicative of neurobehavioral reflex disorders and delayed cortical maturation, further emphasizing the importance of addressing tongue-tie early in development [19,20]. A broader understanding of contributing factors, such as nasal obstruction, limited tongue space, fascial restriction, mouth breathing, retained reflexes, and sensorimotor discoordination, is essential for identifying patients likely to benefit from a combined surgical and therapeutic approach [19–21].

Prior investigations have demonstrated that lingual frenuloplasty, when integrated with structured myofunctional therapy, improves both safety and efficacy compared to surgical intervention alone [10,22]. Recent refinements in this combined approach have prioritized fascia preservation, functional diagnostics, and reproducibility of outcomes across providers and settings.

This paper outlines the evolution of a lingual frenuloplasty protocol combined with myofunctional therapy. Initially developed in 2017 with a primarily anatomic focus, the protocol has matured through 2025 into a standardized, minimally invasive model that prioritizes functional mobility endpoints, fascia-sparing dissection, and interdisciplinary care. This prospective descriptive cohort analysis was designed to transparently document patient outcomes within a high-volume clinical setting. Rather than isolating variables, this study aims to contribute pragmatic data that reflect clinical implementation and ongoing protocol refinement. The findings are intended to support dissemination of best practices, guide interdisciplinary care, and promote future research in the evolving management of ankyloglossia.

This paper builds upon previously published work from 2019 that described outcomes using a scissors-and-suture approach. The present study documents the evolution of that protocol into a reproducible, functionally defined, fascia-preserving model using CO₂ laser-assisted release, objective assessments, and structured perioperative therapy. Key methodological refinements and outcomes to support wider adoption and further validation are outlined.

2. Materials and Methods

2.1. Study Design

This prospective descriptive cohort study involved 445 patients who presented for treatment of ankyloglossia by a single surgeon (SZ) between January 2021 and December 2023 with a minimum follow-up of 2 months post-op. All subjects were screened for appropriate patient selection and completed pre- and post-operative myofunctional therapy according to the protocol detailed in Supplementary Material Figure S2. Therapy was delivered by licensed professionals (SLPs, RDHs) with training in established, evidence-based

orofacial myofunctional therapy programs. Myofunctional therapy sessions were held weekly or biweekly, each lasting 45–60 min. Pre-operative goals included nasal breathing, jaw-lingual dissociation, jaw stabilization, and improved tongue posture, strength, and mobility, all while working to reduce and repattern any compensatory movements. Post-operative sessions focused on scar remodeling, palatal suction restoration, neuromuscular retraining, and compensation elimination. Tongue mobility was tracked using metrics such as Tongue Range of Motion Ratio (TRMR) and Floor of Mouth (FOM) Hold Maneuver, taking into consideration normative values (Figure S3) but also the compensations previously mentioned in Figure S1 that may mask severity of restrictions or reflect post-surgical tissue contraction. Therapy assessment and structure were standardized across all locations to support patient adherence. Only patients who completed both pre- and post-operative evaluations under this protocol were included in the outcome analysis.

Data were collected prospectively under a standardized clinical protocol. Age-appropriate measurements of tongue mobility, using assessments including TRMR-TIP (Tongue tip to Incisive Papilla), TRMR-LPS (Lingual Palatal Suction) (Figure S4), bite-block levels (Figure S5), and FOM Hold Maneuver (Figure S6) were assessed before and after the release procedure. The depth of the release (mucosa, fascia, genioglossus muscle) was recorded (Figure S7). Outcome measures included tongue mobility, patient satisfaction, and complication rates. While clinical tools such as TRMR and FOM Hold Maneuver were used for mobility assessments, evaluations of bleeding, pain, and tissue tightness relied on clinical judgment and patient reporting. During in-clinic, telephone, and/or Zoom follow-up interviews, patients were assessed using a standardized set of questions addressing postoperative symptoms such as bleeding, pain, tissue tightness, and overall satisfaction. Responses were collected using binary (yes/no) questions, and symptom severity was categorized as NONE, MILD, MODERATE, or SEVERE based on predefined clinical criteria. The 2019 cohort utilized a 5-point Likert scale for patient satisfaction, whereas the updated protocol adopted a simplified 4-point scale to enhance clarity and consistency in self-reporting.

To align with clinical protocols and developmental dentition, patients were categorized into three age-based groups according to maturity of dentition which correlates to bite block grading levels used in tongue mobility assessments:

- * Young Pediatric (3–5 years) *: Early primary dentition, Bite Block Level 1 (13 mm) in TIP.
- * Pediatric (5–11 years) *: Late primary or mixed dentition, Bite Block Level 2 (21.5–23 mm) in TIP.
- * Adolescent/Adult (≥ 12 years) *: Permanent dentition, Bite Block Level 3 (28 mm) in TIP.

This stratification reflects both chronological and developmental criteria and was used to guide analysis of assessment tool applicability, treatment response, and clinical outcomes. Tongue mobility and surgical outcomes were subsequently analyzed in aggregate and, where appropriate, separately for each age group to identify any clinically significant trends. Not all tools were applicable across all groups.

Prospective data collection occurred as part of routine clinical care and was documented in a HIPAA secure spreadsheet for research analysis. All patients provided written informed consent acknowledging that their anonymized data could be used for quality improvement and research purposes. The study was approved by an independent ethics board, Solutions IRB (Protocol #0327, Approved 2 April 2025), which initially authorized the project as a Quality Improvement initiative and subsequently as a formal research protocol. This approval explicitly permits prospective data collection and future publication.

The study was conducted in accordance with the Helsinki Declaration of 1975, as revised in 2013.

2.2. Inclusion and Exclusion Criteria

Inclusion Criteria: Patients were eligible if they were 4 years of age or older, diagnosed with ankyloglossia, and demonstrated full adherence to the pre/post-op myofunctional therapy timelines as outlined in the Clinical Protocol Visual Companion Guide.

Exclusion Criteria: Patients were excluded for syndromic craniofacial anomalies, neurological or developmental disorders, unresolved myofunctional compensations at the time of surgery, and functionally inadequate tongue space. In this context, functionally inadequate tongue space also described as restricted intraoral volume refers to insufficient structural capacity to support optimal tongue posture and airway function. This determination was made using a multimodal approach that integrated clinical screening, functional evaluation, and imaging.

The FAirEST 6 + 4 Screening Tool (Figure S8) was used to identify key clinical indicators such as narrow palate, tongue scalloping, and overflow during lingual-palatal suction. These findings were then operationally confirmed using validated CBCT parameters, including intermolar width, palatal depth, and pharyngeal airway space, with reference to normative ranges [21]. FAirEST 6 and FAirEST 6+4 help identify other considerations which may cause implications of limited results with a functional frenuloplasty alone. It is used to screen and inform patients whether or not they only need to address their tongue-tie with lingual frenuloplasty and myofunctional therapy or more commonly, lead to the conversation about other issues to address alongside tongue-tie such as nasal obstruction, large tonsil, narrow palate and limited tongue space.

CBCT interpretation followed a standardized imaging protocol, with head posture controlled using the nasion–basion–C3 (NBC3) angle as described by Coppelson et al. (2023), which has been shown to improve reliability in airway and intraoral volume assessment [23]. Patients were excluded only if both the clinical FAirEST 6+4 indicators and CBCT measurements met criteria for insufficient structural capacity.

2.3. Measurements of Tongue Mobility and Assessment of Ankyloglossia

Tongue Range of Motion Ratio (TRMR):

Maximum interincisal mouth opening with the tongue tip at the incisive papilla (TIP) and tongue body in lingual-palatal suction (LPS) are each divided by the comfortable mouth opening (CMO). See Reference [21] for more details and Figure S4.

Bite Block Levels:

Measurements of tongue elevation can be influenced by compensatory activation of jaw, neck, and facial musculature. To help stabilize mandibular position and reduce extrinsic muscle activity during tongue range of motion, a disposable bite block (EZ Prop) was placed between the central incisors. Patients were instructed to elevate the tongue tip (TIP) to the incisive papilla and mid-tongue (LPS) by suctioning to the highest achievable points during each elevation while lightly holding onto the bite block with the teeth.

Bite block levels were defined as Level 1 (13 mm), Level 2 (21.5–23 mm), and Level 3 (28 mm), corresponding to age-based expectations for dentition stage and anterior/mid-tongue elevation. These levels also approximated 50–60% of comfortable mouth opening (CMO) for anterior mobility and 30–40% for mid-tongue mobility. Clinical observations demonstrated correlations between bite block level, TRMR grading, and normative TRMR values for anterior and mid-tongue mobility [21] (Figures S4 and S5).

Although electromyographic validation has not yet been performed, bite blocks were selected based on internal observational data from 10 trained orofacial myofunctional

therapists assessing over 600 patients. In this internal quality-improvement analysis, the bite block method demonstrated the highest inter-rater agreement among available clinical techniques for controlling visible compensations during tongue mobility testing. While inherently subjective, as is much of clinical myofunctional therapy in the absence of objective EMG measures, this approach currently represents the most consistent method available in our setting for reducing confounding accessory muscle recruitment. See Figure S5.

2.4. Floor of Mouth (FOM) Hold Maneuver for Assessment of Mid-Tongue Restriction (“Posterior Tongue-Tie”)

The assessment of posterior tongue-tie, now more accurately referred to as mid-tongue restriction, is often a challenging and confusing topic. Posterior tongue-tie is defined as limitations affecting the middle body of the tongue, rather than the anterior free portion.

The FOM Hold Maneuver is a clinical technique used to evaluate tongue mobility while minimizing compensatory activity from jaw, neck, and floor-of-mouth musculature. With a gloved finger, the practitioner applies gentle pressure to the sublingual caruncles at the mandibular alveolar ridge (see Figure S6), stabilizing the floor of the mouth and isolating intrinsic lingual effort.

This restriction can be best visualized using the FOM Hold Maneuver, stabilizing the floor of the mouth at its natural resting position below the mandibular alveolar ridge, and the anterior portion of the tongue in order to isolate mid-tongue mobility. This stabilization allows the clinician to focus on intrinsic tongue movement without confounding upward displacement of the floor of the mouth.

During the maneuver, the examiner observes for depression, dimpling, or cupping at the dorsal mid-tongue (DDT), as well as palpable tension. These findings are consistent with structural restriction in the mid-tongue region. A positive result is indicated when there is visible depression and reduced elevation of the tongue in the absence of floor-of-mouth compensation.

It is important to note, however, that reduced mid-tongue mobility may sometimes be due to factors other than an anatomical restriction. Weakness of the tongue, strain, or compensatory recruitment of surrounding musculature can mimic restriction. For this reason, the FOM Hold Maneuver also includes observations of compensatory activity and muscular weakness to help distinguish structural restriction from functional limitations.

These assessments were developed through an iterative process involving multiple rounds of testing and refinement, with internal validation used to progressively improve inter-rater reliability and internal validity.

2.5. Surgical Treatment Protocol

2.5.1. Preparation

All patients underwent an oral rinse with antiseptic solution before surgery. Procedures were performed under local anesthesia. Topical anesthetic in the form of 2% viscous lidocaine (Akorn, Lake Forrest, IL, USA) and/or lidocaine and prilocaine cream (USP 2.5%/2.5%) (Alembic, Vadodara, India) was applied to the mucosa of the lingual frenulum. Injection of ~0.5 mL to 2 mL of 4% prilocaine (Citanest plain, Dentsply, York, PA, USA), 2% lidocaine HCL with 1:100,000 epinephrine, and/or 0.5% Marcaine with 1:200,000 epinephrine (Cook-Waite, Novocol, ON, Canada) was applied submucosally via 30-gauge needle to the fascial layer of the lingual frenulum tissue taking care to avoid any underlying blood vessels, salivary gland, or nerve structures.

The presence of concurrent buccal or labial tethering was addressed at the discretion of the surgeon but was excluded from this outcome analysis. Data and outcomes presented herein reflect only cases of isolated lingual frenulum release.

2.5.2. Release Technique

The procedure began by pushing back on the ventral surface of the tongue at the floor of the mouth with a small square (2×2) of gauze to identify the site of maximal tension of the lingual frenulum near the sublingual caruncles. The tension band was first visualized then palpated and clamped with fine hemostats at a site 2–4 mm above the sublingual caruncles. All cases included in this analysis were performed using the refined protocol, which utilized a CO₂ laser (10,600 nm) (LightScalpel LLC, Bothell, WA, USA) for tissue release at the appropriate settings described in Figure S9. This wavelength enables clean, layer-by-layer dissection of mucosa, fascia, and genioglossus with high precision and minimal collateral thermal damage, especially critical in the anatomically dense floor-of-mouth region. The laser's simultaneous cutting and coagulative properties minimize intraoperative bleeding and reduce the need for suction or electrocautery. Additionally, laser sealing of lymphatics and nerve endings may facilitate improved patient comfort and faster healing [24,25]. The pulsed delivery of the CO₂ laser allows for tailored endpoint control to ensure effective and functionally guided releases. Release of the tissue along the tracks of the clamp from the hemostat was performed with small curved surgical scissors (JedMed, St. Louis, Missouri, USA) and/or CO₂ laser (Lightscalpel) at the appropriate settings. The release procedure continued through continued palpation and observation to identify further tension bands contributing to limited tongue mobility. The endpoint of the release was identified when there was adequate mobility and elevation of the anterior tongue tip and mid-body, consistent with functional tongue anatomy (Figure S10), according to the assessment protocols detailed above (Grade 1–2 TRMR TIP/LPS without compensations as assessed with bite-block and FOM Hold Maneuver). Care was taken to minimize dissection of deep fascia surrounding the genioglossus muscle as well as limiting the release of muscle fibers themselves to the minimal amount necessary to achieve the defined endpoints of tongue mobility.

Laser dissection was supplemented, as needed, with curved surgical scissors (JedMed) along the track defined by the hemostat clamp. Palpation and dynamic testing were employed throughout the procedure to identify and release additional fascial restrictions. The endpoint of the release was defined as functional elevation and mobility of the anterior and mid-tongue, specifically, achievement of Grade 1–2 TRMR-TIP and TRMR-LPS scores (Figure S4) without compensatory recruitment, as confirmed using bite-block (Figure S5) and FOM Hold Maneuver assessments (Figure S6). Care was taken to preserve the surrounding deep fascia and minimize the release of the genioglossus muscle beyond the minimal extent required to achieve the functional endpoint.

2.5.3. Hemostasis

Hemostasis was achieved using the CO₂ laser prior to closure. In cases of persistent bleeding, cyanoacrylate adhesive dressing (Periacryl 90 high-viscosity, violet; GluStitch Inc., Delta, BC, Canada) (Figure S11) was selectively applied to the deep fascia or vascular sites that failed to respond to initial laser coagulation.

2.5.4. Wound Closure

Closure was performed with 4-0 chromic sutures placed 2–6 mm apart in an interrupted fashion. A figure-of-eight suture was typically placed at the base of the wound near the sublingual caruncles. Additional simple interrupted sutures were used along the incision length, and a loosely applied horizontal mattress suture was positioned across the mucosa of the sublingual caruncles. Minimal redundant mucosa at the wound apex was excised with care to preserve tissue integrity. In select cases, cyanoacrylate tissue

adhesive (GluStitch Inc., Delta, BC, Canada) was applied between sutures for added tension support.

2.5.5. Postoperative Care

Patients were instructed to rinse with warm salt water and/or diluted alcohol-based mouthwash three times daily for 7–10 days after the procedure. Pain control regimen included ibuprofen (Genexa Inc., Los Angeles, CA, USA) and/or acetaminophen (Tylenol, Johnson & Johnson, Fort Washington, PA, USA). Some patients elected to use homeopathic (such as arnica) or holistic remedies (turmeric, ginger, cannabidiol oil) for analgesia instead of the other more routine allopathic medications. Ice therapy was recommended in the form of an icepack on the submental area for 10–20 min repeated every 2 h for the first day while awake. The use of narcotic pain medication was not found to be as common or necessary in comparison to the prior protocol. Absorbable sutures typically dissolve within 3–10 days, and cyanoacrylate tissue adhesive if used, should be left undisturbed or gently massaged off with mineral oil after one week. Gentle tongue activities like speaking and singing were recommended initially, with post-operative therapy sessions resuming within a week. Patients were also advised to consider bodywork therapies as recommended by their healthcare provider. For more detailed post-operative care instructions, see Figure S12.

2.5.6. Follow-Up

Patients were seen for follow-up at 1–2 weeks and again at >2 months post-operatively to assess for any complications or problems with wound healing using the Lingual Frenulum Wound Healing Assessment Scale (WHIMS—Figure S13). Postoperative outcomes were assessed at two distinct follow-up intervals. Short-term outcomes, including reports of pain, swelling, and other complications, were recorded during the initial follow-up visit within 1–2 weeks after surgery. Long-term outcomes, including patient satisfaction and perceived treatment benefits, were evaluated at follow-up interviews conducted two or more months postoperatively. In addition to these assessments, patients were also seen by the orofacial myofunctional therapist at 3 days post-op, followed by weekly and biweekly intervals for the first 2 months, and ongoing thereafter as needed depending on the specific goals of care. Sutures typically fell out within 2–10 days, and patients were instructed to perform manual tongue stretches beginning around the third day postoperatively. Expected healing stages and timelines are summarized in (Figure S14). If healing was satisfactory at the 2-month follow-up, reassessment of function determined individualized treatment planning to continue care with their Orofacial Myofunctional Therapist as needed. If concerns remained, such as persistent tension, limited mobility, or reduced WHIMS scores, triamcinolone acetonide (Kenalog-10, Bristol-Myers Squibb Company, Princeton, NJ, USA) injection (Figure S11) was considered between 2 and 6 months postoperatively. If symptoms persisted beyond 6 months despite conservative measures, revision surgery was offered. Overall patient satisfaction and outcome success were based on subjective reports and objective OMT assessments.

2.5.7. Statistical Analysis

All statistical analyses were conducted using JMP Pro 16.0 (SAS Institute Inc., Cary, NC, USA). Continuous variables are reported as mean $\pm$ standard deviation (SD), and categorical variables are, with a two-tailed p -value of <0.01 considered statistically significant. To compare reported frequencies and percentages with standard error (SE), univariate comparisons were performed using independent t -tests for continuous variables and Pearson's Chi-square tests for categorical variables complication rates between the 2019 and 2025 surgical protocols, Pearson's Chi-square analyses were applied to 2×2 contingency tables for each complication moderate and severe pain, moderate and severe bleeding,

numbness, salivary gland issues, and need for second-stage revision with odds ratios (OR), 95% confidence intervals (CI), and *p*-values calculated.

3. Results

3.1. Demographic Characteristics

As listed in Table 1, a total of 445 patients were treated, with 379 (85.1% who completed both pre- and postoperative forms that included symptom reporting) included in the analysis, with a mean age of 25.2 ± 15.9 years (range: 4 to 81 years). The cohort was 55.7% female, with 43.6% pediatric patients. Of the 445 patients included, 110 were in the pediatric group (<12 years) and 335 in the adolescent/adult group (≥ 12 years) which are further broken down in Table 1 to preschool years (3–5), middle school years (6–11) teen years (12–17) young adults (18–40) and middle age/older adults (41+). This stratification may provide a more clinically meaningful framework across the lifespan, helping clinicians identify which symptoms are prevalent at specific psychosocial stages guiding age-appropriate diagnostic and treatment priorities. Presenting symptoms associated with restricted tongue mobility included oral dysfunction (59.4%; e.g., tongue thrust, low tongue posture, swallowing dysfunction) [3], open-mouth posture (57.0%), neck and shoulder tension (48.0%), bruxism (45.9%), headaches (31.4%), and temporomandibular joint symptoms (28.0%). Pediatric patients presented more frequently with speech and feeding issues, whereas adult patients more often reported TMJ, clenching, and postural complaints. Adolescence marks a transition where functional problems exist, but pain-related symptoms begin to emerge. Relevant analyses were separated by pediatric, adolescent, and adult groups. The findings are presented in Tables 1–6 and demonstrate that key outcomes, complication rates, satisfaction, and functional mobility were largely consistent across groups, with some differences noted in symptom profiles.

Table 1. Demographic Characteristics of Patients.

	# Reported					
Total Patients	445					
Response Rate	379 (85.1%)					
Age (mean ± SD)	25.2 ± 15.9 years					
Age Range	4 to 81 years					
Age Distribution						
4 to 5	11 (2.5%)					
6 to 11	99 (22.2%)					
12 to 81	335 (75.3%)					
Gender Distribution						
Female	248 (55.7%)					
Male	197 (44.3%)					
Primary Presenting Symptoms	Total n = 379	Ages 4–5 n = 7	Ages 6–11 n = 87	Ages 12–17 n = 62	Ages 18–40 n = 156	Ages 41+ n = 67
Oral dysfunction	225 (59.4%)	4 (57.7%)	44 (50.6%)	35 (55.6%)	90 (57.3%)	52 (76.5%)
Open mouth posture	216 (57.0%)	4 (57.7%)	56 (64.4%)	45 (71.4%)	86 (54.8%)	25 (36.8%)
Neck and shoulder tension	182 (48.0%)	0	0	4 (6.3%)	129 (82.2%)	49 (72.1%)
Bruxism	174 (45.9%)	3 (42.9%)	31 (35.6%)	12 (19.0%)	93 (59.2%)	35 (51.5%)
Headaches	119 (31.4%)	0	4 (4.6%)	4 (6.3%)	83 (52.9%)	28 (41.2%)
Temporomandibular joint dysfunction	106 (28.0%)	0	2 (2.3%)	1 (1.6%)	79 (50.3%)	24 (35.3%)
Speech issues	95 (25.1%)	3 (42.9%)	44 (50.6%)	23 (36.5%)	18 (11.5%)	7 (10.3%)

3.2. Assessment of Tongue Mobility

Among the 445 patients, 183 exhibited moderate to severe tongue mobility restriction (Grade 3: $n = 155$; Grade 4: $n = 28$) as assessed by TRMR and FOM Hold Maneuver to control compensatory recruitment of extrinsic structures such as the jaw, floor of the mouth, and neck muscles (Table 2). Among them, 75.5% were found to have DDT suggestive of a mid-tongue restriction, and 95.1% were found to have a change in range of motion using the FOM Hold Maneuver, suggestive of compensatory recruitment. Immediately after the release procedure, all patients demonstrated normal levels of tongue mobility and resolution of DDT except for 19 patients (4.5%) who exhibited partial resolution of compensation associated with tongue weakness.

Table 2. Assessment of Tongue Mobility.

	# Observed/Assessed
Number of patients with compensated mobility (TRMR and FOM Hold Maneuver)	262/445 (58.9%)
Number of patients with moderate to severe restriction of tongue mobility	183/445 (41.1%)
Grade 3	155/445 (34.8%)
Grade 4	28/445 (6.3%)
Assessment of Compensated Mobility	
Change in Range of Motion (FOM Hold Maneuver)	423/445 (95.1%)
Normal levels of tongue mobility and resolution of DDT post-release	174/183 (95.1%)
Persistently compensated mobility post-release associated with tongue weakness, instability, or fasciculation/Improved but Persistently Compensated Mobility	19/445 (4.3%)
Depression on dorsal surface of the tongue (DDT) indicative of Mid-Tongue Restriction (“posterior tongue-tie”)	198/262 (75.5%)

3.3. Overall Risks and Complications Associated with Lingual Frenuloplasty

There were 379 of the 445 patients (85.1%) for whom data with follow-up of at least 2 weeks was available with an additional mean long-term follow-up time of 83 ± 124 days. Table 3 lists overall risks and complications stratified by age. Pain: 57.0% mild, 25.9% moderate, 3.7% severe. Bleeding: 14.5% mild, 1.1% moderate; only one (0.3%) patient experienced severe or prolonged bleeding. Swelling: 23.2% mild, 11.3% moderate, 2.4% severe. Tightness or contraction: 39.1% mild, 12.1% moderate, 0.3% severe. Most symptoms of tightness or contraction are resolved on their own by 2–6 months post-op. There were 14/379 (3.6%) who were treated with triamcinolone acetonide (10 mg/mL) (Kenalog-10) (see Figure S11) to address hypertrophic scarring and there were 8 subjects (2.1%) who proceeded with a second-stage or revision lingual frenuloplasty. Numbness: 5.3% mild, 0.5% moderate. Zero patients experienced prolonged numbness of the tongue-tip over 2 weeks. Salivary gland: One patient developed an anterior lingual gland cyst that was treated by excision. There were no other long-term complications with any of the other salivary glands or ducts. To evaluate the impact of surgical protocol refinements, complication rates in the 2025 cohort were compared to those reported in the original 2019 protocol.

The updated protocol was associated with significant improvements in postoperative outcomes across multiple measures. Significant reductions were observed in the following:

- **Severe pain:** decreased from 15.8% to 3.7% (OR 4.89; 95% CI: [2.67–8.98]; $p < 0.001$).
- **Numbness:** decreased from 4.9% to 0.5% (OR 9.68; 95% CI: [2.22–42.22]; $p = 0.0013$).
- **Salivary gland issues:** decreased from 3.4% to 0.3% (OR 13.50; 95% CI: [1.75–104.37]; $p = 0.0063$).

- **Second-stage revisions:** decreased from 6.6% to 2.1% (OR 3.28; 95% CI: [1.45–7.44]; $p = 0.0022$).

Moderate pain showed a decrease from 29.3% to 25.9% ($p = 0.149$). Bleeding rates (moderate and severe) were too low in the 2025 cohort for valid statistical comparison but were notably reduced overall, from 14.6% in 2019 to 1.4% in 2025.

These findings support the conclusion that the refined 2025 protocol featuring standardized patient selection, functional surgical endpoints, and structured pre- and post-operative care, was associated with statistically and clinically meaningful reductions in complication rates

Table 3. Overall Risks and Complications.

	Reported Total n = 379	Reported Ages 4–5 n = 7	Reported Ages 6–11 n = 87	Reported Ages 12–17 n = 63	Reported Ages 18–40 n = 156	Reported Ages 41+ n = 67
Pain						
Mild	216 (57.0%)	3 (42.9%)	54 (62.1%)	39 (62.9%)	83 (53.2%)	37 (55.2%)
Moderate	98 (25.9%)	1 (14.3%)	16 (18.4%)	17 (27.4%)	45 (28.8%)	19 (28.4%)
Severe	14 (3.7%)	0	3 (3.4%)	1 (1.6%)	8 (5.1%)	2 (3.0%)
Bleeding						
Mild	56 (14.8%)	0	6 (6.9%)	13 (21.0%)	26 (16.7%)	11 (16.4%)
Moderate	4 (1.1%)	0	0	1 (1.6%)	2 (1.3%)	1 (1.5%)
Severe	1 (0.3%)	0	0	0	1 (0.6%)	0
Numbness						
Mild	24 (6.3%)	0	6 (6.9%)	1 (1.6%)	10 (6.4%)	7 (10.4%)
Moderate	2 (0.5%)	0	0	0	2 (1.3%)	0
Severe	0	0	0	0	0	0
Swelling						
Mild	88 (23.2%)	1 (14.3%)	16 (18.4%)	17 (27.4%)	40 (25.6%)	14 (20.9%)
Moderate	43 (11.3%)	0	1 (1.1%)	6 (9.7%)	23 (14.7%)	13 (19.4%)
Severe	9 (2.4%)	0	0	0	8 (5.1%)	1 (1.5%)
Tightness/Contraction						
Mild	148 (39.1%)	1 (14.3%)	22 (25.3%)	27 (43.5%)	73 (46.8%)	25 (37.3%)
Moderate	46 (12.1%)	0	4 (4.6%)	3 (4.8%)	26 (16.7%)	13 (19.4%)
Severe	1 (0.3%)	0	0	0	0	1 (1.5%)
Salivary Gland Issues	1 (0.3%)	0	0	0	1 (0.6%)	0
Second Stage/Revision	8 (2.1%)	0	0	0	4 (2.6%)	4 (6.0%)

3.4. Depth of Release

All cases included some element of mucosa and fascia dissection (Table 4). In 52.3% of cases, it was found necessary to release the genioglossus muscle to achieve the surgical goals. Cases involving release of the genioglossus muscle were associated with significantly higher reports of moderate to severe postoperative swelling compared to cases limited to mucosa and fascia only. Specifically, moderate to severe swelling occurred in 21% of patients when the muscle was released, versus just 6% when it was not. Mucosa and Fascia Only: 94% (170/181) none/mild, 6% (11/181) moderate, 0% severe; Mucosa, Fascia, and Genioglossus Muscle: 79% (157/198) none/mild, 16.1% (32/198) moderate, 4.5% (9/198) severe. The odds ratio for moderate to severe swelling was 4.0-fold higher for cases

involving the genioglossus muscle (95% Confidence Interval 1.99–8.08, Pearson Chi Square 16.9, $p < 0.0001$). There were no statistically significant differences in any of the other risks or complications by depth of release. Based on our experience, however, increasing depth does increase the complexity of the case including the possibility of bleeding and pain; this was offset with good hemostatic techniques and deep injection of Marcaine into the muscle to offset potential pain.

Table 4. Depth of Release and Associated Complications.

	# Cases
Depth of Release	445
Mucosa only	0
Cases with mucosa and fascia dissection	212 (47.7%)
Release of genioglossus muscle required	233 (52.3%)
Swelling: Mucosa and Fascia Only	181
None/Mild	170 (93.9%)
Moderate	11 (6.1%)
Severe	0
Swelling: Mucosa, Fascia, and Genioglossus Muscle	198
None/Mild	157 (79.3%)
Moderate	32 (16.1%)
Severe	9 (4.5%)

3.5. Patient-Reported Satisfaction Rates

The overall patient-reported satisfaction rate was 86% (320/372; 86% $\pm$ 1.8% SE) (Table 5). Due to the small number of children aged 4–5, they were combined with ages 6–12 for the table. Although outcomes were largely consistent across age cohorts, it is noteworthy that the youngest patients (ages 4–6) demonstrated the highest satisfaction rates. This may reflect a combination of early intervention benefits and parental reporting, but the finding should be considered preliminary given the small sample size. There were 12.1% (45/372; 12.1% $\pm$ 1.7% SE) who reported feeling “neutral” regarding their experience with no issues but no perceived benefit but only 1.3% who were “somewhat dissatisfied” (5/372; 1.3% $\pm$ 0.6% SE) or “very dissatisfied” (2/372; 0.5% $\pm$ 0.4% SE). The major complaints regarding dissatisfaction were associated with contraction, persistent tightness, or reattachment (e.g., failure to adequately improve tongue mobility to the degree of patients’ expectations or desire). One patient experienced worsening of sleep, grinding symptoms, and biting of the tongue; another patient described a subjective sense of fascia destabilization along with postural discomfort, re-emergence of tongue thrusting, and lateral tongue biting. Of the 7 dissatisfied patients, 5 had borderline structural findings on initial evaluation but elected to proceed with surgery despite being counseled on potential limitations related to tongue space.

Table 5. Patient Reported Satisfaction Rates.

	# Reported Total n (% ± SE)	# Reported Ages 4–12 n (% ± SE)	# Reported Ages 13–17 n (% ± SE)	# Reported Ages 18–40 n (% ± SE)	# Reported Ages 41+ n (% ± SE)
Number of Patients	372	108	50	152	62
Overall satisfaction rate	320 (86.0% ± 1.8%)	93 (86.1% ± 3.3%)	45 (90% ± 4.2%)	134 (88.2% ± 2.6%)	48 (77.4% ± 5.3%)
Neutral	45 (12.1% ± 1.7%)	14 (13% ± 3.2%)	5 (10% ± 4.2%)	15 (9.9% ± 2.4%)	11 (17.7% ± 4.9%)
Somewhat dissatisfied	5 (1.3% ± 0.6%)	1 (0.9% ± 0.9%)	0	2 (1.3% ± 0.9%)	2 (3.2% ± 2.2%)
Very dissatisfied	2 (0.5% ± 0.4%)	0	0	1 (0.7% ± 0.7%)	1 (1.6% ± 1.6%)

3.6. Management of Persistent Symptoms

Patients with inadequately treated symptoms and/or worsened postoperative dysfunction were treated with a combination of the following avenues: (1) topical application of serrapeptase and/or injections of triamcinolone (see Figure S11) to reduce scarring followed by revision frenuloplasty if indicated; (2) physical therapy and bodywork modalities including deep tissue laser therapy, (3) referral for evaluation and treatment of limited tongue space by a qualified dentist, orthodontist, and/or maxillofacial surgeon, (4) further myofunctional, speech, and/or swallow therapy.

Key Findings

This prospective descriptive cohort study of 445 patients builds upon our previously published 2019 series of 348 patients treated with a scissors-and-suture technique (Table 6) [10]. The refined, standardized protocol for lingual frenuloplasty combined with myofunctional therapy demonstrated enhanced safety, reproducibility, and clinical outcomes in a high-volume, real-world clinical setting.

Key advancements included:

- Standardized pre- and postoperative myofunctional therapy protocol with readiness assessments.
- Use of functional mobility endpoints (TRMR and FOM Hold Maneuver) for improved diagnosis and surgical planning.
- Transition to CO₂ laser-assisted, fascia-sparing dissection for improved surgical precision, healing, and reduced complications.
- Use of cyanoacrylate adhesives and optimized suturing for enhanced wound stability.

Table 6. Comparative Look at 2019 Study vs. 2025 Study.

Overall Risks and Complications: 2019 Protocol	Patient Reported Findings at 2 Weeks		Patient Reported Findings at 2 Weeks	
	# Reported: 2019	% Reported: 2019	# Reported 2025	% Reported: 2025
Pain				
Moderate	102/348	29.3%	98/379	25.9%
Severe	55/348	15.8%	14/379	3.7%
Bleeding				
Moderate	8/348	2.3%	4/379	1.1%
Severe	7/348	2.0%	1/379	0.3%
Numbness	17/348	4.9%	2/379	0.5%
Salivary Gland Issues	12/348	3.4%	1/379	0.3%
Second Stage/Revision	23/348	6.6%	8/379	2.1%

4. Discussion

The present findings reflect a systematic evolution in the management of ankyloglossia, transitioning from an anatomy-focused surgical technique to a functionally integrated, outcome-based protocol. In comparison to the 2019 cohort, refinements in patient selection, surgical approach, and standardized preoperative and postoperative care were associated with notable reductions in complication rates. Although this study cannot determine which components led to the improvements, the consistent application of the full protocol yielded positive outcomes across multiple domains. Under the updated 2025 protocol, severe pain decreased from 15.8% to 3.7%, moderate bleeding from 13% to 1.1%, numbness from 5% to 0.5%, salivary gland issues from 3.4% to 0.3%, and the need for second-stage revision from 6.6% to 2.1% (Table 6). These reductions in complication rates, especially in pain, bleeding, and need for revision, represent important clinical findings and warrant further study to validate in other settings. These improvements were achieved without compromising patient satisfaction, which remained high at 86%.

Age-stratified analyses revealed that outcomes were largely consistent across pediatric, adolescent, and adult cohorts, with satisfaction rates remaining high in all groups ($\geq 86\%$). Our findings highlight age-specific patterns in presenting symptoms. Pediatric patients (ages 4–11) most often presented with functional and speech-related concerns such as oral dysfunction, open mouth posture, and speech issues, with few pain complaints. Adolescents (12–17) showed a transitional profile, maintaining functional difficulties while beginning to report bruxism and headaches. In adults, particularly those ages 18–40, pain and tension symptoms (neck/shoulder tension, TMJ dysfunction, headaches, bruxism) became predominant, while functional/speech issues decreased. Older adults (41+) demonstrated persistence of functional impairment and tension, although headache prevalence declined. These patterns suggest that treatment planning should be age-informed: pediatric care may emphasize functional rehabilitation and speech support, while adult care may prioritize tension, TMJ stabilization, and pain management.

The incorporation of clearly defined functional endpoints and consistent therapeutic protocols appears to enhance clinical outcomes while promoting safety, precision, and reproducibility. In our experience, the structured clinical protocol enabled consistent application of therapy milestones, surgical endpoints, and follow-up procedures across a diverse patient population.

Ankyloglossia is increasingly recognized as a multifactorial condition with consequences extending well beyond speech and feeding. Restricted tongue mobility impairs palatal tongue posture, contributing to open-mouth posture, altered craniofacial development, dental malocclusion, clenching and bruxism, cervical strain, and sleep-disordered breathing [26–29]. In vocally demanding populations, such as singers and professional speakers, ankyloglossia may also contribute to muscle tension dysphonia (MTD), resulting in vocal fatigue, range limitations, and increased laryngeal tension [30]. Addressing these complex functional impairments requires more than anatomical correction alone. The combined approach of lingual frenuloplasty with targeted myofunctional therapy seeks to address both mechanical tethering and associated dysfunctions and behaviors, thereby enhancing overall function, health, and quality of life [7,10–12,31,32]. By freeing the tongue to achieve a fuller range of motion, frenuloplasty directly addresses the mechanical limitations imposed by ankyloglossia. Myofunctional therapy enhances the outcomes of lingual frenuloplasty by using targeted stretches and neuromuscular exercises to maintain postoperative range of motion, promote optimal wound healing, and prevent reattachment.

In addition to preserving mobility, myofunctional therapy retrains proper tongue function and reduces compensatory patterns. Long-term success is further supported by careful patient selection, appropriately timed surgical release, and integration with

adjunctive therapies such as palatal expansion, red light therapy, and bodywork modalities such as physical therapy, craniosacral therapy, manual fascial release, and other integrative techniques [33]. Although these adjunctive therapies were not directly evaluated in this study, their widespread clinical use underscores the need for further research into their potential role in optimizing long-term functional outcomes.

Major refinements to the protocol over time, have included: (1) adoption of a standardized pre- and postoperative therapy protocol with readiness assessments and defined functional mobility endpoints; (2) use of CO₂ laser-assisted, fascia-sparing dissection for precise release with minimal collateral trauma; (3) application of cyanoacrylate adhesives and refined suturing techniques to optimize wound stability and healing; and (4) incorporation of the FOM Hold Maneuver to improve diagnostic precision. These refinements contributed to improved patient outcomes, including reduced reports of postoperative pain, bleeding, numbness, and the need for revision procedures.

The FOM Hold Maneuver, used in conjunction with TRMR assessments, enhances diagnostic accuracy by identifying DDT, an objective marker of mechanical restriction. This allows clinicians to distinguish true restrictions, best addressed with surgical release, from compensated patterns, which may resolve with therapy alone. This layered approach helps prevent unnecessary interventions and strengthens diagnostic precision.

The CO₂ laser technique enhanced surgical precision by enabling controlled, layer-by-layer dissection with preservation of fascia and muscle when indicated, thereby reducing complications and promoting faster healing trajectories. Deeper dissection involving the genioglossus muscle was associated with transient swelling but did not increase the risk of major complications.

Importantly, diagnosis of tongue-tie should rest on demonstrable functional limitation, not merely on anatomical appearance or secondary signs such as high-arched palate or mouth breathing. Multiple etiologies, including nasal obstruction, adenoidal hypertrophy, and poor orofacial tone can contribute to low tongue posture. When restriction is suspected but not clearly visualized, tongue-tie should be a diagnosis of exclusion after failed conservative therapy. This approach helps mitigate overdiagnosis and reinforces clinical integrity.

A key strength of this study is its pragmatic design: outcomes were prospectively captured from a high-volume, authentic clinical setting using a reproducible, standardized protocol. The pragmatic aspect allows the results to be considered in light of real-world settings, acknowledging the limitations inherent in clinical variability and non-controlled conditions. These findings support the safety, feasibility, and efficacy of this combined surgical–therapeutic approach and provide a strong foundation for further interdisciplinary training and controlled trials.

Future research should continue to refine surgical endpoints, further isolate the effects of individual protocol components, and explore novel adjunctive modalities such as 800–1064 nm wavelength laser therapy (e.g., red light therapy, cold laser, Oralase) for their potential to enhance healing, reduce inflammation, alleviate pain, and improve neuromuscular outcomes.

Limitations

Despite the advancements and comprehensive approach of the current study, several limitations should be noted. Although this study is prospective, which helps reduce some biases inherent in retrospective studies, it lacks a control group, which limits the ability to draw definitive conclusions about the efficacy of the interventions compared to alternative treatments or no treatment at all.

The follow-up period in this study was also relatively short, extending just over two months for most patients. However, this timeframe is relevant to the stages of wound healing during which contraction occurs and generally is completed and the maturation process has begun [34,35]. While many patients continued with orofacial myofunctional therapy beyond the formal follow-up window (2 weeks standardized objective (WHIMS) and subjective reporting with some additional reports at >2 months), no structured long-term tracking of functional outcomes was conducted. Future studies with extended follow-up are warranted to assess the durability of therapeutic gains in breathing, chewing, swallowing, oral rest posture, speech, and quality of life.

While patient-reported outcomes are valuable for capturing patient satisfaction and perceived benefits, they remain subjective and prone to recall bias or patient expectations. Objective measures are crucial in future research to complement these findings, ensuring a more comprehensive understanding of the intervention's true efficacy. Additionally, variations in surgical techniques (e.g., use of scissors vs. CO₂ laser) could have impacted the outcomes observed in this study. While this study emphasizes the importance of a holistic and multidisciplinary approach to treating ankyloglossia, further exploration is needed to determine the specific contributions of each component, such as nasal breathing rehabilitation, myofunctional therapy, physical therapy and additional body work modalities, and lingual frenuloplasty toward the overall outcomes.

Lastly, assessment tools such as TRMR and CBCT have been primarily validated in older children and adults. However, these tools remain useful in younger pediatric populations when interpreted with appropriate clinical judgment. These measures may demonstrate greater variability among children due to normal developmental differences, cooperation levels, and results should therefore be interpreted within that clinical context. Small subgroup sample sizes may also limit power for certain age-based comparisons. Additionally, the lack of inter-rater reliability measures and the absence of standardized outcome validation tools limit generalizability. Future research should prioritize the development and testing of all assessment tools and protocol components for reliability and validity across age groups and clinical settings.

5. Conclusions

This prospective descriptive cohort study demonstrates that a refined, standardized protocol for lingual frenuloplasty combined with myofunctional therapy can be safely and effectively implemented in a high-volume, real-world setting. The evolution of this protocol from an anatomy-based surgical model to a functionally integrated, outcome-driven protocol reflects significant advancements in surgical precision, functional assessment, perioperative care, and interdisciplinary management of ankyloglossia.

By addressing both structural restrictions and neuromuscular compensations, this combined treatment approach yields reproducible, durable functional outcomes with fewer complications and high patient satisfaction. Although presenting symptoms varied by age, with younger patients more frequently affected by speech and feeding issues and adults more often reporting TMJ and postural complaints, treatment outcomes were uniformly favorable. High satisfaction and low complication rates across all age cohorts suggest that the refined lingual frenuloplasty protocol is both safe and effective throughout the developmental spectrum. The integration of validated assessment tools (TRMR, FOM Hold Maneuver), fascia-sparing surgical techniques, and optimized wound management has further enhanced diagnostic precision, surgical planning, and clinical outcomes. This work highlights the efficacy of a multidisciplinary protocol that integrates surgical release, myofunctional therapy, and adjunctive modalities to achieve durable improvements in tongue function and orofacial health.

To support reproducibility and broader clinical adoption, all protocol components, including assessment tools, surgical best practices, and structured therapy frameworks, have been consolidated into a Clinical Protocol Visual Companion Guide (Supplementary Material), developed to facilitate training, protocol fidelity, and future validation efforts.

This refined protocol provides an evidence-based, replicable model for interdisciplinary teams seeking to advance outcomes in the management of ankyloglossia and related orofacial myofunctional disorders.

Supplementary Materials: The following supporting information can be downloaded at: <https://www.mdpi.com/article/10.3390/ijom51020011/s1>, Clinical Protocol Visual Companion Guide which includes Figures S1–S14.

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Abbreviations

The following abbreviations are used in this manuscript:

OMD	Orofacial Myofunctional Disorder
OMT	Orofacial Myofunctional Therapy
RCT	Randomized Controlled Trial
SLP	Speech-Language Pathologist
RDH	Registered Dental Hygienist
IAOM	International Association of Orofacial Myology
AOMT	Academy of Orofacial Myofunctional Therapy
TRMR	Tongue Range of Motion Ratio
TRMR-TIP	Tongue Range of Motion Ratio—Tip to Incisive Papilla
TRMR-LPS	Tongue Range of Motion Ratio—Lingual Palatal Suction
CMO	Comfortable Mouth Opening
FOM	Floor of Mouth
DDT	Depression on the Dorsal Surface of the Tongue
MTD	Muscle Tension Dysphonia
OSA	Obstructive Sleep Apnea
WHIMS	Wound Healing Integration + Maturation Scale
CO ₂	Carbon Dioxide (as in CO ₂ laser)

HIPAA Health Insurance Portability and Accountability Act
 IRB Institutional Review Board

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Systematic Review

Mouth Breathing and Obstructive Sleep Apnea in Children: An Umbrella Review

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Abstract: Background: Mouth breathing and obstructive sleep apnea (OSA) in children are interrelated conditions that can negatively impact neurocognitive development and overall quality of life. This study aimed to critically analyze the available evidence regarding the relationship between these conditions, highlighting their prevalence, clinical consequences, and therapeutic approaches. Methods: To this end, an umbrella review was conducted, including systematic reviews and meta-analyses retrieved from scientific databases, following rigorous inclusion criteria. Results: A total of six systematic reviews met the inclusion and exclusion criteria and were included in the final analysis. These studies explored various aspects of the topic and underwent a thorough assessment of methodological quality. Conclusions: The findings indicated that mouth breathing may act as both a predisposing and aggravating factor for OSA, while OSA itself may contribute to the persistence of this breathing pattern. However, the methodological heterogeneity among the included studies posed a challenge to synthesizing the findings, underscoring the need for more standardized research. It is concluded that early interventions and multidisciplinary approaches are essential for the effective management of these conditions. Furthermore, this review provides a foundation for future research in this area.

Keywords: obstructive sleep apnea; mouth breathing; umbrella review; pediatrics; sleep disorders

1. Introduction

Sleep plays an indispensable role in neurological, somatic, and psychosocial development during childhood and adolescence [1]. The architectural integrity of sleep is fundamental for memory consolidation, emotional regulation, and endocrine and immune function [2,3]. However, this vital process can be profoundly disrupted by sleep-disordered breathing (SDB), of which obstructive sleep apnea (OSA) represents the most prevalent and clinically significant manifestation in the pediatric population, with prevalence estimates ranging from 1% to 5% [4]. OSA is characterized by recurrent episodes of partial or complete collapse of the upper airway during sleep. This obstruction results in interruptions of airflow that trigger a pathophysiological cascade of intermittent hypoxemia, hypercapnia, frequent arousals, and sleep fragmentation [5]. The primary anatomical cause in children is adenotonsillar hypertrophy, although factors such as obesity and craniofacial anomalies are also significant contributors [6].

The consequences of untreated pediatric OSA are multisystemic and can lead to long-term morbidities. In the neurocognitive domain, sleep fragmentation and chronic hypoxemia are associated with deficits in executive functions, attentional difficulties, impaired

academic performance, and symptoms that mimic attention-deficit/hyperactivity disorder (ADHD) [7,8]. Furthermore, growing evidence points to cardiovascular repercussions, including endothelial dysfunction, elevated blood pressure, and cardiac remodeling, as well as metabolic disturbances, such as insulin resistance [9,10]. Such adverse outcomes compromise a child's quality of life and underscore the urgency of the early identification and intervention.

Within the spectrum of risk factors for pediatric OSA, mouth breathing has emerged as a central element, not merely as a symptom but as a potential causal agent in the development and perpetuation of airway obstruction. Chronic mouth breathing, often a compensatory adaptation to nasal obstruction from conditions like allergic rhinitis or adenoid hypertrophy, disrupts the functional equilibrium of the stomatognathic system [11]. The absence of physiological nasal airflow and the abnormally low posture of the tongue alter the forces that shape the growth and development of maxillomandibular structures. This can result in an anomalous craniofacial growth pattern, classically described as "adenoid facies", which includes a high-arched palate, mandibular retrognathia, and increased anterior lower facial height [12–17].

These morphological and postural changes are not merely cosmetic; they hold direct implications for upper airway patency. The atresic maxilla and repositioned mandible contribute to the narrowing of the pharyngeal airway space, predisposing the individual to a greater risk of collapse during sleep and, consequently, aggravating the severity of OSA [18–22]. A vicious cycle is thus formed: nasal obstruction leads to mouth breathing, which promotes craniofacial changes that, in turn, exacerbate airway obstruction and perpetuate the dependence on mouth breathing throughout life [3,23–26].

The multifactorial nature and bidirectional relationship between mouth breathing and pediatric OSA have generated a vast and heterogeneous body of research, spanning various specialties such as otolaryngology, orthodontics, pediatrics, and sleep medicine. Despite the clinical recognition of this association, the literature lacks a systematic synthesis that integrates the evidence on prevalence, risk factors, dysmorphic consequences, and therapeutic strategies [10,27–32]. The breadth of these approaches necessitates a comprehensive and critical evaluation of the scientific knowledge produced to date. Therefore, the objective of this study is to conduct an umbrella review of the current evidence on the role of mouth breathing in the context of pediatric OSA, with the aim of critically analyzing trends, identifying knowledge gaps, and delineating the clinical implications of this complex association to optimize clinical practice and direct future investigations.

This study is justified by the need for an umbrella review that synthesizes the available evidence, providing a global and reliable perspective on the topic. In addition to offering essential information for healthcare professionals, educators, and policymakers, this research may guide future studies and contribute to the development of preventive and therapeutic strategies aimed at minimizing the impacts of OSA in children.

2. Objectives

This study aims to conduct an umbrella review on the topic Mouth Breathing and Obstructive Sleep Apnea (OSA) in Children. The umbrella review represents a robust methodology for synthesizing complex research, enabling a comprehensive and reliable analysis of the scientific knowledge on a specific subject.

Specific Objectives

- To synthesize the results of different systematic reviews on the relationship between mouth breathing and OSA in children.
- To assess the methodological quality of the included systematic reviews.

- To analyze different perspectives on the topic.
- To identify inconsistencies and knowledge gaps regarding the subject, guiding future research.
- To provide theoretical and practical implications for healthcare professionals, educators, and policymakers regarding the importance of assessing and managing mouth breathing in children.

3. Methodology

This umbrella review was conducted and reported in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 statement [4] (Figure S2). The study exclusively selected systematic reviews and meta-analyses centered on mouth breathing and obstructive sleep apnea (OSA) within a pediatric population, defined as individuals aged 0 to 18 years. This paper is not registered in a public registry. PRIOR checklist was performed (Supplementary Materials Figure S1).

The selection process was rigorous and systematic. Two reviewers independently screened titles and abstracts for eligibility. The full texts of potentially relevant studies were subsequently assessed against the inclusion criteria. Any disagreements at either stage were resolved through discussion or, if necessary, consultation with a third reviewer to reach a consensus. Following selection, a formal data extraction was performed by one reviewer using a predefined, standardized form; a second reviewer then meticulously verified the extracted data to ensure accuracy and completeness.

To ensure the methodological robustness of the included literature, a critical appraisal was conducted using the A MeaSurement Tool to Assess systematic Reviews 2 (AMSTAR 2.0). This assessment was performed independently by two reviewers, with any discrepancies in ratings resolved through consensus or adjudication by a third party. Finally, due to the anticipated high degree of clinical and methodological heterogeneity among the included reviews and the qualitative nature of the evidence synthesis, a formal assessment of publication bias was not performed. ChatGPT (version 3.5) was used for linguistic editing in English.

3.1. Study Eligibility Criteria

Eligibility for inclusion in this review was predicated on a defined set of criteria. The review only considered systematic reviews and meta-analyses that investigated the relationship between OSA and mouth breathing. The target population was strictly pediatric, encompassing studies focused exclusively on children and adolescents (0–18 years). Studies were excluded if their scope was narrowed to specific subpopulations with distinct anatomical malformations, genetic syndromes, or other significant comorbidities that could confound the results and thereby limit the generalizability of the findings to the broader pediatric population.

3.2. Information Sources

A comprehensive and systematic literature search was conducted across several major electronic databases renowned for their extensive coverage in health sciences. The platforms utilized were PubMed, Scopus (Elsevier), Web of Science, SciELO, and EMBASE. This multi-database approach was designed to ensure the thorough and up-to-date retrieval of all relevant literature.

3.3. Search Strategy

The search strategy was meticulously developed utilizing a combination of Medical Subject Headings (MeSH) and free-text keywords in English. Core search concepts included “mouth breathing,” “oral breathing,” “obstructive sleep apnea,” “children,” and

“pediatrics,” along with their relevant variations. Boolean operators (AND, OR) were strategically employed to combine these terms. The search encompassed all literature published up to August 2024 and was filtered within each database to retrieve only articles classified as systematic reviews or meta-analyses.

4. Results

4.1. Methodological Quality Assessment

The methodological quality of each included review was systematically evaluated using the 16-item AMSTAR 2.0 checklist. This instrument facilitates a critical appraisal of the conduct and reporting of systematic reviews. Two reviewers independently assigned ratings across each domain, culminating in an overall confidence rating for each review: high, moderate, low, or critically low. This process involved a detailed assessment of critical domains, including the a priori registration of a protocol, the adequacy of the literature search, and the consideration of risk of bias in the primary studies. The final ratings provided a structured framework for interpreting the robustness of the evidence presented in each review and for contextualizing the overall synthesis of findings.

The studies included in this umbrella review investigated different aspects of the relationship between mouth breathing and OSA in children. While some reviews focused on prevalence and risk factors, others analyzed the effectiveness of specific interventions. Although there is consensus on the negative impact of mouth breathing on sleep quality, diagnostic methods and study populations varied, making direct comparisons challenging (Table 1).

Table 1. Results of the AMSTAR 2.0 Assessment.

Study Reference	Protocol Registered	Included Studies Quality	Clear Inclusion/Exclusion Criteria	Adequate Database Search	Risk of Bias Assessment	Discussion on Bias Impact	Final Rating
Barbosa et al. (2023) [9]	Yes	Moderate	Yes	Yes	Yes	Yes	High confidence
Ji et al. (2021) [10]	No	Moderate	Yes	Yes	Yes	Yes	Moderate confidence
Lumeng & Chervin (2008) [5]	No	High	Yes	Yes	Yes	Yes	High confidence
Mohammed et al. (2021) [6]	No	Low	Yes	Yes	Yes	No	Low confidence
Neiva et al. (2018) [7]	No	Low	Yes	Yes	Yes	No	Low confidence
Zhao et al. (2021) [21]	Yes	Moderate	Yes	Yes	Yes	Yes	Moderate confidence

Given the broad scope of the topic Mouth Breathing and Obstructive Sleep Apnea in Children, the analysis of the included studies was structured into thematic categories, allowing for clearer organization of the findings and facilitating comparison among systematic reviews and meta-analyses (Figure 1).

Categorization was based on the main focuses of the studies, resulting in the following areas of analysis: prevalence, risk factors and pathophysiological mechanisms, impact on child health and development, and therapeutic interventions (Table 2). Each study was classified according to its primary approach, and the results were synthesized within each category.

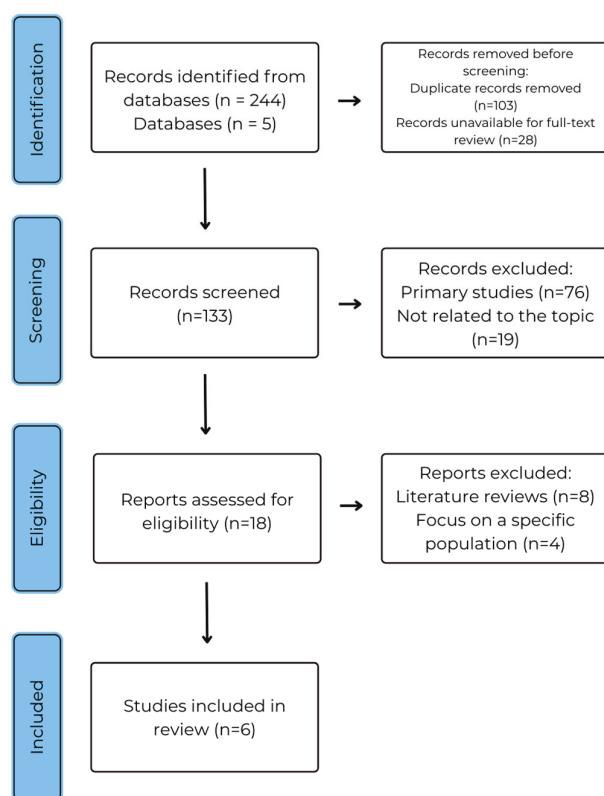


Figure 1. PRISMA Flow Diagram.

Table 2. Categorization of the Studies.

Category	Key Findings	References	Limitations
Epidemiology and Diagnosis	OSA prevalence ranges from 0.1% to 13%; lack of standardized diagnostic criteria	Lumeng & Chervin (2008) [5]	Inconsistent diagnostic methods
Child Development	Craniofacial alterations, postural changes, and speech/language impairments associated with mouth breathing	Zhao et al. (2021) [21]; Neiva et al. (2018) [7]; Mohammed et al. (2021) [6]	Small sample sizes, selection bias
Therapeutic Interventions	RME and montelukast show promising results, but evidence remains limited	Barbosa et al. (2023) [9]; Ji et al. (2021) [10]	High heterogeneity, potential adverse effects

This categorization enabled the identification of convergences and divergences among studies, highlighting methodological aspects that may influence findings. Furthermore, it revealed gaps in the literature, underscoring the need for more integrative studies that address the relationship among the different factors analyzed.

4.2. Findings from Individual Studies

4.2.1. Epidemiology and Diagnosis of OSA

The review conducted by Lumeng and Chervin (2008) [5] provides a comprehensive overview of the epidemiology of pediatric OSA, with particular emphasis on the challenges associated with defining, diagnosing, and estimating the prevalence of this condition. The wide variability in methods prevented comparisons across studies and hindered

the generalization of findings. Consequently, the study highlighted the need for more standardized diagnostic criteria.

The authors emphasized diagnostic challenges in pediatric OSA in the context of growing recognition of the disorder, noting that few studies have established direct correlations between OSA severity levels and adverse clinical outcomes. One of the main inconsistencies lies in the heterogeneity of the Apnea-Hypopnea Index (AHI) criteria, ranging from 1 to 5 events per hour, with no clear consensus on the optimal cut-off.

Other patient assessment methods were also discussed, including home audio and video recordings, as well as pulse oximetry, which, although promising, still requires extensive validation against polysomnography (PSG), the gold standard for OSA diagnosis. Additional aspects reviewed included the reliability of questionnaires for screening snoring and sleep disorders, and the lack of standardized definitions of clinical entities across populations, which limits reproducibility.

Regarding prevalence, pediatric OSA has been estimated to range from 0.1% to 13%, depending on methodology, sampling, and population, with most studies reporting between 1% and 4%. The authors also observed demographic variations and suggested that differences in the perception of snoring between community and clinical populations may influence prevalence estimates.

In conclusion, the study underscored the need for further research employing increasingly standardized diagnostic criteria and sampling strategies to facilitate early diagnosis and intervention in pediatric OSA. These findings highlight the importance of systematic and rigorous approaches to understanding the condition and its impact on child health (Table 3).

Table 3. Summary of Findings.

Study Reference:	Total Studies Included:	Population (Sample):	Metrics:	Main Findings:
Barbosa, D. et al., 2023 [9]	8	0–18 years	AHI; SaO ₂ ; LSAT; AI;	The studies presented high heterogeneity, compromising the uniformity of results. Despite some improvements in sleep after RME, the evidence is limited for definitive recommendations. The study highlights the importance of assessing the disease phenotype prior to intervention and reinforces the need for preventive strategies for childhood respiratory disorders.
Ji, T. et al., 2021 [10]	4	0–18 years	AHI; ODI; AI; SpO ₂ ; PSQ; OSA-18;	Montelukast, when combined with conventional treatments, showed improvements in sleep parameters, such as apnea-hypopnea index and oxygen saturation. However, concerns remain regarding serious side effects reported by the FDA. The quality of evidence was considered moderate due to methodological limitations and inconsistencies across studies.

Table 3. Cont.

Study Reference:	Total Studies Included:	Population (Sample):	Metrics:	Main Findings:
Lumeng et al., 2008 [5]	48	0–18 years	AHI; ODI; SDB Score;	The study highlights the lack of standardization in diagnostic criteria for pediatric OSA, resulting in wide variability in prevalence (0.1% to 13%). It points out the limitations of alternative methods, such as questionnaires and home recordings, and reinforces the need for standardized diagnoses to improve identification and intervention in at-risk children.
Mohammed, D. et al., 2021 [6]	6	2–13 years	PSG; Behavior Rating Inventory of Executive Function–Preschool Version (BRIEF-P); Child Behavior Checklist (CBCL 1.5–5); Caregiver-Teacher Report Form (C-TRF 1.5–5); Behavior Assessment System for Children, 2nd Ed. (BASC-II) Parent/Primary; Psychological tests, such as the Token Test (TT); Physical examinations to assess adenotonsillar hypertrophy and malocclusion.	It was concluded that speech and language difficulties are common in these children, with an impact associated with low oxygen saturation during sleep, affecting neurocognitive and neurobehavioral functions. However, the quality of evidence was considered very low due to methodological limitations and small sample sizes.
Neiva, P. D. et al., 2018 [7]	10	5–14 years	New York Postural Assessment Scale; Photography; Motion capture; Postural Analysis Software (SAPO); Goniometer; ALC image; MATLAB (version 2.1) program routines.	The review indicates a possible association between mouth breathing and postural changes in children, such as forward head posture and body misalignment. However, all studies analyzed presented low methodological quality, with shortcomings in participant description and in the standardization of assessment methods. Thus, no conclusive evidence exists, underscoring the need for more rigorous research to validate this relationship.

Table 3. Cont.

Study Reference:	Total Studies Included:	Population (Sample):	Metrics:	Main Findings:
Zhao, Z. et al., 2021 [21]	10	2–14 years	SNA (Sella–Nasion–A); SNB (Sella–Nasion–B); ANB; SN-OP (Sella–Nasion–Occlusal Plane); SN-PP (Sella–Nasion–Palatal Plane); PP-MP (Palatal Plane–Mandibular Plane); SNGoGn (Sella–Nasion–Gonion); 1-NA (Tooth 1–Nasion); 1-NB (Tooth 1–B); Overjet; Overbite; SPAS; PAS; C3-H;	The findings showed that children with mouth breathing had unique facial characteristics, such as posterior mandibular rotation, steeper occlusal plane, and limited upper arch width, commonly referred to as an “adenoid face.” Additionally, this group presented higher frequencies of malocclusion, especially Class II and crossbite. The study also demonstrated that nasal stenosis exacerbates these changes. Comparisons were made using control groups, and statistically significant differences in facial growth were identified, emphasizing the need for early diagnosis and timely intervention in pediatric patients.

4.2.2. Impacts of OSA on Child Health and Development

a. Postural Disorders

The review by Neiva et al. (2018) [7] examined the association between mouth breathing and postural alterations in children, assessing the methodological quality of existing studies on this topic. Studies published up to March 2016 were retrieved from MEDLINE, CINAHL, PEDro, LILACS, EMBASE, and the Cochrane Central databases, resulting in the selection of ten studies including 417 children aged 5 to 14 years. Postural assessment methods varied, ranging from photographs to specific software, and methodological quality was evaluated using the Downs and Black checklist (external validity, bias control, and confounding variable control).

The average methodological quality scores of the included studies were low. Key limitations identified included the lack of participant descriptions and methodological details regarding posture assessment, as well as failure to control for variables such as age and type of mouth breathing. Despite these limitations, limited evidence supported the hypothesis that mouth-breathing children present with forward head posture, body misalignment, and scapular changes, although further confirmation is needed.

The review concluded that current evidence is limited and emphasized the importance of rigorous and standardized methods for evaluating posture in mouth-breathing children in future studies. These findings underline the need for cautious approaches among healthcare professionals, such as physiotherapists and pediatric respiratory and developmental specialists, to verify potential postural effects of mouth breathing and to promote timely interventions.

b. Craniofacial Development

The review by Zhao et al. (2021) [21] examined how mouth breathing affects the craniofacial skeletal system and dental occlusion in children up to 18 years of age. The review included clinical trials and cohort studies assessing maxillofacial deformities associated with this breathing pattern, applying cephalometric markers to measure structural variations.

The findings revealed that mouth-breathing children exhibited distinctive facial characteristics, such as posterior mandibular rotation, a steeper occlusal plane, and reduced maxillary arch width, commonly described as the “adenoid face.” Additionally, this group showed a higher prevalence of malocclusions, particularly Class II malocclusion and cross-bite. The study also noted that nasal stenosis exacerbates these changes. Comparisons with control groups revealed statistically significant differences in facial growth, highlighting the importance of early diagnosis and timely intervention in pediatric patients.

Despite methodological heterogeneity among the included studies, this systematic review underscores the relevance of addressing mouth breathing to mitigate its effects on craniofacial development in children.

c. Speech Development

The review “The Impact of Childhood Obstructive Sleep Apnea on Speech and Oral Language Development: A Systematic Review”, conducted by Dania Mohammed et al., analyzed the relationship between sleep-disordered breathing and communication difficulties in children. The review included studies published between 2000 and 2020, focusing on children aged 2 to 13 years diagnosed with OSA or sleep-disordered breathing. After rigorous screening, only six articles were selected, and methodological quality was assessed using the PEDro-P tool.

The results indicated that speech and language difficulties are common in these children, with one study addressing speech specifically and five others investigating receptive and expressive language. Associations were also identified between lower oxygen saturation levels during sleep and language performance, suggesting that the impact of OSA extends beyond communication, affecting neurocognitive and neurobehavioral functions. However, the quality of evidence was deemed very low due to methodological limitations and small sample sizes.

The review concluded that significant gaps remain in the literature and reinforced the need for more robust studies to clarify how these disorders affect speech and language development. It also highlighted the importance of involving speech–language pathologists in early assessment and intervention, recommending a multidisciplinary approach to minimize the impact of OSA on child communication.

4.2.3. Therapeutic Interventions for OSA

a. Rapid Maxillary Expansion (RME)

The review by Barbosa et al. (2023) [9] investigated the effectiveness of Rapid Maxillary Expansion (RME) as a treatment for pediatric OSA. The main objective was to compare polysomnographic parameters across studies to determine whether RME is a viable alternative in managing pediatric OSA. To this end, the authors conducted a systematic review of eight meta-analytic reviews, analyzing outcomes such as the Apnea-Hypopnea Index (AHI) and oxygen desaturation levels.

The results revealed substantial heterogeneity among studies, with methodological differences compromising consistency. Although some studies demonstrated improvements in sleep parameters following RME, the authors emphasized that the overall quality of available evidence remains limited and insufficient to support definitive recommendations. The study further stressed the importance of evaluating disease phenotype before selecting interventions and highlighted the role of preventive strategies for childhood sleep-disordered breathing.

In conclusion, the authors suggested that although RME is a widely used orthopedic procedure, current evidence is insufficient to confirm its efficacy in treating pediatric OSA. Further high-quality research is required to guide clinical practice more accurately.

b. Montelukast

The review by Ji et al. (2021) [10] investigated the use of montelukast as a therapeutic option for children with mild to moderate OSA. The study aimed to evaluate the drug's efficacy and safety through randomized controlled trials. Four studies were included, involving a total of 305 children, and findings indicated that montelukast, when combined with conventional treatments, significantly improved sleep parameters such as AHI and oxygen saturation.

However, the review also warned of potential severe side effects associated with the drug, as reported by the FDA, raising concerns about its safety. The overall quality of evidence was rated as moderate due to methodological limitations and inconsistencies across studies.

Montelukast functions by blocking the action of leukotrienes, inflammatory mediators that can cause airway constriction and increased mucus production. Its mechanism involves binding to leukotriene receptors, thereby reducing inflammation, improving airway morphology, and alleviating OSA symptoms such as snoring. The drug is administered orally and is typically used as part of a broader treatment strategy, particularly in children with mild to moderate OSA.

The authors concluded that although benefits were observed, further rigorous studies are needed to confirm montelukast's efficacy and clarify its associated risks in pediatric OSA management.

4.3. Results of Syntheses

The presentation of results was conducted using comparative tables and descriptive syntheses, which facilitated data visualization and enabled critical discussion of the limitations and implications of the findings for clinical practice and future research.

5. Discussion

The findings of this review corroborate the existing literature by demonstrating that Obstructive Sleep Apnea (OSA) in childhood can significantly impact anatomical, neurocognitive, behavioral, and language development, highlighting the need for early interventions. Based on the results, it was possible to identify the multifaceted nature of the topic and, in particular, the cyclical relationship between OSA and mouth breathing, since mouth breathing may predispose to apnea, while apnea may, in turn, reinforce the habit of mouth breathing. This interrelationship underscores the importance of multidisciplinary approaches in diagnosis and treatment, involving dentists, otorhinolaryngologists, speech-language pathologists, and pediatricians.

At a broader level, a recurring pattern was observed across several of the studies evaluated: the presence of significant methodological shortcomings. These limitations introduced complexity in the synthesis of results, as many of the findings were considered inconsistent due to the low quality of the primary studies included. Methodological heterogeneity compromised the validity of the findings and hindered data comparability, rendering the application of more advanced statistical analyses, such as meta-analysis, unfeasible.

Beyond methodological issues, the lack of standardization in diagnostic criteria and outcome measures also undermines the reliability of the studies. The absence of uniform parameters for assessing pediatric OSA may lead to variability in results and impede evidence synthesis. This reinforces the need for the adoption of more standardized and rigorous methodological criteria to establish comparable metrics and generate more robust findings in systematic and umbrella reviews.

From a clinical standpoint, the findings of this review highlight the importance of therapeutic strategies such as Rapid Maxillary Expansion (RME) and the use of montelukast.

While some evidence suggests that RME may improve polysomnographic parameters, the quality of studies remains variable, preventing definitive conclusions about its efficacy in managing pediatric OSA. Montelukast, in turn, demonstrated potential in reducing symptoms associated with mild to moderate OSA; however, its long-term safety continues to raise concerns, particularly due to FDA warnings regarding possible neuropsychiatric side effects.

Therefore, the results of this review point to the need for further high-quality research, especially randomized clinical trials and longitudinal studies, to evaluate the impact of different therapeutic approaches on the neurocognitive and anatomical development of children with OSA. In addition, health policies directed at the early screening and continuous follow-up of these children are essential to minimize the impacts of OSA and improve patients' quality of life. Thus, this study reinforces the relevance of a multidisciplinary approach and the implementation of evidence-based strategies for the management of pediatric OSA.

Supplementary Materials: The following supporting information can be downloaded at: <https://www.mdpi.com/article/10.3390/ijom51020013/s1>, Figure S1: PRIOR Checklist [33]; Figure S2: PRISMA Checklist [4].

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Review

Myofunctional Therapy in Atypical Swallowing: A Scoping Review

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Abstract: Background: Orofacial myofunctional therapy (OMT) is frequently applied to correct atypical swallowing, yet its therapeutic strategies remain heterogeneous and poorly standardized. Objective: This scoping review aimed to characterize the strategies described in the literature for OMT in individuals diagnosed with atypical swallowing. Methods: Following Joanna Briggs Institute and PRISMA-ScR guidelines, and with a registered protocol, we included clinical and experimental studies without age restriction, conducted in clinical or research contexts. Studies were retrieved from PubMed, EMBASE, and Cochrane Library using MeSH terms and specific keywords. Data were extracted using a standardized form and summarized descriptively. Results: Twelve studies published between 1989 and 2024, involving 164 participants aged 5–26 years, were included. Interventions were mainly performed by speech-language pathologists in pediatric and adolescent populations, combining tongue posture exercises, muscle strengthening, orofacial mobility, and functional swallowing training. Treatment duration ranged from 8 weeks to 6 months, with weekly sessions and home practice recommendations. In 83% of studies, improvements in swallowing patterns and tongue posture were reported, especially when combined with orthodontic treatment. Conclusions: OMT is characterized as a multifactorial intervention integrating muscle training and functional re-education, but variability in protocols and lack of standardization limit clinical comparability. Future multicenter studies with greater methodological control are needed.

Keywords: atypical swallowing; tongue interposition; tongue thrusting; myofunctional therapy; rehabilitation of speech and language disorders

1. Introduction

Swallowing is a physiological process that, along with other orofacial functions such as chewing and sucking, allows the intake of food and liquids, thus ensuring body hydration [1]. The function of swallowing involves a series of coordinated movements between the muscles of the mouth, such as the tongue, lips, and cheeks, as well as the pharyngeal

and esophageal muscles [2]. These movements are controlled by both the central and peripheral nervous systems, ensuring proper functional performance [3].

Throughout life, oral structures grow and change, allowing for the development and maturation of orofacial functions [1]. During this process, various adaptations occur in response to functional demands related to age and the passage of time [4]. One example is the evolution of the swallowing function, which is initially characterized by tongue movements interposed between the gingival ridges in early childhood. However, between 12 and 15 months, thanks to the eruption of teeth, these movements evolve, and the tongue tip begins to position itself in the anterior third of the hard palate. This phenomenon is described as the transition from infant swallowing to mature swallowing [5]. This mature swallowing process contributes to the growth of orofacial structures and the consolidation and maintenance of the morphofunctional balance of the stomatognathic system [6].

The persistence of the infant swallowing pattern is considered pathological. This dysfunctional process is most commonly referred to as atypical swallowing, and in the literature it may also appear as tongue thrust swallowing or infantile swallowing [7]. All of these terms describe an abnormal swallowing pattern that occurs during the oral preparatory and oral (propulsive) phases of swallowing, and is characterized by incorrect tongue positioning—typically pressing against the anterior or lateral teeth during swallowing and/or at rest [8]. This affects the myofunctional balance of the oral structures, leading to poor maxillofacial development and potentially resulting in dental malocclusions [9]. The causes of these inappropriate movements are varied and include unhealthy oral habits, lack of functional exposure during childhood (such as limited opportunities for chewing solid foods, delayed weaning from bottle feeding, or insufficient practice of adequate swallowing patterns), as well as mouth breathing, among other factors [10].

The diagnosis of atypical swallowing is part of the evaluation of orofacial myofunctional disorders and requires a comprehensive understanding of the muscular condition and functions of the stomatognathic system. This evaluation is commonly performed by speech-language pathologists in collaboration with orthodontists and other dental specialties [11]. Several clinical protocols guide the identification of atypical swallowing. These include procedures that assess lip competence during swallowing, the degree of tongue interposition, mandibular sliding, head movement, facial muscle tension, and the efficiency of swallowing solids and liquids. Such parameters are often quantified using numerical scoring systems to better capture functional impairments. Among these tools, standardized instruments like the Orofacial Myofunctional Evaluation with Scores (OMES) protocol have been increasingly adopted in both clinical and research settings to support diagnostic reasoning and inform evidence-based therapeutic planning [12].

Regarding orofacial myofunctional therapy for atypical swallowing, it is important to note that it focuses on restoring neuromuscular movement patterns with the goal of reorganizing muscle function, both at rest and during swallowing [8]. In atypical swallowing, these altered patterns may include tongue thrusting against or between the teeth, reduced elevation of the tongue tip to the hard palate, inadequate lip closure, and excessive or uncoordinated activation of perioral and mandibular muscles [6–8].

Although various clinical approaches have been described, there is currently no widely accepted set of intervention strategies specific to speech-language pathology treatment for atypical swallowing—defined here as a dysfunction involving the oral preparatory and oral (propulsive) phases of swallowing. Instead, most existing studies have primarily focused on improving early detection (such as identifying abnormal tongue posture, atypical swallowing patterns, or associated oral habits) and providing diagnostic guidance (establishing criteria and clinical indicators that support speech-language pathologists and dental specialists in determining the presence and severity of atypical swallowing).

Consequently, there is limited information on structured, evidence-based therapeutic strategies targeting these two phases. It is important to note that effective and well-researched intervention approaches exist for other swallowing disorders, particularly those affecting the pharyngeal phase, commonly addressed in the context of dysphagia.

Thus, this study aims to characterize orofacial myofunctional therapy in patients diagnosed with atypical swallowing through a scoping literature review. Based on this objective, the following guiding question was established: “How has orofacial myofunctional therapy been characterized in patients diagnosed with atypical swallowing through the scientific literature?”.

2. Materials and Methods

2.1. Protocol

This scoping review was conducted following the methodology proposed by the Joanna Briggs Institute (JBI) for scoping reviews [13]. Furthermore, the writing of this article followed the guidelines of the Preferred Reporting Items for Systematic Reviews and Meta-Analysis Extension for Scoping Reviews (PRISMA-ScR) [14]. The PRISMA checklist can be found in Table S1. The protocol for this review was registered in the Open Science Framework (<https://osf.io/nftks/>; accessed on 17 September 2024)

The population, concept, and context (PCC) strategy [13] was adopted for study inclusion: (a) regarding the population: individuals diagnosed with atypical swallowing, with no age restrictions; (b) regarding the concept: orofacial myofunctional therapy applied for the treatment of atypical swallowing; and (c) regarding the context: studies conducted in clinical or research settings describing orofacial myofunctional therapeutic interventions in patients with atypical swallowing.

2.2. Eligibility Criteria

Studies describing or analyzing the application of orofacial myofunctional therapy in patients diagnosed with atypical swallowing were included. Both clinical studies and experimental investigations were considered, observing how therapy has been applied across different age groups and populations.

The types of studies included were quantitative experimental, quasi-experimental, observational, descriptive, exploratory, correlational studies, and case analysis studies.

Studies that were not fully available, those focusing on descriptive analyses without presenting specific results on therapeutic intervention, as well as qualitative studies, secondary reviews, and authors’ opinions were excluded. Also excluded were conference presentations published in scientific proceedings and Master’s and Doctoral theses available on official university websites.

2.3. Search Strategy and Information Sources

Studies were extracted from the PubMed/Medline, EMBASE, and Cochrane Library databases, with no restrictions on year or language. Search terms were selected based on the research question, using validated Medical Subject Headings (MeSH) terms and supplemented with additional keywords relevant to the topic (Table 1).

2.4. Study Selection and Data Extraction

During the selection process, all studies were analyzed by title/abstract, full text, and final review. The selection was conducted by two independent researchers, and in case of discrepancies, a third researcher intervened to resolve conflicts. This process was managed using the Covidence and Rayyan[®] platforms, which facilitated the initial screening and analysis of titles and abstracts.

Table 1. Search Strategy.

#	Search Strategy
1	Myofunctional therapy.mp. or muscle training/
2	Atypical swallowing.mp.
3	Tongue interposition.mp.
4	Tongue thrust.mp. or tongue thrusting/
5	2 or 3 or 4
6	1 and 5
7	remove duplicates from 6

After the initial screening, the full texts of potentially relevant publications were read. Data extraction was carried out by one of the authors using a standardized form that collected detailed information in the following sections: study origin (first author, publication year, country, institution); participant characteristics (total number, age range, gender distribution, swallowing diagnosis, and dental diagnosis); general study description (research objective, study type, methodological design, and main conclusions); in situ dental treatment (details of orthodontic devices or treatments used); relationship with other myofunctional disorders (additional orofacial function disorders, such as oral breathing or speech sound disorders); specific activities for orofacial myofunctional therapy (methods, strategies, and approaches implemented); total therapy duration (number of sessions, weeks or months); duration of each therapy session (in minutes); therapy frequency (weekly, biweekly, or other); home exercises (whether prescribed or not); home training time (in minutes); professional in charge of the therapeutic process (speech-language pathologist or other); and achievement measures (criteria and tools used to evaluate treatment effectiveness).

Finally, the extracted data were reviewed by two other authors, consolidated into a single version, and systematically organized for analysis and synthesis.

3. Results

3.1. Selection of Evidence Sources

After removing duplicates, a total of 45 studies were identified. Based on the reading of titles and abstracts, 22 studies were selected, and after a full-text review, 12 records were chosen (Figure 1).

3.2. Characteristics of the Evidence Sources

Table 2 provides a detailed summary of the characteristics of the included studies, which includes information on the origin of the studies, participants, research objectives, methodologies used, and key conclusions obtained.

3.3. Results of Individual Evidence Sources

The characteristics of the orofacial myofunctional therapy are summarized in Table 3.

3.4. Synthesis of Results

Regarding the characteristics of the origin, participants, and general description of the studies presented in Table 2, the following can be summarized:

The 12 studies reviewed were published between 1989 [15] and 2024 [16,17]. Italy had the highest representation, contributing 50% of the studies (6/12) [17–22], followed by the United States [15], South Korea [16], Canada [23], Australia [24], Belgium [25] and Romania [26], each with one study (8.3% of the total each). 58.3% of the studies (7/12) were conducted in hospital institutions or dental schools, while the rest were carried out in academic or clinical settings without specifying a hospital environment.

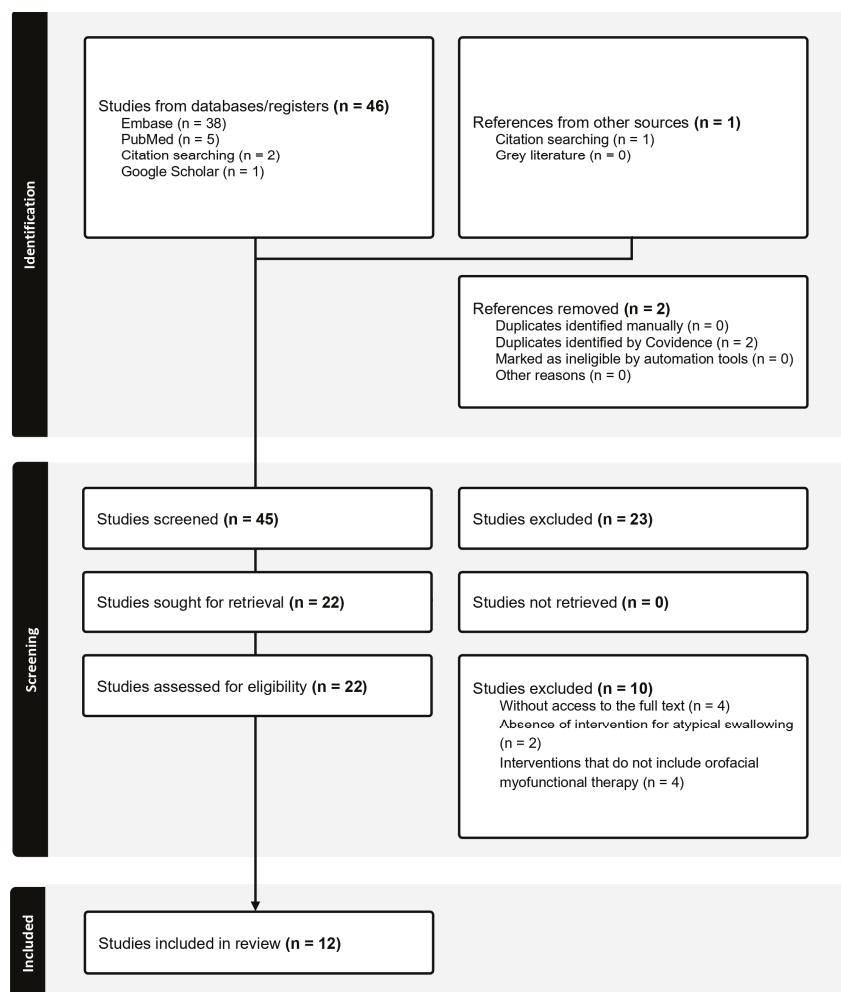


Figure 1. Flowchart of source selection.

In total, the reviewed studies included 164 participants, aged between 5 and 26 years. The gender distribution was relatively balanced: 54.8% females (90/164) and 48.1% males (74/164).

Regarding swallowing diagnoses, the studies used terms such as atypical swallowing [17–20,22,26], visceral swallowing pattern [25], tongue thrust [15,21,23,24], infantile swallowing with tongue thrust [16], and tongue interposition, among others. These terms are often employed to describe the presence of dysfunctions or alterations in the typical pattern of swallowing. Regarding dental diagnoses, 58.3% of the studies (7/12) reported anterior open bite as the primary condition addressed [15,16,19,21,22,24,25], while others identified Class II malocclusion [16,19] and unhealthy oral habits. Notably, 41.7% of the studies (5/12) did not specify any dental diagnosis [17,18,20,23,26].

All studies sought to assess the efficacy of orofacial myofunctional therapy (OMT) in treating swallowing pattern disorders and associated issues such as tongue thrust and malocclusions. Some studies also addressed secondary objectives, such as analyzing the role of dentition in the effectiveness of OMT or exploring strategies to improve motivation and adherence in pediatric patients [17].

In terms of study design, 91.7% (11/12) were prospectively designed, including descriptive case reports (6/12) [15,16,19,22,23,26], quasi-experimental studies (4/12) [18,20,21,24], and a randomized pilot study (1/12) [25]. Only 8.3% (1/12) of the studies were explicitly retrospective, corresponding to an observational, retrospective study [17].

In terms of methodological design, single-case pre-post designs with follow-up were the most common approach, appearing in 41.7% of the studies (5/12) [15,16,19,22,23]. Prospective single-group pre-post designs represented 33.3% (4/12) [18,20,21,24], while multiple single-case pre-post designs with a one-year follow-up were present in 8.3% (1/12) [19]. One study (8.3%) utilized a randomized controlled pilot trial with a 6-month follow-up [25], and another (8.3%) followed a prospective two-group pre-post design [26]. Lastly, a retrospective single-group pre-post design accounted for 8.3% of the studies [17].

In relation to in situ dental treatment, 41.6% of the studies (5/12) integrated some form of orthodontic intervention [15,16,18,19,25], such as palatal expansion devices, fixed or removable orthodontics in combination with OMT, to address malocclusions, particularly in cases of anterior open bite. Myofunctional therapy was associated with other orofacial disorders in 66.6% of the studies (8/12); in particular, oral breathing was reported in 50% (6/12) [17–19,22,23,26], speech sound disorders (SSD) in 25% (3/12) [15,23,25] and thumb sucking in 8.3% (1/12) [19].

The specific activities within the OMT protocols were diverse. 25% of the studies (3/12) implemented exercises based on the Garliner method, aimed at strengthening orofacial muscles through isometric and isotonic exercises involving the tongue, soft palate, and lateral pharyngeal walls [20,21,23]. Additionally, 16.7% of the studies (2/12) included activities focused on tongue posture and swallowing, which involved smiling, retracting the tongue, and swallowing while clenching molars, avoiding labial sealing [16,22]. Other studies focused on correcting open bite and tongue posture, instructing participants on the correct resting position of the tongue on the palate by using elastic bands, thus facilitating both strengthening and coordination of the tongue [21–23].

The total treatment duration varied between 8 weeks [24] and 6 months [17] in studies that provided this information. Studies reporting the number of sessions ranged from 12 [17] to 30 sessions [19]. Therapeutic sessions with the therapist lasted between 20 [24] and 60 min [25], with weekly frequency being predominant in 58.3% of the studies (7/12) [15,18,20–22,25,26], while 16.7% (2/12) used a biweekly frequency [17,24]. 75% of the studies (9/12) included home practice activities [15–18,20–22,25,26], with daily training times recommended to vary between 10 [16] and 90 min [22].

Regarding the professionals in charge of therapy, 75% of the studies (9/12) identified the speech-language pathologist (SLP) as the primary professional responsible [17–24,26], while one study was led by an orofacial myologist [15], one by an orofacial myofunctional therapist [25], and another by an orthodontist [16].

Evaluation methods included the Orofacial Myofunctional Evaluation Protocol (OMES and OMES-Expanded) [20,21,26], measurement devices such as the IOPI System [21,23,25] and surface electromyography (sEMG) to quantify tongue strength, endurance, and muscle activation [18–20], and clinical assessments of oral rest posture, swallowing, speech articulation, and occlusion [15–17,22]. Additional methods included cephalometric analysis [19,24], electropalatography [24], dynamometry for orbicularis oris strength [17,18], extraoral and intraoral photographs, plaster models, and lateral cephalograms [19]. Functional evaluations were complemented by specific tests like the Rosenthal test [22], photogrammetry and fluorescein dye application to verify tongue posture [17]. Some studies also assessed patient compliance [17]. Primary outcomes focused on improvements in tongue posture, swallowing function, occlusal changes, and post-treatment stability.

Table 2. Characteristics of the Origin, Participants, and General Description of the Studies.

Origin		Participants				General Description of the Study				Main Findings			
First Author	Year	Country	Institution of Origin	N°	Age (Years)	M	F	Swallowing Diagnosis	Dental Diagnosis	Objective	Study Type	Methodological Design	
Zimmerman, J.B. [15]	1989	United States	NR	1	13	0	1	Bilateral tongue thrust with an anterior component	Open Bite	To describe the coordination between OMT and orthodontics in a case of AOB	Descriptive case report	Longitudinal single-case design with follow-ups at 1, 3, 6, and 12 months	OMT helped improve tongue posture and swallowing pattern, reducing tongue thrust and stabilizing orthodontic treatment
Gommerman, S.L. [23]	1995	Canada	Capital Health Authority, University of Alberta	1	16	0	1	Tongue thrust swallowing pattern	NR	To investigate the effects of OMT on tongue thrust swallowing and interdental sibilant distortion	Descriptive case report	Single-case pre-post design with 6-month follow-up	Significant improvements in swallowing, but not in the production of sibilant sounds after OMT
Cayley, A.S [24]	2000	Australia	Orthodontic Department, Perth Dental Hospital	8	9.08–11.75	8	0	Tongue thrust swallowing pattern	AOB	To assess the effect of tongue re-education therapy on tongue function and dentofacial form in patients with AOB	Quasi-experimental	Prospective single-group pre-post design	OMT showed partial effectiveness in enhancing swallowing function and contributing to the reduction in anterior open bite
Saccomanno, S. [18]	2012	Italy	Catholic University A. Gemelli	23	5–17	10	13	AS	NR	To analyze the causal relationship between malocclusion and oral muscle dysfunction, and the impact of OMT	Quasi-experimental	Prospective pre-post design	Patients who received OMT showed increased orbicularis strength. sEMG analysis indicated muscle activity imbalances related to bite type in skeletal Class I and II cases
Saccomanno, S. [19]	2014	Italy	Catholic University A. Gemelli	3	8–13	2	1	AS (lateral tongue); AS (anterior tongue); AS (anterior tongue)	Class II, lateral open bite AOB; Class II, AOB and maxillary contraction	To evaluate the effectiveness of OMT combined with orthodontics in patients with oral bad habits (thumb sucking, OB, AS and labial interposition)	Descriptive case report	Multiple single-case pre-post design with 1-year follow-up	The combination of orthodontics and OMT was effective in correcting oral habits and malocclusions
Van Dyck, C. [25]	2016	Belgium	University Hospitals Leuven	22	7.1–10.6	11	11	Visceral swallowing pattern	AOB	To investigate the effects of OMT on tongue behavior in children with AOB and a visceral swallowing pattern	Randomized pilot study	RCT pilot with 6-month follow-up	OMT produced significant changes in tongue elevation strength, resting tongue posture, and tongue position during solid food swallowing, but further research is needed

Table 2. Cont.

Origin	Participants					General Description of the Study			Main Findings				
First Author	Year	Country	Institution of Origin	N°	Age (Years)	M	F	Swallowing Diagnosis	Dental Diagnosis	Objective	Study Type	Methodological Design	Main Findings
Begnoni, G. [20]	2020	Italy	University of Milan	15	17.72 ± 5.21	4	11	AS	NR	To analyze the effects of OMT on muscular function and orofacial behavior in a group of patients with AS and second dentition completed	Quasi-experimental	Prospective single-group pre-post design	OMT allows the shortening of the muscular activation pattern and increases submental muscle activity
Mozzanica, F. [21]	2020	Italy	Department of Clinical Sciences and Community Health, University of Milan	22	8.8 ± 1.1; 19.8 ± 4.7	9	13	Tongue thrust	AOB, Overjet	To evaluate the effects of OMT using a validated instrument and to explore the influence of dentition on its efficacy	Quasi-experimental	Prospective single-group pre-post design	OMT improves swallowing and tongue strength in patients with tongue thrust, regardless of dentition type
Saccomanno, S. [22]	2022	Italy	Department of Health, Life and Environmental Science, University of L'Aquila	1	9	0	1	AS	AOB	To verify the advantages of OMT through the description of a clinical case treated only with this kind of therapy	Descriptive case report	Single-case pre-post design with 1-year follow-up	In one clinical case, OMT alone resolved AS and improved malocclusion, helping to stabilize the treatment
Debucean, D. [26]	2023	Romania	Faculty of Medicine and Pharmacy, University of Oradea	61	12-26	25	36	AS	NR	To explore whether OMT combined with a physiotherapeutic rehabilitation program for postural problems adds benefits to swallowing rehabilitation in healthy young population	Analytical observational	Prospective two-group pre-post design	The OMT combined with physiotherapy (manual therapy and Global Postural Re-education) proved to be more effective than single OMT
Noh, H. [16]	2024	South Korea	Department of Orthodontics, School of Dentistry, Kyungpook National University	1	8 (follow-up until 23)	0	1	Infantile swallowing pattern	AOB, Class II (right side)	To correct AOB and tongue thrust through OMT and orthodontics	Descriptive case report	Single-case pre-post design with follow-up two months after bite stabilization	Controlling infantile swallowing is crucial for AOB treatment stability. The smile-clenching-swallowing exercise was key to long-term stability
Saccomanno, S. [17]	2024	Italy	University of L'Aquila	6	7-14	5	1	AS	NR	To explore the use of edible spread cream and small candies as tools to enhance motivation and compliance in children undergoing OMT for optimizing oral functions, including AS	Observational, retrospective	Retrospective single-group pre-post design	Young patients' compliance limits OMT effectiveness in AS. Creative solutions like edible tools could improve cooperation and outcomes

Abbreviations: NR = Not Reported; OMT = Orofacial Myofunctional Therapy; AS = Atypical Swallowing; AOB = Anterior Open Bite; OB = Oral Breathing; RCT = Randomized Controlled Trial.

Table 3. Characteristics of Orofacial Myofunctional Therapy.

First Author (Year)	In Situ Dental Treatment	Other Functional Disorders	Specific Activities for the Treatment	Total Therapy Duration	Therapy Session Duration	Therapy Frequency	Home Practice	Home Training Time	Therapist in Charge	Outcome Measures
Zimmerman (1989) [15]	Orthodontic retainer with lingual spurs after palatal expansion and headgear	SSD	1. Increase awareness of the orofacial musculature to establish an appropriate resting posture of the tongue and lips, as well as functional movements during speech and swallowing. 2. Develop neuromuscular movement patterns to support conscious and coordinated swallowing of food, liquids, and saliva. 3. Assign therapeutic activities to promote the automatization of these motor skills, including speech therapy tasks to correct the interdental lisp. 1. Phase of OMT: 14 sessions included patient education on normal swallowing physiology, tongue strengthening exercises, and structured practice of correct swallows. Therapy incorporated modified versions of Garliner's elastic swallowing exercises. 2. Phase of Articulation Treatment: 4 structured sessions followed a hierarchical model from isolated sounds to connected speech. Techniques included direct feedback, mental imagery, and structured self-monitoring with clinician-patient agreement on performance ratings.	16 weeks	NR	Once a week for 5 weeks and then every 15 days	Yes	NR	Orofacial myologist	Clinical evaluation of oral rest posture, speech and swallowing function, and occlusion at follow-up.
				18 sessions	NR	NR	NR	NR	SLT	Swallowing measures: frequency of tongue thrust swallowing, duration of swallows and ease of swallowing. Tongue strength and endurance measured with IOPI. Sibilant distortion and labial diadochokinetic rate. Cephalometric analysis. Elec-tropalatography to assess tongue-palate contact during speech and tongue position during the propulsive phase of saliva and water swallowing.
Cavley (2000) [24]	No treatment	NR	1. Development of new muscle patterns needed as a foundation for proper swallowing and appropriate lip and tongue posture. 2. Swallowing training with liquids and semi-solids.	8 weeks	20 min	Every 15 days	NR	NR	SLT	

Table 3. Cont.

First Author (Year)	In Situ Dental Treatment	Other Functional Disorders	Specific Activities for the Treatment	Total Therapy Duration	Therapy Session Duration	Therapy Frequency	Home Practice	Home Training Time	Therapist in Charge	Outcome Measures
Saccomanno (2012) [18]	Rapid palatal expansion	OB	Therapeutic approach varied by malocclusion. For overbite ≤ 2 mm, a fixed grid/tongue crib was used to partially close the bite before starting speech therapy. For overbite > 1 mm, speech therapy was applied. In overjet ≥ 4 mm, Class I patients received OMT only; Class II patients combined OMT with orthodontics. For overjet ≤ 0 mm, 20 speech therapy sessions plus daily home exercises preceded orthodontics. Exercises not specified.	20 weeks	NR	Once a week	Yes	NR	SLT	Strength of the orbicularis muscle measured with a dynamometer; sEMG used to assess masseter and temporalis muscle activity.
Saccomanno (2014) [19]	The 2nd case was treated with a palatal crib and Fränkel III appliance. The third case was treated with rapid palatal expander, and with a removable orthodontic appliance.	OB, thumb sucking	Functional rehabilitation of the orofacial musculature. No specific exercises were described. Emphasis was placed on patient and family compliance with home therapy and interdisciplinary collaboration among professionals involved.	20–30 sessions	NR	NR	NR	NR	SLT	Extraoral and intraoral photographs, plaster models, cephalometric analysis (lateral cephalogram), labial orbicular muscle contraction measurement, and tongue posture analysis.
Van Dyck (2016) [25]	Removable maxillary expansion device	SSD	Session 1. Explanation of treatment process and motivation; Sessions 2–3. Strengthen tongue and lip musculature; Sessions 4–5. Basis of the swallowing process; Session 6. Strengthen the anterior part of the tongue; Sessions 7–9. Strengthen the mid part of the tongue; Sessions 10–11. Strengthen the posterior part of the tongue; Sessions 13–14. Coordination of the total swallow movement; Sessions 15–16. Practice on conscious habit formation; Sessions 17–18. Practice on unconscious habit formation; Session 19. Control of physiological swallowing act; Session 20. Control of physiological swallowing act and follow-up.	4–6 months	30 or 60 min	Weekly or every 2 weeks	Yes	NR	OMT therapist	Maximum tongue elevation strength measured with IOPI. Functional characteristics such as resting tongue posture, swallowing pattern, and articulation were assessed through clinical evaluation performed by a speech pathologist.

Table 3. Cont.

First Author (Year)	In Situ Dental Treatment	Other Functional Disorders	Specific Activities for the Treatment	Total Therapy Duration	Therapy Session Duration	Therapy Frequency	Home Practice	Home Training Time	Therapist in Charge	Outcome Measures
Begnoni (2020) [20]	NR	NR	Myofunctional exercises based on the Garliner method. Myofunctional exercises based on the Garliner method: Session 1: Education on physiology and dysfunctional habits, initial training on tongue posture. Session 2: Maintaining tongue posture for 5–10 min, practicing swallowing with 1–2 elastic bands, start strengthening. Session 3: Extending posture to 20 min, swallowing practice with bands and water retention, strengthening lips and masseter. Session 4: Maintaining posture for 30 min, swallowing with water and crackers, alternating chewing, strengthening exercises. Session 5: Maintaining posture for 45 min, correct swallowing during meals, reinforcement of tongue, lips, and masseter exercises. Session 6: Maintaining posture for 50 min with lip closure, swallowing during meals, strengthening continued. Session 7: Maintaining posture for 60 min, swallowing without bands, lip and masseter strengthening during meals. Session 8: Maintaining posture for 60 min, checking swallowing at two meals, establishing daily self-monitoring. Session 9: Maintaining posture twice daily for 15 min, monitoring swallowing at all meals, continuing self-recording. Session 10: Consolidating correct posture and swallowing habits with daily exercises and ongoing monitoring	10 weeks	45 min	Once a week	Yes	NR	SLT	Duration and intensity of electrical activation (sEMG) of masseter, temporal, and sublingual muscles. OMES protocol score.
Mozzanica (2020) [21]	No treatment	NR		10 weeks	45 min	Once a week	Yes	NR	SLT	OMES protocol scores. Tongue strength measured with IOPI.

Table 3. Cont.

First Author (Year)	In Situ Dental Treatment	Other Functional Disorders	Specific Activities for the Treatment	Total Therapy Duration	Therapy Session Duration	Therapy Frequency	Home Practice	Home Training Time	Therapist in Charge	Outcome Measures
Saccomanno (2022) [22]	No treatment	OB, difficulties chewing	1. Teach the child the correct resting position of the tongue, ensuring that the tongue remains lightly in contact with the alveolar ridge (incisive papilla) at rest, with the teeth apart and the lips gently closed. 2. Stimulate the anterior, middle- and posterior parts of the tongue through targeted exercises to promote balanced activation and correct tongue posture against the palate. 3. Instruct the child to place the tip of the tongue on the incisive papilla and the rest of the tongue pressed flatly against the hard palate, maintaining this posture both at rest and during swallowing. 4. Perform an exercise in which the child holds an elastic band with the tip of the tongue on the retroincisal papilla, initially for 10 min per day with lips open and teeth apart, progressively increasing the time and advancing to perform the exercise with teeth slightly in contact and lips closed. 1. Nasal breathing. 2. Tongue training with a new resting position. Exercises stimulate the anterior tongue first, then the lateral parts, and finally the posterior tongue. 3. Restoration of lip seal. 4. Increase in facial muscle tone. 5. Restoration of soft palate tone. 6. Restructuring of proper swallowing. OMT includes smiling to naturally move the tongue backward, positioning the tongue against the hard palate, and swallowing by clenching the molars and pushing the tongue toward the palatal rugae without lip seal, aiming to establish a mature swallowing pattern and correct resting tongue posture.	3.5 months	NR	Once a week	Yes	30 min, 3 times a day	SLT	Clinical evaluation, through the Rosenthal test, observation of swallowing patterns, assessment of masticatory function, and caregiver interviews.
Debucean (2023) [26]	NR	OB		20 weeks	40 min	Once a week	Yes	15 min daily	SLT	OMES-Expanded protocol scores.
Noh (2024) [16]	Habit control devices (tongue cribs) and fixed orthodontic treatment with mi-croimplants	NR		NR	NR	NR	Yes	10–20 min twice each day	Orthodontist	Closure of AOB, changes in tongue posture, post-treatment stability.

Table 3. Cont.

First Author (Year)	In Situ Dental Treatment	Other Functional Disorders	Specific Activities for the Treatment	Total Therapy Duration	Therapy Session Duration	Therapy Frequency	Home Practice	Home Training Time	Therapist in Charge	Outcome Measures
Saccomanno (2024) [17]	NR	OB	1. Development of oral awareness. 2. Correction of resting tongue posture. 3. Specific exercises to strengthen the anterior, middle, and posterior parts of the tongue, as well as the lip muscles. 4. Swallowing training: patients practice swallowing with liquids, semi-solids, and finally solids to ensure physiological swallowing function. 5. Automation of the swallowing function.	12 sessions over a 6-month period	30 min	Every 15 days	Yes	15 min daily	SLT	Increased strength of lip muscles measured with a dynamometer, appropriate tongue posture verified with fluorescein and photogrammetry. Level of cooperation assessed by the therapist.

Abbreviations: NR = Not Reported; OMT = Orofacial Myofunctional Therapy; AOB = Anterior Open Bite; OB = Oral Breathing; sEMG = Surface Electromyography; SSD = Speech Sound Disorder; SLT = Speech-Language Therapist; OMES = Orofacial Myofunctional Evaluation with Scores.

4. Discussion

This scoping review aimed to characterize OMT in patients diagnosed with atypical swallowing (AS), considering the profile of participants, clinical, geographical, and methodological contexts, as well as the therapeutic strategies used. The publications span a wide temporal range, from 1989 [15] to 2024 [16,17], reflecting a sustained interest in OMT. Pioneering studies, such as Zimmerman [15], focused on correcting tongue patterns and malocclusions, while more recent studies, such as those by Debucean [26] and Noh [16], incorporate motivational strategies, edible materials, or interdisciplinary approaches in combination with orthodontic treatment.

Italy stands out as the country with the highest scientific output on this topic, accounting of the studies reviewed. From 2012 to 2024, its research has addressed various therapeutic approaches, both in combination with orthodontic techniques and aimed at improving treatment adherence. Italy is also a leader in OMT research, particularly in older adult populations [27]. Countries such as South Korea [16] and Romania [26] have also emerged as new players, bringing methodological diversity by integrating OMT with orthodontic approaches and interdisciplinary postural rehabilitation programs.

Regarding the population, the analyzed studies included a total of 164 participants, aged 5 to 26 years, with a predominance of children and adolescents. This trend is justified both by the high prevalence of tongue thrust during school-age—ranging between 5.4% [28] and 62.3% [29]—and by neurophysiological factors. The first decade of life provides a therapeutic window of opportunity, due to active bone growth [30], neuromuscular plasticity [31], and adaptability of orofacial muscle fibers [32]. In this regard, myofunctional and orthopedic intervention aims to promote harmonious craniofacial development and prevent skeletal discrepancies [33,34].

From a methodological perspective, the included studies exhibit significant heterogeneity. Case studies such as those by Noh [16] and Saccomanno [22] provide detailed clinical descriptions, allowing for a deep understanding of individual therapeutic processes. However, their small sample sizes limit the generalizability of the results. In contrast, prospective studies with larger sample sizes, such as those by Mozzanica [21] and Debucean [26], offer greater empirical robustness and the ability to compare different strategies.

Recent literature has highlighted the potential of OMT when combined with orthodontic treatment. Literature reviews such as those by Cenzato, Iannotti, and Maspero [8] have reported significant improvements in swallowing patterns and tongue posture by integrating both interventions. However, other authors, such as Homem, Vieira-Andrade, Falci, Ramos-Jorge, and Marques [35], caution about the high risk of bias present in many of these studies, which limits the strength of the available evidence. This therapeutic integration is based on an updated view of the stomatognathic system, where the orofacial musculature is understood as a functionally interconnected network, rather than a set of isolated symptoms [36,37].

This synergistic effect has also been demonstrated in other clinical contexts. AlQah-tani [38] reported that patients who combined OMT with orthodontics not only experienced greater occlusal stability but also better facial esthetics and higher satisfaction. Additionally, in cases of bruxism [39], obstructive sleep apnea [40], and other sleep disorders [41], the incorporation of OMT has led to significant functional benefits. These findings underscore the value of OMT as a structuring intervention within the stomatognathic system, with benefits extending beyond atypical swallowing to related functions such as oral breathing and speech [10,42,43].

The therapeutic activities described in the studies included a wide range of strategies, personalized according to individual needs. These strategies encompassed activities focused on tongue posture, muscle strengthening, and orofacial mobility, using isotonic and

isometric exercises based on methods such as Garliner's (1974), aimed at strengthening the tongue, soft palate, and lateral pharyngeal walls, promoting stable and balanced orofacial function [44].

An important shortcoming is that most studies do not clearly report the fundamental parameters of muscle training. The prescription of exercises in speech therapy must consider multiple interrelated factors: objectives (mobility, strength, or endurance), muscle specificity, type of contraction (isotonic, isometric, resistance), number of repetitions, weekly frequency, rest, intensity relative to maximum effort, total volume, program duration, and load progression [45–47]. This omission complicates both the comparison and replication of studies and limits the potential to optimize therapy based on the physiological properties of orofacial muscles, which are highly adaptable to directed stimuli [32,48,49].

Complementarily, the functional training of motor patterns such as swallowing requires integrating principles of sensorimotor learning. Acquisition during practice does not guarantee consolidated learning, which is only evident through retention and transfer to untrained contexts [50]. According to Madill [51], to achieve clinically significant results, tasks that not only favor correct execution in-session but also the integration of new patterns into daily life, should be taken into account.

Pre-practice considerations such as motivation, modeling, and clear verbal instruction represent fundamental pillars in the early stages of sensorimotor learning, as they prepare the motor and cognitive systems of the patient for effective execution with therapeutic meaning [50,51]. These conditions seek to establish a conducive environment for the acquisition of the new motor pattern, facilitating attention, understanding, and willingness to actively participate. Some studies included in this review reported concrete strategies in this stage, such as simple functional explanations about the importance of tongue posture [15,22] and visual or tactile supports to facilitate the precise placement of the tongue. Moreover, Saccomanno [17] reported the use of edible tools as a motivational resource, which not only stimulates participation but also incorporates relevant sensory elements for neuromuscular reorganization. However, these elements are still reported in a superficial manner and lack explicit systematization in protocols.

Regarding practice conditions, essential aspects such as the number of trials or sessions (small vs. large), distribution (massed vs. distributed), variability (constant vs. variable), organization (blocked vs. random), attentional focus (internal vs. external) and progressive task complexity (simple vs. complex) are crucial for strengthening motor learning and its generalization [50]. However, most of the studies reviewed did not clearly specify these parameters. Only a few, such as Saccomanno [17], indicated a hierarchical progression in tasks, moving from liquids to semisolids and then to solids, which can be interpreted as a planned organization based on functional complexity. This progressive task planning is key to achieving effective transfer of the motor pattern to natural contexts such as feeding. Still, the lack of detail in describing these elements limits the ability to replicate or adjust practice conditions for different populations.

Finally, feedback—an essential component for error correction, learning consolidation, and motor autonomy promotion—was scarcely described in the studies analyzed. According to Madill [51], feedback parameters should be adapted to the learning stage: high and frequent in the initial phases to favor acquisition, and spaced and reflective in advanced stages to promote retention and generalization. Nevertheless, Van Dyck [25] mentioned the use of verbal correction or tactile guidance by the therapist. The absence of more detailed information on the type (knowledge of results vs. performance), modality (auditory, visual or tactile), timing (immediate vs. delayed), and frequency of feedback (high vs. low), highlights a significant gap in the description of myofunctional interventions. This omission limits the understanding of how new functional patterns are effectively learned

and emphasizes the need for future research that integrates and documents these essential variables for therapeutic design.

Regarding treatment time, there was considerable variability, with protocols ranging from 8 [24] to 6 months [17]. This lack of consensus contrasts with other clinical conditions, such as obstructive sleep apnea [52], temporomandibular disorders [53], or post-orthognathic surgery patients [54], where interventions of 3 to 4 months have shown functional benefits and improvements in participants' quality of life. In the specific case of atypical swallowing, studies are needed to analyze the relationship between duration, frequency, and clinical impact.

Home practice was identified as a central component. Research by Saccomanno [17] and Debucean [26] highlights that daily home practice promotes motor automation. Additionally, variability in practice has been shown to allow the nervous system to optimize motor patterns through trial and error [55], while strategies such as using playful materials or digital devices can enhance adherence [17,56].

As for the professionals involved, most interventions were carried out by speech-language pathologists. According to the Brazilian Society of Speech-Language Pathology (SBFa), Orofacial Myology is a specialization in Speech-Language Pathology that covers the promotion, diagnosis, and intervention of orofacial functions across the life cycle [57]. Complementary, the American Speech-Language-Hearing Association (ASHA) [58,59] states that speech-language pathologists are trained to identify orofacial strengths and weaknesses, intervene functionally, and design supports to facilitate an individual's participation in their environment. Both institutions agree on the speech-language pathologist's leading role in these interventions, integrating evaluation, functional intervention, and interdisciplinary guidance.

Regarding evaluation and follow-up, the studies reviewed employed diverse tools. Some used non-standardized clinical protocols [15,22,23], while others applied the OMES Protocol [20,21,26] validated for assessing orofacial functionality [60]. Furthermore, instrumental methods such as dynamometers [17,18], IOPI [21,23,25], and surface electromyography [18–20] were integrated. Some studies also applied techniques such as electropalatography to analyze tongue patterns with precision [24]. However, the heterogeneity in the choice of instruments and the lack of longitudinal follow-up make it difficult to compare results and analyze post-treatment stability.

4.1. Clinical Implications and Future Research Directions

This review emphasizes the need for an integrated approach to the intervention of atypical swallowing, combining principles of muscle training, sensorimotor learning, and contextualized functional practice. While there has been progress toward more systematic interventions, challenges remain, such as the lack of standardized protocols, methodological heterogeneity, and limited longitudinal follow-up. Future research should design comparable multicenter studies, define clear therapeutic parameters, use validated instruments, and evaluate functional retention. These steps are essential to optimizing clinical practice, strengthening evidence, and ensuring effective and sustainable interventions for treating orofacial myofunctional disorders.

4.2. Limitations

This review has some limitations that should be considered when interpreting its findings. First, the search was restricted to three main databases, which may have excluded relevant studies available in other sources or gray literature. Additionally, although rigorous inclusion and exclusion criteria were applied, some pertinent studies may have been omitted due to the choice of keywords or search terms, which could have been ex-

panded or adjusted. Lastly, while this review provides a broad overview of myofunctional therapy in atypical swallowing, its scope does not allow for causal relationships to be established, reinforcing the need for future experimental and multicenter studies with greater methodological control.

5. Conclusions

This review characterized the therapeutic strategies employed in orofacial myofunctional therapy (OMT) for patients with atypical swallowing, showing an evolution toward multidimensional approaches that integrate oromotor exercises, functional training, and principles of sensorimotor learning. The studies highlight the effectiveness of combining OMT with orthodontic interventions, as well as the importance of home practice for reinforcing the automation of motor patterns. Interventions included specific activities aimed at tongue posture, muscle strengthening, mobility, and swallowing reeducation, although with significant methodological variability.

Despite advances, there remains a lack of standardization in training parameters, practice conditions, and therapeutic evaluation. This heterogeneity limits comparisons across studies and clinical replicability. Therefore, future research should adopt multicenter designs, define clear therapeutic criteria, incorporate objective measurements, and evaluate long-term functional retention. These steps are critical for optimizing the efficacy, sustainability, and clinical applicability of OMT in the comprehensive treatment of orofacial myofunctional disorders.

Supplementary Materials: The following supporting information can be downloaded at: <https://www.mdpi.com/article/10.3390/ijom51020010/s1>, Table S1: Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for Scoping Reviews (PRISMA-ScR) Checklist.

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Abbreviations

The following abbreviations are used in this manuscript:

OMT	Orofacial myofunctional therapy
JB	Joanna Briggs Institute
PRISMA-ScR	Preferred Reporting Items for Systematic Reviews and Meta-Analysis Extension for Scoping Reviews
PCC	Population, concept, and context
AS	Atypical swallowing
OMES	Orofacial Myofunctional Evaluation Protocol With Scores

sEMG
SBFa

Electromyography
Brazilian Society of Speech-Language Pathology

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