Review Article

Orofacial myofunctional assessments in adults with malocclusion: A scoping review

Samantha C. Washington (*Southeast Missouri State University*)

Jayanti Ray (*Southeast Missouri State University*)

Suggested Citation

Washington, S. C., & Ray, J. (2021). Orofacial myofunctional assessments in adults with malocclusion: A scoping review. *International Journal of Orofacial Myology and Myofunctional Therapy*, 47(1), 22-31.

DOI: <https://doi.org/10.52010/ijom.2021.47.1.4>

This work is licensed under a [Creative Commons Attribution-NonCommercial-NoDerivatives 4.0 International License](https://creativecommons.org/licenses/by-nc-nd/4.0/).

The views expressed in this article are those of the authors and do not necessarily reflect the policies or positions of the International Association of Orofacial Myology (IAOM). Identification of specific products, programs, or equipment does not constitute or imply endorsement by the authors or the IAOM. The journal in which this article appears is hosted on [Digital Commons](https://digitalcommons.elsevier.com/), an Elsevier platform.

REVIEW ARTICLE

Orofacial Myofunctional Assessments in Adults with Malocclusion: A Scoping Review

Samantha C. Washington, Ed.D., CCC-SLP, & Jayanti Ray, Ph.D., CCC-SLP

Southeast Missouri State University, Cape Girardeau, Missouri

Background: Breathing, chewing, swallowing, sleep, and speech disorders are known to be associated with malocclusions. Assessment protocols using non-instrumental evaluation of orofacial myofunctional disorders (OMD) in adults with malocclusions are almost nonexistent.

Purpose: This scoping review aimed to determine the existence of scientific evidence demonstrating the areas of non-instrumental assessment of OMD in adults with malocclusion. Another purpose was to identify the protocols for assessing the nature of orofacial myofunctional assessments in adults with malocclusion.

Methods: An electronic search was performed in the databases: MEDLINE, EBSCOhost, PsycINFO, CINAHL, Cochrane Library, Health & Medical Collection, Medline, Nursing and Allied Health Database, Common Health Complete, PubMed, Consumer Health, and Health Services: Nursing/Academic Edition, for papers published between 2000 and October 2021. This exhaustive search was conducted using the key search terms: oral myofunctional disorders, orofacial myofunctional disorders, malocclusion, assessment protocols, and adults. The articles were selected for inclusion and analysis by two independent researchers.

Results: The search strategy with a list of eligibility criteria resulted in the retrieval of 72 peer-reviewed studies. Only 21 were included in the article since they were related to the assessment areas of OMD due to malocclusion. Out of 21, only three articles included information on OMD assessment protocols for adults. Information on assessments from the articles was extracted and analyzed by the authors. The results of this study indicated that published oromyofunctional assessment protocols, specifically for adults with malocclusion, are limited. **Conclusions:** Though the availability of valid and reliable protocols is limited, OMD assessments must address various orofacial functions and draw from multiple disciplines to initiate appropriate referrals for improving the quality of life of patients with OMD.

Keywords: orofacial myofunctional, malocclusion, adults, assessment

INTRODUCTION

Orofacial myofunctional disorders (OMDs), often found in children and adults, involve the cranio-orofacial complex that interferes with typical growth, development, or function of orofacial structures, and can cause speech and swallowing disorders (American Speech-Language-Hearing Association, 2021). Amongst many OMDs, conditions such as tongue thrust, ankyloglossia (tongue tie), mouth breathing, and malocclusions are commonly found in school-aged children (e.g., Hale et al., 1988) who may develop maladaptive articulatory patterns (Hitos et al., 2013). Not only are children affected by OMDs, a high

number of adults receiving orthodontic treatment due to dental malocclusions and temporomandibular joint disorders also experience symptoms of OMDs such as chewing, breathing, and speech issues (Dellepiane et al., 2020; Ferreira et al., 2009; Shortland et al., 2020; Van Lierde et al., 2012).

The prevalence and incidence of dental malocclusions in adults have not been widely studied in the United States. Many international studies have investigated the incidence and prevalence of malocclusions in children; however, a few studies focused on the incidence and prevalence within adults. According to Mokhtar et al. (2020), malocclusions in East Asians are much higher than any other race. In a study conducted by Elfseyie et al. (2020), Class III malocclusions were found to be the most predominant within Malaysian Malay adults, and Class II had the lowest incidence. Overall, the prevalence of malocclusion in the general population is estimated to be approximately 38% (Scarponi et al., 2018). No longitudinal studies were found regarding the prevalence of malocclusions in adults.

Contact Author: Samantha Washington, Ed.D.,
MS#2600, One University Plaza, Cape Girardeau,
MO 63701; swashington@semo.edu
<https://orcid.org/0000-0002-4204-7398> (SW)
<https://orcid.org/0000-0001-7032-0649> (JR)

Received August 30, 2021; Accepted October 29, 2021

<https://doi.org/10.52010/ijom.2021.47.1.4>

There are various causes of dental and skeletal malocclusions that can be congenital or acquired and are primarily the result of developmental disturbances (Rapeepattana et al., 2019). Moyers (1988) classified the etiologies of malocclusions into six categories: developmental factors of unknown origin, physical agents, trauma, habit, diseases, and inheritance (hereditary). Some of the most common dental diseases children exhibit leading to malocclusion include dental caries, pulpal lesions, periapical lesions, adverse oral habits, and dental trauma (Zou et al., 2018). The presence of ankyloglossia influences dental malocclusion, and with the increasing severity of tongue-tie, there may be signs such as increased lower crowding of the incisors, maxillary constriction, anterior open bite, and diastemas within the lower anterior teeth (Vaz & Bai, 2015). Individuals demonstrating malocclusion often exhibit more than one factor contributing to the deviance; therefore, the exact cause has not been established. Class III malocclusion presents with a multifactorial etiology characterized by distorted normal development of mandible and maxilla due to interactions between hereditary and environmental factors (Zere et al., 2018).

Often related to malocclusions, facial skeletal anomalies impact various orofacial functions, including changes to the positions of bones, teeth, and muscles. As a result, chewing functions, articulation of speech sounds, swallowing, as well as breathing are modified to adapt to the dentofacial environment (Trench & Araujo, 2015). Hence, when conducting an OMD assessment, one will need to determine the characteristics of malocclusions. Angle's Classification system is often used to identify malocclusion types. According to Angle's Molar Classification, there are three main types of malocclusions. They are Class I, Class II, and Class III (Angle, 1907). Class I occlusions are considered neutral; Class II occlusions are distocclusions and may involve overjet and overbite. Class III occlusions involve mesiocclusion and at times, an underbite. Adults who demonstrate malocclusions experience various symptoms of OMD (Campbell & Goldstein, 2021). Practitioners' awareness of how OMD and malocclusions coexist and can impact one another is vital for the assessment process. Furthermore, a practitioner's awareness of OMD and malocclusion will facilitate appropriate collaborative efforts between interdisciplinary team members when developing treatment measures.

A systematic qualitative review was conducted by Shortland et al. (2021) regarding orofacial myofunctional treatments (OMT) administered by

interdisciplinary team members such as, dentists, orthodontists, otolaryngologists, physicians, and others. Based on a pool of 28 studies, the authors concluded that the studies on OMT were highly variable with lower levels of evidence. Most of the studies included discussion on pre- and post-treatment data while reporting improvements in breathing, swallowing, mastication, oral behaviors, and oral hygiene. The authors reported that both standardized and nonstandardized assessments were used to measure OMT outcomes. Most of the assessment tools were meant for swallowing functions (e.g., Functional Oral Intake Scale, Dysphagia Risk Evaluation Protocol) and temporomandibular disorders. The authors reported that there is a need for developing appropriate assessment protocols to advance measurements of the OMT outcomes (Shortland et al., 2021). The systematic review by Shortland et al. (2021) offered useful insights into OMT, it did not explicitly discuss assessing OMD in adults, which is the focus of this scoping review.

Several assessment protocols have been published that help detect orofacial dysfunctions in children (e.g., Oromyofunctional Evaluation with Scores [OMES]; de Felicio & Ferreira, 2008; de Felicio et al., 2012; Scarponi et al., 2018), however a few OMD protocols are available for adults that are geared toward visual observations of clients' facial profiles and motor behaviors during specific tasks (Marchesan et al., 2012). The purpose of this scoping review (Tricco et al., 2018) was to identify OMD assessment protocols available for adults with malocclusion and to explore the major areas of assessment of malocclusion. Additionally, the existing knowledge gaps in the assessment of OMDs were identified to include suggestions for future research that might help advance interdisciplinary practice in OMD. The research question was: What are the available non-instrumental assessment protocols for diagnosing OMD in adults with malocclusion?

METHODS

The review was conducted in accordance with the PRISMA-ScR guidelines (Tricco et al., 2018). Relevant literature was searched from the years 2000 to 2021. Given the purpose of this scoping review to locate OMD assessment protocols for adults, the databases were explored with specific search terms – orofacial myofunctional disorders, malocclusion, assessment protocols, and adults. The databases compiled under health sciences and communication disorders were used for the review. The specific databases searched were MEDLINE, EBSCOhost, PsycINFO, CINAHL, Cochrane Library, Health &

Medical Collection, Medline, Nursing and Allied Health Database, Common Health Complete, Consumer Health, and Health Services: Nursing/Academic Edition. Hand searches were performed for the PubMed.gov website. Additionally, reference lists identified from selected articles were reviewed for detecting pertinent articles of interest. The themes that arose from within the literature were manually identified and coded by the researchers and were subjected to discussion to reach a consensus on the assessment areas.

Inclusionary and Exclusionary Criteria

OMD assessment protocols include standard procedures for evaluating the orofacial structures by interdisciplinary team members. The inclusionary criteria pertained to articles containing OMD assessment protocols on malocclusion in adults between the ages of 18 and 64 years. Only studies that were geared toward noninstrumental assessments were included. These assessments consist of visual and observational analysis of areas such as tongue functioning, soft and hard tissues, or dental status. Also, full-text original articles published in the English language in a peer-reviewed journal were included. The exclusionary criteria pertained to adults with other comorbid health conditions, including neurological or cognitive disorders, orthognathic surgery, and post-surgery status. Studies that described patient perceptions of malocclusions and their effect on various activities (e.g., swallowing, chewing, and breathing) were excluded. Studies on OMD assessment protocols for children and adolescents, instrumental assessments (e.g., cephalograms, electromyography, magnetoencephalography), acquired temporomandibular disorders, dentition-related temporomandibular disorders, facial trauma, head/neck cancer, respiratory disorders, OMDs in adult patients with Down syndrome, and sleep apnea were also excluded. Protocols related to continuing education documents or non-peer reviewed status were excluded; protocols subjected to validity and reliability studies in languages other than English were also excluded from the review. No inclusionary or exclusionary criteria were identified for study designs or methods or for studies that received specific sources of funding. The authors of this scoping review did not receive any funding and no stakeholders were included for discussion of OMD assessment protocols.

RESULTS AND DISCUSSION

A total of 191 peer-reviewed records were identified based on the database searches; 120 records from 2000-2021 were retrievable. Thereafter, 48 records

were removed based on the exclusionary criteria and duplicates. Subsequently, 72 articles were screened based on an abstract review, and finally, 21 studies met the criteria for inclusion in the review (see Figure 1). However, three out of the 21 articles only mentioned the use of assessment protocols for evaluating OMD in adults with malocclusion. Studies that focused on other topics were excluded given the scope of the review; these were articles about patients with burns, cancer, stuttering, disc displacement, cleft lip and palate, temporomandibular joint disorders, Sjogren's syndrome, and obstructive sleep apnea. Articles on assessment of chewing, swallowing, breathing, oral hygiene, and speech production were included to answer the research questions. The first section consists of the assessment protocols for adults with OMD, whereas the second section highlights the target areas of assessment.

Non-Instrumental Assessment Protocols for Adults

The Nordic Orofacial Test-Screening (NOT-S) is a non-instrumental assessment that involves a structured interview as well as a clinical examination for observing orofacial structures and related dysfunctions. As a screening protocol for both adults and children, it may be administered within a short period of time, and no objective measures are needed (Bakke et al., 2007). The interview involves asking questions about sensory functions (e.g., gag reflex), breathing (e.g., sleep apnea, snoring), oral habits (e.g., grinding teeth), chewing, swallowing, drooling, and dryness of the mouth.

During the orofacial examination using NOT-S, the face is observed at rest position to rule out possible asymmetry due to problems in both hard and soft tissues. Deviation in lip position is noted when the mouth is both closed and open. The tongue position is noted to ensure that the tongue tip is not visible between the teeth more than two-thirds of the time. During this time, involuntary movements are noted to understand any underlying neurological condition. The client is tested for nasal breathing. Facial expressions are tested to examine the integrity of the seventh cranial nerve. Pouting and rounding of the lips are tested. The activity of the masseter muscle is tested when the client bites hard on their back teeth. Mouth opening is noted to make sure that the temporomandibular joint is functional. The other motor activities include sticking out the tongue as far as possible, followed by licking the lips. The movement of blowing up one's cheeks without air leaking out can help understand the integrity of the seventh cranial nerve. While producing the vowel /a/

Figure 1. A flow diagram of literature search (Page et al., 2020)

in repetitions, the uvula and soft palate position are noted. Voice is evaluated by asking the client to count from one to ten in a loud voice. The sequential motion rate, which refers to the production of /pʌtʌkʌ/ in succession as fast as possible is observed to gauge the rate of movement of articulators. Overall, the protocol is efficient in observing facial profiles and gauging the client's performance on oral motor tasks and appears to be a valid protocol for screening OMD (Bakke et al., 2007). In a review study on NOT-S scores obtained from diverse age groups, Bergendal et al. (2014) mentioned that the test could be used as a standard instrument for assessing OMD.

Another noninstrumental protocol for assessing speech and swallowing by Paskay (2012) identified that posture of head and shoulders, facial symmetry, lip seal, range of motion of the temporomandibular joint, palatal shape, bruxism, teeth anomalies, articulation, and voice are important to complete a comprehensive evaluation of OMD. This protocol is a one-page assessment form that can be used efficiently to examine orofacial structures while gauging their status from regular to dysfunctional in terms of range, strength, and accuracy of motion. Certified orofacial myologists with a speech-language pathology background can use this protocol (Paskay, 2012).

Additionally, it can be used by dental professionals, cranio-osteopathic physicians, occupational therapists, and other healthcare professionals with necessary training (Paskay, 2012).

For assessing breathing, swallowing, speech, and chewing, the Marchesan, Berrentin-Felix, Genaro, and Rehder (MBGR) protocol can be used (Marchesan et al., 2012). This protocol consists of history information and clinical examination. The history pertains to general health problems, breathing, sleep, feeding, chewing, swallowing, oral and postural habits, communication, education, speech, hearing, and voice. The clinical examination focuses on body posture, facial structures, mandibular and occlusion measurements, mobility of the articulators, facial pain and tone, and other orofacial functions such as breathing, chewing, and speech (Marchesan et al., 2012). This protocol is administered mainly by speech-language pathologists trained in orofacial myology and does not mention interdisciplinary involvements (see Table 1 for a synopsis of the three OMD protocols).

Target Areas of Noninstrumental Assessment of OMD in Adults with Malocclusion

The selected articles in this study were reviewed to extract specific information on the assessment of malocclusion in adults using non-instrumental measures. As an essential part of the assessment, various health professionals traditionally assess the oral motor system. Besides oromyofunctional therapists, speech-language pathologists are highly trained to evaluate the oral motor system for understanding its impact on respiration, swallowing, and speech production. Additionally, oral motor functions are assessed to understand deviations in oral postures and functions that could lead to tongue thrust swallowing, open mouth breathing, deviant jaw movements during mastication, and abnormal dentofacial development. The purpose of evaluating the orofacial structures is to identify structural or functional abnormalities that contribute to clinical decision making for treatment planning. The areas of assessment of OMD in adults are discussed in this section.

Table 1. Synopsis of three OMD assessment protocols for adults

Nordic Orofacial Test -Screening (Bakke et al., 2007)

Protocol used by professionals: dentist, speech therapist, physician, physiotherapist

Interview sections: sensory function, breathing, habits, chewing and swallowing, drooling, and dryness of the mouth

Six sections for examination: face at rest, nose breathing, facial expression, masticatory muscle and jaw function, oral motor function, and speech

Scoring: yes= 1; no=0; not assessed= --; total range of scores: 0-12

The MBGR [Marchesan, Berrentin-Felix, Genaro, and Rehder protocol] (Marchesan et al., 2012)

Protocol used by professionals: speech-language pathologist/speech therapist

Case history section: general health problems; breathing; sleep; previous treatments; feeding; chewing; swallowing; oral and postural habits; communication; education; speech; hearing; and voice.

Clinical examination section: body posture; the face, mandibular and occlusion measurements; extra-oral and intra-oral examinations; mobility of lips, tongue, velum, and jaw; pain; tone of lips, mentum, tongue and cheeks; orofacial functions including breathing, chewing, swallowing, speech, and voice

Scoring: Higher score=deficient results; 0= best or normal performance

A One-Page Oromyofunctional Assessment Form (Paskay, 2012)

Protocol used by professionals: speech-language pathologist/speech therapist; orofacial myologists with a speech-language pathology background; dental professionals, cranio-osteopathic physicians, occupational therapists, and others

Clinical examination section: body posture, sitting, walking, breathing, sleep disorders, orofacial symmetry, temporomandibular joint functions, dental status, malocclusion, palatal structures, tongue tie, swallowing, speech, voice, and hearing functions.

Scoring: Notes are collected at the time of evaluation; no available scoring criteria

Case History

A case history, the most crucial assessment area, is essential to determine the root cause of symptoms by collecting information from the patient, interdisciplinary team members, and caregivers (see Table 2). To confirm differential diagnosis with the required diagnostic workup, it is important to obtain detailed information from the assessments available from the team members. For adults with malocclusion problems, it is necessary to ask for the presence of allergies, breathing, and sleep habits. Past medical history pertaining to dental or orthodontic surgeries along with the use of orthodontic appliances may be useful (Paskay, 2012).

Oral habits

A habit is a repetitive and automatic action, and oral habits are learned patterns of muscle contractions that can continue to persist in adults. Adults with malocclusion may show tongue thrusting and bruxism (Kamdar & Al-Shahrani, 2015). Tongue thrusting occurs when the tongue protrudes between the teeth during swallows, and this may be seen when malocclusion is treated with orthodontic appliances. Another oral habit, sleep bruxism, is tooth grinding during sleep that commonly occurs in adults. It is thought to be familial or related to genetic predisposition. Sleep bruxism can result in erosion of the teeth occlusal surfaces and hypertrophy of masseter muscles; it could also increase tooth sensitivity and temporomandibular joint sounds or crepitus (Kamdar & Al-Shahrani, 2015).

Visualization of Hard and Soft Tissues

To visualize hard and soft tissues, photographs, and videos of facial/oral structures along with oral movements and postures are important to document. At the same time, face and body alignment are noted. Orofacial appearance related to symmetry, posture, and growth patterns are documented. The clinician examines the client's face, nose, eyes, ears, mouth, and head for structural differences/abnormalities (Paskay, 2012). Movements of the lips, jaw, tongue, and velum, as well as the configuration of the hard and soft palates and dentition status are also relevant for this assessment (Marchesan et al., 2012).

Mandible and Chewing Functions

The main items of the clinical evaluation pertain to myofunctional orofacial alterations in young adults, particularly regarding changes in mandibular movements and patterns of chewing or swallowing. An open bite (lack of normal vertical overlap of teeth) may occur anteriorly or posteriorly on one or both sides of the dental arches leading to chewing difficulties. It is important to gauge the functioning of the masticatory muscles and the range of motion of the mandible. Facial skeletal anomalies can lead to chewing problems; these effects can be assessed by measuring chewing efficiency and maximum bite time (Trench & deArujo, 2015). Many items of assessment and characterization are the same for children and adults and age-related differences should be considered regarding their interpretation (Macedo & Bianchini, 2014). Interference of malocclusions on

Table 2. Identification of OMDs due to Malocclusion by Interdisciplinary Team (e.g., Benkert, 1997; Grandi, 2012; Kondo & Aoba, 1999)

<u>Professionals</u>	<u>Major Areas of Assessment</u>
Dentist/Orthodontist	Skeletal (maxilla and mandible) and dental anomalies
Otorhinolaryngologist	Oral/nasal airway; allergies; tonsils
Primary care physician	General health conditions secondary to OMDs related to malocclusion
Sleep specialist	Sleep patterns; sleep apnea/dyspnea
Speech-language pathologist	Articulation of speech sounds; chewing; swallowing; tongue functioning; hard and soft palatal tissues; lips
Certified orofacial myologist	Tongue thrust; atypical swallows; oral habits; lingual frenulum
Dental hygienist	Tongue thrust; atypical swallows; oral habits; lingual frenulum
Neurologist	Cranial nerve disorders; jaw/facial pain
Physical therapist	Body posture and alignment

chewing and swallowing should be noted, though not all members on an assessment team will diagnose the severity of malocclusion.

Sleep Patterns

Malocclusion is thought to be related to a person's sleep patterns. Limited maxillary space affects optimal tongue posturing, thus leading to compromised oropharyngeal volume (Banabihl, 2017). Class II malocclusion, overbite, dental crowding, and lateral crossbite may lead to the development of obstructive sleep apnea (Banabihl, 2017). In addition, mouth breathing and nasopharyngeal airway obstruction are typically found in patients with Class II malocclusions (Banabihl, 2017). Furthermore, a high-arched palate can lead to maxillary constriction, which is associated with high nasal airway resistance (Yoon et al., 2020). All of these problems can contribute to sleep-disordered breathing.

Airway Functions

There is a close relationship between malocclusions and upper airways; however, only a limited number of studies found that individuals with Class II malocclusion had larger oropharyngeal space as compared to Class I and Class III groups (Indriksone & Jakobsone, 2014). Backward tongue position results from Class II malocclusions which could potentially disturb respiration functions, leading to mouth breathing (Junqueira et al., 2012). Patients with Class II malocclusion showed significantly decreased orofacial space along with constricted or significantly narrow airways (Lopatiene et al., 2016). Sometimes, the jaw can interfere with the airway, and the hard palate can impact the sinus spaces, thus making it challenging to breathe nasally (D'Onofrio, 2019). Considering the breathing manifestations of individuals with dentofacial deformities, adults with Class II malocclusion may demonstrate reduced maximum phonation time for consonants (/s/ and /z/); however, there were no differences in maximum phonation duration between individuals with and without dentofacial deformities (Prado et al., 2014).

Dental Status

Dentofacial deformities in skeletal malocclusion can impact facial appearance (Ruf et al., 2021) and chewing efficiency along with mandibular range of motion (Trench & de Araújo, 2015). The dental status is examined based on the location and alignment of permanent teeth in adults. An observation of the types of altered malocclusions (Class I, Class II, and Class III) based on Angle (1907) can be helpful to understand different types of spatial relations of teeth,

such as overbite, underbite, and crossbite (Macedo & Bianchini, 2014). Class I malocclusion should be noted for any existing dental rotation and teeth alignment, yielding information on spacing and crowding between teeth (Paskay, 2012). It is also important to note the patient's use of dental appliances while examining the oral cavity (Macedo & Bianchini, 2014).

Tongue Functions

The tongue plays a crucial role in chewing, swallowing, and speech, and tongue functions are affected by various types of malocclusions (e.g., Ihan Hren & Barbič, 2016; Lee et al., 2021; Menezes et al., 2018). Lichnowska and Kozakiewicz (2021a) mentioned functional evaluation of tongue frenulum status found in adults. They emphasized the importance of evaluating ankyloglossia or tongue tie as part of assessing malocclusion and facial skeletal deformities. Tongue mobility in all directions is needed to accomplish swallowing, chewing, and preparing the food bolus. Measurements of tongue range of motion, tongue tip, and posterior tongue mobility can help understand the lingual-palatal contact necessary for oral health and swallowing (Zaghi et al., 2021). Zaghi et al. (2021) also suggested using self-assessment on four-point Likert scale targeting resting tongue position, elevation of tongue tip and tongue body to the palate, mouth breathing, body posture, and sleep. It is important to note that the tongue is contained within the oral cavity and is resting against the alveolar ridge.

Articulation Problems

Articulation of speech sounds is known to be affected due to persisting malocclusion even after orthodontic treatment, and quite often, the tongue and lips status are ignored in adults (Lichnowska & Kozakiewicz, 2021a). Though orthodontists correct most dental malocclusions, the skeletal anomalies can continue to cause persistent articulation errors. Due to deviant lip and tongue movements, palatal sounds (e.g., 'sh'), alveolar sounds (e.g., /t/), fricatives (e.g., /s/), and labiodental sounds (e.g., /f/) tend to be affected (Lichnowska & Kozakiewicz, 2021b). An open bite can result in the tongue protruding into the space between the upper and lower dental arches, thus producing frontal and lateral dental and palatal sounds. An open bite can prevent the lips from touching, and hence, sounds produced by the two lips (e.g., 'p') may sound distorted. Also, the forward placement of the tongue can lead to a depressed mandible during articulation of 's.' Speech evaluation is marked by several observations as they relate to malocclusions

where the maxilla and mandible are not in normal occlusal relations. Speech errors can exist in clients with occlusal anomalies such as open bite, deep bite, Class II, and Class III malocclusions (Van Lierde et al., 2012). Other factors that must be considered for articulation include alveolar height, palatal contour, and position of incisors. An accumulation of saliva at the labial commissure, lip movements, speech rate, phonetic distortions, as well as overall articulatory precision are a few areas of articulation assessment.

CONCLUSIONS, LIMITATIONS, AND FUTURE RESEARCH

Based on the current scoping review, no high-quality evidence was found that corresponded with randomized studies with limited biases. Given the heterogeneity of the published studies on OMD assessments, the overall evidence was considered low. According to the literature, an OMD assessment must begin with a detailed case history, including current problems, quality of life, and past medical history. The specific areas of assessment were oral habits, orofacial structures, sleep, airway, dental status, and articulatory deviations. The three studies with OMD assessment protocols for adults mentioned that orofacial myofunctional protocols are clinically useful, but not all of them have been tested for validity and reliability. A crucial part of OMD assessment is the team of professionals who collaborate among themselves to provide evidence-based care to clients. For the team dedicated toward the assessment of malocclusions, it is important to have an allergist, dentist, certified orofacial myologist, oral surgeon, orthodontist, otolaryngologist, and a physician who specializes in sleep.

It was recommended in the literature that OMD assessments are conducted by interdisciplinary teams consisting of medical professionals, orthodontists, and dentists, because of the importance of malocclusion. In addition, authors recommend supplementing noninstrumental assessments with objective data from instrumental analysis, such as cephalometry, electropalatography, electromyography, and others (e.g., D'Onofrio, 2018; Menezes et al., 2017; Zere et al., 2018). Though temporomandibular joint (TMJ) disorders may coexist with malocclusions, this study did not include any TMJ assessments. Additionally, the authors of this review did not establish criteria to evaluate the published protocols' study designs, validity, and reliability. Since only a few studies explored OMD assessments in adults with malocclusion, future research is needed in this area.

Regarding future research, the authors recommend focusing on the establishment of both instrumental and non-instrumental assessment protocols. The developed protocols should associate various severity levels of malocclusion to the manifestations of OMD and increase the reliability of OMD assessments by clinicians. Since different types of dentofacial deformities are related to stomatognathic functions, the authors also suggest future research focus on the relationship between various oral structures and functions pertaining to breathing, swallowing, chewing, and speech. Lastly, further research should address the client's awareness and self-perception of the effects of OMD on their breathing, swallowing, articulation, airway function, sleep patterns, tongue function, and dental status. Increasing awareness of a client's knowledge about their OMD and potential effects will facilitate a more effective treatment plan.

REFERENCES

- American Speech-Language-Hearing Association (2021). *Orofacial Myofunctional Disorders*. Retrieved from <https://www.asha.org/practice-portal/clinical-topics/orofacial-myofunctional-disorders/>
- Angle, E. (1907). *Malocclusion of the Teeth* (7th ed.). The S.S. White Dental Manufacturing Co.
- Bakke, M., Bergendal, B., McAllister, A., Sjögreen, L., & Åsten P. (2007). Development and evaluation of a comprehensive screening for orofacial dysfunction. *Swedish Dental Journal*, 31(2), 75-84.
- Banabihl, S. M. (2017). Orthodontic view in the diagnoses of obstructive sleep apnea. *Journal of Orthodontic Science*, 6(3), 81-85. https://doi.org/10.4103/jos.JOS_135_16
- Benkert, K.K. (1997). The effectiveness of orofacial myofunctional therapy in improving dental occlusion. *International Journal of Orofacial Myology*, 23, 35-46. <https://doi.org/10.52010/ijom.1997.23.1.6> PMID: 9487828.
- Bergendal, B., Bakke, M., McAllister, A., Sjögreen, L., & Åsten, P. (2014). Profiles of orofacial dysfunction in different diagnostic groups using the Nordic Orofacial Test (NOT-S): A review. *Acta Odontology Scandinavica*, 72(8), 578-84. <https://doi.org/10.3109/00016357.2014.942874>
- Campbell, S., & Goldstein, G. (2021). Angle's Classification-A prosthodontic consideration: Best evidence consensus statement. *Journal of Prosthodontics*, 30(S1), 67-71. <https://doi.org/10.1111/jopr.13307>. PMID: 33331655.

- D'Onofrio, L. (2019). Oral dysfunction as a cause of malocclusion. *Orthodontics & Craniofacial Research*, 22 Suppl 1(Suppl 1), 43–48. <https://doi.org/10.1111/ocr.12277>
- de Felício, C.M., & Ferreira, C.L. (2008). Protocol of orofacial myofunctional evaluation with scores. *International Journal of Pediatric Otorhinolaryngology*, 72(3), 367–75. <https://doi.org/10.1016/j.ijporl.2007.11.012>
- de Felício, C.M., Medeiros, A.P., & de Oliveira, M. M. (2012). Validity of the protocol of orofacial myofunctional evaluation with scores for young and adult subjects. *Journal of Oral Rehabilitation*, 39(10):744–753. <https://doi.org/10.1111/j.1365-2842.2012.02336.x>
- Dellepiane, E., Pera, F., Zunino, P., Mugno, M.G., Pesce, P., & Menini, M. (2020). Oral health-related quality of life and full-arch immediate loading rehabilitation: An evaluation of preoperative, intermediate, and posttreatment assessments of patients using a modification of the OHIP questionnaire. *Journal of Oral Implantology*, 46(6), 540–549. <https://doi.org/10.1563/aaid-joi-D-19-00274>
- Elfseyie, M., Hassan, M., Mohammed, N., & Al-Jaf, A. (2020). Prevalence of malocclusion and occlusal traits of Malay adults (18–23 years) in Shah Alam, Malaysia. *International Journal of Dentistry Research*, 81–86. <https://doi.org/10.31254/dentistry.2020.5211>
- Ferreira, C.L., Da Silva, M.A., & de Felício, C.M. (2009). Orofacial myofunctional disorder in subjects with temporomandibular disorder. *Cranio*, 27(4), 268–74. <https://doi.org/10.1179/crn.2009.038>. PMID: 19891261.
- Grandi, D. (2012). The "Interdisciplinary Orofacial Examination Protocol for Children and Adolescents": A resource for the interdisciplinary assessment of the stomatognathic system. *International Journal of Orofacial Myology*, 38, 15–26. <https://doi.org/10.52010/ijom.2012.38.1.3> PMID: 23362750.
- Hale, S.T., Kellum, G.D., Nason, V.M., & Johnson, M.A. (1988). Analysis of orofacial myofunctional factors in kindergarten subjects. *International Journal of Orofacial Myology*, 14(3), 12–5. <https://doi.org/https://doi.org/10.52010/ijom.1988.14.3.3>
- Hitos, S.F., Arakaki, R., Solé, D., & Weckx, L.L. (2013). Oral breathing and speech disorders in children. *Journal of Pediatrics*, 89(4), 361–5. <https://doi.org/10.1016/j.jpeds.2012.12.007>
- Ihan Hren, N., & Barbič, U. (2016). Tongue volume in adults with skeletal Class III dentofacial deformities. *Head & Face Medicine*, 12, 12. <https://doi.org/10.1186/s13005-016-0110-4>
- Indriksone, I., & Jakobsone, G. (2014). The upper airway dimensions in different sagittal craniofacial patterns: A systematic review. *Stomatologija*, 16(3), 109–17. PMID: 25471995
- Junqueira, P., Marchesan, I.Q., de Oliveira, L.R., Ciccone, E., Haddad, L., & Rizzo, M.C. (2010). Speech-language pathology findings in patients with mouth breathing: Multidisciplinary diagnosis according to etiology. *International Journal of Orofacial Myology*, 36, 27–32. <https://doi.org/10.52010/ijom.2010.36.1.3>
- Kamdar, R. J., & Al-Shahrani, I. (2015). Damaging oral habits. *Journal of International Oral Health*, 7(4), 85–87. PMID: 25954079
- Kondo, E., & Aoba, T.J. (1999). Case report of malocclusion with abnormal head posture and TMJ symptoms. *American Journal of Orthodontics and Dentofacial Orthopedics*, 116(5), 481–93. [https://doi.org/10.1016/S0889-5406\(99\)70177-0](https://doi.org/10.1016/S0889-5406(99)70177-0). PMID: 10547505.
- Lee, Y-S., Ryu, J., Baek, S-H., Lim, W.H., Yang, I-H., Kim, T-W., & Jung, S-K. (2021). Comparative analysis of the differences in dentofacial morphology according to the tongue and lip pressure. *Diagnostics*, 11(3), 503. <https://doi.org/10.3390/diagnostics11030503>
- Lichnowska, A., & Kozakiewicz, M. (2021a). The effectiveness of frenotomy on speech in adults. *Applied Science*, 11, 2727. <https://doi.org/10.3390/app11062727>
- Lichnowska, A., & Kozakiewicz, M. (2021b). The logopedic evaluation of adult patients after orthognathic surgery. *Applied Science*, 11, 5732. <https://doi.org/10.3390/app11125732>
- Lopatiene, K., Borisovaite, M., & Lapenaite, E. (2016). Prevention and treatment of white spot lesions during and after treatment with fixed orthodontic appliances: A systematic literature review. *Journal of Oral & Maxillofacial Research*, 7(2), <https://doi.org/10.5037/jomr.2016.7201>
- Macedo, P.F., & Bianchini, E.M. (2014). Myofunctional orofacial examination: Comparative analysis in young adults with and without complaints. *Codas*, 26(6):464–70. <https://doi.org/10.1590/2317-1782/20142014015>
- Marchesan, I. Q., Berretin-Felix, G., & Genaro, K.F. (2012). MBGR Protocol of orofacial myofunctional evaluation with scores. *International Journal of Orofacial Myology*, 38(1), 38–77. <https://doi.org/10.52010/ijom.2012.38.1.5>
- Menezes, L.F., da Rocha, A.M., Paulino, C.E.B., Laureano, J.R., & Studart-Pereira, L.M. (2018).

- Tongue pressure and endurance in patients with Class II and Class III malocclusion. *Revista CEFAC*, 20(2), 166-174.
<https://doi.org/10.1590/1982-0216201820210917>
- Mokhtar, K. I., Bakar, N. A., & Tahir, A. H. M. A. (2020). Genetics of malocclusion: A review. *IJUM Journal of Orofacial and Health Sciences*, 1(1), 1–6. <https://doi.org/10.31436/ijohs.v1i1.2>
- Moyers, R. (1988). *Handbook of orthodontics*. Yearbook Medical Publisher.
- Page, M. J., McKenzie, J. E., Bossuyt, P. M., Boutron, I., Hoffmann, T. C., Mulrow, C. D., Shamseer, L., Tetzlaff, J. M., Akl, E. A., Brennan, S. E., Chou, R., Glanville, J., Grimshaw, J. M., Hróbjartsson, A., Lalu, M. M., Li, T., Loder, E. W., Mayo-Wilson, E., McDonald, S., McGuinness, L. A., ... Moher, D. (2021). The PRISMA 2020 statement: An updated guideline for reporting systematic reviews. *BMJ (Clinical research ed.)*, 372, n71.
<https://doi.org/10.1136/bmj.n71>
- Paskay, L. C. (2012). A one-page orofacial myofunctional assessment form: A proposal. *International Journal of Orofacial Myology*, 38(1), 27-37.
<https://doi.org/10.52010/ijom.2012.38.1.4>
- Prado, D.G.A., Filho, H.N., Berretin-Felix, G., & Brasalotto, A.G. (2014). Breathing characteristics of individuals with dentofacial deformity. *Rev. CEFAC*, 16(4), 1194-1200.
- Rapeepattana, S., Thearmontree, A., & Suntornlohanakul, S. (2019). Etiology of malocclusion and dominant orthodontic problems in mixed dentition: A cross-sectional study in a group of Thai children aged 8-9 years. *Journal of International Society of Preventive & Community Dentistry*, 9(4), 383–389.
https://doi.org/10.4103/jispcd.JISPCD_120_19
- Ruf, S., Proff, P., & Lisson, J. (2021). Tooth and jaw misalignments - health relevance and treatment. *Federal Health Gazette, Health Research, Health Protection*, 64(8), 918–923.
<https://doi.org/10.1007/s00103-021-03372-3>
- Scarponi, L., de Felicio, C. M., Sforza, C., Pimenta Ferreira, C. L., Ginocchio, D., Pizzorni, N., Barozzi, S., Mozzanica, F., & Schindler, A. (2018). Reliability and validity of the Italian version of the protocol of Orofacial Myofunctional Evaluation with Scores (I-OMES). *Folia Phoniatrica et Logopaedica*, 70(1), 8–12.
<https://doi.org/10.1159/000488027>
- Shortland, H.L., Hewat, S., Vertigan, A. & Webb, G (2020). Orofacial myofunctional therapy and myofunctional devices used in speech pathology treatment: A systematic quantitative review of the literature. *American Journal of Speech-Language Pathology*, 30, 301–317.
https://doi.org/10.1044/2020_AJSLP-20-00245
- Trench, J.A., & de Araújo, R.P. (2015). Dentofacial deformities: Orofacial myofunctional characteristics. *Review CEFAC*, 17(4), 1202-1214.
- Tricco, A.C., Lillie, E., Zarin, W., O'Brien, K.K., Colquhoun, H., Levac, D., Moher, D., Peters, M.D., Horsley, T., Weeks, L., Hempel, S. Akl, E.A., Chang, C., McGowan, J., Stewart, L., Hartling, L., Aldcroft, A., Wilson, M.G., Garritty, C., Lewin, S., Godfrey, C.M., Macdonald, M.T., Langlois, E.V., Soares-Weiser, K., Moriarty, J., Clifford, T., Tunçalp, Ö., & Straus, S.E. (2018). PRISMA extension for scoping reviews (PRISMA-ScR): Checklist and explanation. *Annals of Internal Medicine*, 169 (7), 467-473.
<https://doi.org/10.7326/M18-0850>
- Van Lierde, K., Browaeys, H., Corthals, P., Mussche, P., Van Kerkhoven, E., & De Bruyn, H. (2012). Comparison of speech intelligibility, articulation and oromyofunctional behaviour in subjects with single-tooth implants, fixed implant prosthetics or conventional removable prostheses. *Journal of Oral Rehabilitation*, 39, 285–293.
<https://doi.org/10.1111/j.1365-2842.2011.02282.x>
- Vaz, A. C., & Bai, P. M. (2015). Lingual frenulum and malocclusion: An overlooked tissue or a minor issue. *Indian Journal of Dental Research*, 26(5), 488. <https://doi.org/10.4103/0970-9290.172044>
- Yoon, A., Guilleminault, C., Zaghi, S., & Liu, S.Y. (2020). Distraction Osteogenesis Maxillary Expansion (DOME) for adult obstructive sleep apnea patients with narrow maxilla and nasal floor. *Sleep Medicine*, 65, 172-176.
<https://doi.org/10.1016/j.sleep.2019.06.002>
- Zaghi, S., Shamtoob, S., Peterson, C., Christianson, L., Valcu-Pinkerton, S., Peeran, Z., Fung, B., Kwok-Keung Ng, D., Jagomagi, T., Archambault, N., O'Connor, B., Winslow, K., Lano, M., Murdock, J., Morrissey, L., & Yoon, A. (2021). Assessment of posterior tongue mobility using lingual-palatal suction: Progress towards a functional definition of ankyloglossia. *Journal of Oral Rehabilitation*, 48(6), 692–700.
<https://doi.org/10.1111/joor.13144>
- Zere, E., Chaudhari, P. K., Sharan, J., Dhingra, K., & Tiwari, N. (2018). Developing Class III malocclusions: Challenges and solutions. *Clinical, Cosmetic and Investigational Dentistry*, 10, 99–116. <https://doi.org/10.2147/CCIDE.S13430>
- Zou, J., Meng, M., Law, C. S., Rao, Y., & Zhou, X. (2018). Common dental diseases in children and malocclusion. *International Journal of Oral Science*, 10(1), 1–7.
<https://doi.org/10.1038/s41368-018-0012-3>