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Expanded protocol of orofacial myofunctional evaluation with scores: Validity and reliability

Cláudia Maria de Felício [a,*], Gislaine Aparecida Folha [b], Cláudia Lúcia Pimenta Ferreira [b], Ana Paula Magalhães Medeiros [b]

[a] Faculty of Medicine of Ribeirão Preto, University of São Paulo, Department of Otorhinolaryngology, Ophthalmology and Head and Neck Surgery, Brazil
[b] Department of Otorhinolaryngology, Ophthalmology and Head and Neck Surgery, University of São Paulo, Ribeirão Preto, Brazil

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ABSTRACT

Objective: Clinical evaluation of the stomatognathic system is indispensable for the diagnosis of orofacial myofunctional disorders. In order to obtain a more precise diagnosis, the protocol of orofacial myofunctional evaluation with scores (OMES protocol) (Int. J. Pediatr. Otorhinolaryngol. 72 (2008) 367–375) was expanded in terms of number of items and scale amplitude. The proposal of this study is to describe the expanded OMES protocol (OMES-E) for the evaluation of children. Validity of the protocol, reliability of the examiners and agreement between them were analyzed, as also were the sensitivity, specificity and predictive values of the instrument.

Methods: The sample consisted of videorecorded images of 50 children, 25 boys (mean age = 8.4 years, SD = 1.8) and 25 girls (mean age = 8.2 years, SD = 1.7) selected at random from 200 samples. Three speech therapists prepared for orofacial myofunctional evaluation participated as examiners (E). The OMES and OMES-E protocols were used for evaluation on different days. E1 evaluated all images, E2 analyzed children with recordings from 1 to 25 and E3 analyzed children with recordings from 26 to 50. The validity of OMES-E was analyzed by comparing the instrument to the OMES protocol using the Pearson correlation test complemented with the split-half reliability test ($p < 0.05$). The linear weighted Kappa coefficient of agreement (Kw′), the sensitivity, specificity and predictive values and the prevalence of OMD were calculated.

Results: There was a statistically significant correlation between the OMES and OMES-E protocols ($0.79 > r < 0.94$, $p < 0.01$) and a significant test–retest correlation with the OMES-E ($0.75 > r < 0.86$, $p < 0.01$), with a reliability range of 0.86–0.93. The correlation and reliability coefficients between examiners were: E1 × E2 ($r = 0.74$, 0.84), E1 × E3 ($r = 0.70$, 0.83) ($p < 0.01$). Kw′ coefficients with moderate and good strength predominated. The OMES-E protocol presented mean sensitivity = 0.91, specificity = 0.77, positive predictive value = 0.87 and negative predictive value = 0.85. The mean prevalence of OMD was 0.58.

Conclusion: The OMES-E protocol is valid and reliable for orofacial myofunctional evaluation.

1. Introduction

Orofacial myofunctional disorders (OMD) include changes of orofacial muscles and stomatognathic functions such as mastication, deglutition and speech, that can have a negative impact in oral and general health [1,2].

The oral sensorimotor system is traditionally evaluated by health professionals, among them speech therapists when speech is the main complaint [3], for the diagnosis of OMD in cases of malocclusions [4,5], mouth breathing [6], surgery for tonsil hypertrophy [7,8], and temporomandibular disorders [2].

As previously pointed out, orofacial myofunctional clinical evaluation is essential for the diagnosis of OMD [3,4,6,9–16] and can often be complemented, but not replaced, with other exams. In addition, the execution of certain exams may be impaired by technical complexity and by limited access to certain special materials [17].

The use of numerical scale in the orofacial myofunctional clinical evaluation can contribute to the analysis, permitting comparisons between subjects and the monitoring of the results obtained with treatment. Some authors have attempted to express numerically the results of the orofacial myofunctional clinical

* Corresponding author at: Av. Dos Bandeirantes - 3900 - Ribeirão Preto - SP-14049-900, Brazil. Tel.: +55 16 36022523; fax: +55 16 36022860.
E-mail address: cfelicio@fmrp.usp.br (C.M.d. Felício).

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evaluation [7,15,18]. However, the score ranges from (0) to (1), with no grading for each item.

So far, only two protocols for the clinical assessment of structures and functions of the stomatognathic system have been tested for validity: the Nordic orofacial test-screening (NOT-S) [15] and the protocol of orofacial myofuncional evaluation with scores (OMES protocol) [3].

Specifically, the OMES protocol is an instrument for the clinical evaluation of orofacial structures and functions of children that will permit the examiner to express numerically his perception of the characteristics and behaviors observed, and that can be administered without special equipment and in a brief manner [3].

In view of the clinical necessity of a more detailed and precise assessment of OMD for the diagnosis and monitoring of responses to therapy, the OMES protocol [3] was modified.

The OMES protocol was expanded in terms of number of items to be evaluated and in terms of the amplitude of its numerical scales, since the precision of diagnosis can be improved with more expanded numerical assessment scales [19].

The objectives of the present report are to describe the expanded OMES protocol (OMES-E) and to present an analysis of its validity, reliability and intra- and inter-examiner agreement, as well as its sensitivity, specificity and predictive values.

2. Methods

2.1. Sample selection

The project was approved by the Human Research Ethics Committee of the Faculty of Medicine of Ribeirão Preto, University of São Paulo, Brazil, Protocol No. 2008.1.311.58.7.

The sample for the present study consisted of recorded images and videos of 50 children, presenting or not OMD, out of a total of 200 samples from a data bank. Its included images recorded during the diagnosis evaluation of individuals with various degrees of OMD and without OMD, since several degrees of alteration, as well as normal standards were needed for the scale construction [3].

The registration number of the subjects was used separately by gender for random selection with the aid of the GraphPad software (www.graphpad.com/quickcalcs), in order to select an equal number of boys and girls. The selected children later received new registration numbers from 1 to 50. All recorded images were clear, permitting good visualization.

Twenty-five boys ranging in age from 6 to 12 years (mean age = 8.4 years, SD = 1.8) and 25 girls ranging in age from 6 to 11 years (mean age = 8.2 years, SD = 1.7) were selected.

The inclusion criteria were: no apparent or reported history of neurological, developmental or intellectual problems according to parent report and examiner observation, no previous or current tumors or traumas in the head and neck region, and no orthodontic treatment or previous or current orofacial myofunctional therapy.

2.2. Examiners

Three speech therapists prepared for orofacial myofunctional evaluation and unfamiliar with the subjects were chosen as examiners (E) after analysis of their ability to use the OMES protocol. The evaluations for this purpose were performed with subjects not included in the present study. The correlations and test–retest (intra-examiner) reliability were $r = 0.94$, 0.91 for E1, $r = 0.85$, 0.92 for E2 and $r = 0.93$, 0.96 for E3, respectively. The correlations and reliability between E1 and E2 were $r = 0.88$, 0.94; and between E1 and E3 were $r = 0.70$, 0.82, all with $p < 0.01$. The strength of the weighted Kappa coefficient Kw′ [20] for application of the OMES was predominantly moderate.

2.3. Procedures

2.3.1. Data collection

During the recording sessions previously held, the individuals sat on a chair with a backrest with their feet resting on the floor at a standardized distance (1 m) from the lens of the camera, which stood on a tripod set at a height adjusted to focus on the face, neck and shoulders of the child. A Sony Handycam videocamera (Hi8/ccd-TRV 138) was used to obtain the recordings, which were stored on recordable DVDs (4.7 Gb 8× Sony).

In the present study, orofacial myofunctional evaluation of the children was performed by the analysis of the images recorded on a DVD reading instrument (DVD Player Philips/DVP 4000). This allowed the multiple analysis by the same examiner and by different examiners, at different times. Still, it was possible to prevent the children being subjected to repetitive tasks and delay in treatment initiation, when necessary.

The recordings contained a static image (10 s) for the evaluation of the appearance and posture of the components of the stomatognathic system, plus the tests of mobility, deglutition and mastication. The OMES and OMES-E protocols were applied with an interval of at least 15 days between them to avoid memory effects.

All samples were evaluated by E1, E2 analyzed recordings from 1 to 25 and E3 analyzed recordings from 26 to 50. The examiners were instructed not to exchange information with one another during image evaluations. The data collected were transcribed to printed protocols and later digitized for analysis. The total time spent to evaluate each sample was, on average, 15 min.

The OMES protocol was used for evaluation according to a previously described methodology [3].

In the evaluation with the OMES-E protocol (Appendix A) regarding the appearance and posture of the components of the stomatognathic system, scores were attributed using a 4-point scale: 4 = normal, 3 = mild alteration, 2 = moderate alteration, and 1 = severe alteration. The following items were evaluated:

- Face: symmetry between the right and left sides, proportion between the facial thirds, and nasolabial sulcus;
- Cheeks: volume, tension/configuration;
- Maxillomandibular relation: free way space, midline, presence of overjet and overbite;
- Lips: resting posture, lips volume and configuration and labial commissures;
- Mentalis muscle: absence or presence of apparent contraction at rest;
- Tongue: position at rest and volume;

The hard palate was not analyzed because of the impossibility of doing so by means of the video recorded images, but the item is part of the protocol.

For the evaluation of mobility, the children were asked to perform separate movements of the lips, tongue, jaws, and cheeks. The following movements were considered:

Lips: protrusion, stretching, lateroprotrusion to the right and to the left.
Tongue: protrusion, lateralization to the right, lateralization to the left, elevation, lowering, and ability to keep the tongue stable in protrusion for 5 s.
Mandible: protrusion, lowering, elevation, lateralization to the right and to the left sides.

In the analysis, separate movements of each component, precise and without tremors, were considered to be normal.

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Dysfunction was considered to be present when lack of precision in the movement, tremor, associated movements of other components (e.g., lips accompanying the movements of the tongue) and inability to perform the movement were observed. Using the OMES-E Protocol, the examiner attributed scores on a 6-point scale: 6 = normal, 5 = insufficient ability, 4 = insufficient ability and associated movements, 3 = insufficient ability and tremors and/or deviation, 2 = insufficient ability, associated movement tremors and/or deviation, and 1 = absence of ability or being unable to perform the task.

Breathing was observed throughout the evaluation and was classified as nasal or oronasal. The examiner attributed scores on a 4-point scale: 4 = when the lips remained in occlusion without effort, mainly during situations of rest and mastication, with the tongue contained in the oral cavity (normal pattern); 3 = mild alteration, when the subject presented oronasal inspiration but was able to perform inspiration only through the nose without showing signs of fatigue and dyspnea, 2 = moderate alteration when the condition was similar to the previous one but the subject did not maintain a nasal pattern, and 1 = severe alteration when the subject, while trying to perform nasal only inspiration, showed signs of fatigue and dyspnea and opened his mouth to inspire within a few seconds, a pattern observed both at rest and during mastication. No other analysis of breathing was possible based on the video images.

During the video recording of the deglutition test the subject was asked to bring a cup containing water at room temperature to his mouth and, after placing water in his mouth, to lower the cup so that his entire face could be visualized and to swallow in his habitual manner. A minimum of two and a maximum of four replicates were performed. Next, it was explained to the subject that he should proceed as done in the previous test, but that the examiner would place her index finger under his chin and her thumb under his lower lip (region of the mentalis muscle) and that his lips would be separated after he had swallowed. Immediately after deglutition, the examiner separated the lips of the subject in order to visualize his teeth or even his tongue in case of the occurrence of tongue interposition.

Regarding labial behavior during deglutition, when the lips were occluded without apparent contraction the behavior was considered normal and a score of 6 was attributed to it. When the lips showed apparent contraction beyond the normal level or when lip interposition occurred, a score of 4 was attributed to light lips contraction, a score of 3 to medium contraction, a score of 2 to severe contraction, and a score of 1 to the absence of lips occlusion.

Tongue behavior during deglutition was considered normal when the tongue was contained in the oral cavity and received a score of 4. The remaining scores were assigned to the following behaviors: 3 = tongue interposed between teeth in the limit of the incisal surfaces (or margins, in the absence of teeth), with a reduced vertical dimension of occlusion (VDO) in cases of overbite; 2 = tongue on the limits of the incisal surfaces with normal VDO; 1 = tongue placed beyond the incisal surfaces (or margins, in the absence of teeth) and/or the vestibular cusps.

When the child presented malocclusion as anterior open bite and abnormal overjet (normal values = between 1 and 4 mm), the following scores were attributed according to the position of the tongue: 3 = when the tongue was on the limit of the incisal surfaces; 2 = when the tongue thrust occurred beyond the incisal surfaces and/or vestibular cusps in a moderate manner; 1 = when tongue thrust occurred beyond the incisal surfaces in an excessive manner. Other behaviors and signs of alteration such as movement of the head or of other parts of the body, sliding of the mandible, tension of the facial musculature, food escape, choking, and noise were observed. In the absence of each one of this signs, a score of 2 was attributed. If present, each one received a score of 1.

The efficiency of deglutition, considered to be the ability to impel the bolus from the oral cavity to the oropharynx, was assessed for both solid and liquid boluses. A score of 3 was attributed for both consistencies when there was no more than one repetition of deglutition of the same bolus, a score of 2 when there were two to three repetitions, and a score of 1 when multiple deglutition occurred.

A chocolate-flavored stuffed Bono® cookie (Nestlé, São Paulo, SP, Brasil) was used for the chewing test and the subject was instructed to chew it in his habitual manner. The total time spent to consume the food was measured with a digital chronometer (Casio - HS-60W-1DF) which was started after the food was placed in the oral cavity and stopped after the final deglutition of each portion.

Solid food ingestion was analyzed starting from the bite and the following scores were attributed: 4 = biting with the incisors, 3 = biting with the canines and the premolars, 2 = biting with the molars, 1 = when the subject did not bite the food but broke it into pieces with his hands before bringing it to his mouth.

Mastication (trituration) was classified in terms of type and the following scores were attributed to it: 10 when it was bilateral and alternate, i.e., the masticatory strokes occurred on each side 50% of the times, or 40% on one side and 60% on the other; 8 = simultaneously bilateral, with the masticatory strokes occurring on both sides of the oral cavity 95% of the times; 6 = unilateral preference-grade 1 when the masticatory strokes occurred on the same side 61–77% of the times; 4 = unilateral preference-grade 2 when the masticatory strokes occurred on the same side 78–94% of the times; 2 = chronic unilateral, when the masticatory strokes occurred on the same side 95–100% of the time, or anterior when the masticatory strokes occurred in the region of the incisors and canines; 1 = when the patient did not perform the function.

In addition, the presence of other behaviors and signs of alteration was analyzed, such as movement and/or altered posture of the head and of other parts of the body, food escape and uncoordinated jaw movements. A score of 1 was attributed to the presence of each of these items, and a score of 2 to its absence.

2.4. Analysis of criterion validity of the OMES-E protocol

To test the behavior of the proposed protocol (OMES-E) and to determine if it really measured the parameters for which it was proposed, concurrent validity was calculated, i.e., comparison of the OMES-E to the previously validated OMES protocol.

The OMES-E protocol contains more items and therefore these items were grouped into categories corresponding to those of the OMES protocol and the sum of scores was calculated for comparison.

The categories regarding appearance/posture consisted of the scores for the items indicated within parentheses: face (symmetry, proportions between the thirds of the face, and nasolabial sulcus); cheeks (volume and tension/configuration); maxillomandibular relation (midline, and vertical and anteroposterior relations); lips (resting, volume, configuration, labial commissures and contraction of the mentalis muscle); tongue (position, appearance and volume). Regarding masticatory function, the sum of the scores for the bite, masticatory type and other signs of alteration was calculated.

2.4.1. Analysis of reliability and agreement

The reliability and agreement of the application and/or interpretation of the OMES-E was tested in order to establish the extent to which the instrument reproduced the results obtained previously by each examiner (test–retest) and between

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Table 1
Sensitivity, specificity, positive predictive value and negative predictive value of the OMES-E protocol and prevalence of orofacial myofunctional disorders in the study population by item and as the mean value.

N = 50	Predictive values				
	Sensitivity	Specificity	Positive	Negative	Prevalence
Posture/apperance	0.86	0.64	0.75	0.78	0.56
Mobility	0.89	0.77	0.95	0.71	0.74
Breathing	0.89	0.97	0.94	0.94	0.36
Deglutition	0.90	0.74	0.85	0.82	0.62
Mastication	1.00	0.74	0.86	1.00	0.62
Mean	0.91	0.77	0.87	0.85	0.58

examiners. The data used for the validation of the protocol (test) were considered and each examiner performed a new analysis of the images of the same subjects (retest) after at least 15 days in order to avoid memory effects on the results. Inter- and intra-examiner agreement for the use of the protocol was also determined.

2.4.2. Analysis of sensitivity, specificity, predictive values, and prevalence

Based on the data obtained in the evaluation of 50 subjects by E1, the 75% percentile was established, i.e., 25% of the subjects who obtained lower scores than the remainder of the population were characterized as presenting alterations of the category assessed. This analysis was realized by category, because the study sample consisted of subjects without OMD and of subjects with OMD, but not necessarily for all items. Thus, the OMES-E protocol sensitivity, specificity, positive and negative predictive values and prevalence of OMD in the study population were calculated. The OMES protocol was considered the test standard (''gold standard'').

In the present study, the diagnostic ability of the OMES-E is represented by sensitivity (the proportion of true positives that were correctly identified) and the specificity (the proportion of true negatives that were correctly identified). Whereas, predictive value is the probability that the test will give the correct diagnosis. Positive predictive value is the proportion of subjects with positive test results who were correctly diagnosed. Negative predictive value is the proportion of patients with negative test results who were correctly diagnosed. The prevalence is the proportion of the population that presented DMO in the study population [20,22].

Data regarding posture/appearance, mobility, respiration, deglutition, and mastication were calculated separately and the mean for the categories was also calculated.

2.5. Data analysis

Correlation and reliability between the OMES and OMES-E protocols and between the intra- and inter-examiner evaluations were calculated by the Spearman correlation coefficient and the split-half reliability method. The cut-off point for a diagnosis of oral myofunction disorders was determined using the descriptive analysis for percentile calculation (75th percentile). The calculations were made using the Statistica software (StatSoft Inc., Tulsa, Oklahoma, USA), with the level of significance set at 0.05.

To determine intra- and inter-examiner agreement the linear weighted Kappa coefficient (Kw′) was calculated using the MedCalc software (Mariakerke, Belgium, Version 11.0.1). The strength of agreement of Kw′ was classified as poor (<0.20), reasonable (0.21–0.40), moderate (0.41–0.60), good (0.61–0.80) and very good (0.81–1.00) according to the method of Altman [20].

Sensitivity, specificity, positive and negative predictive values, and the prevalence of OMD in the study population were also calculated using Microsoft Office Excel, 2007, spreadsheets (Microsoft Corporatian, Redmond, WA, USA).

3. Results

3.1. Criterion validity of the OMES-E protocol

There was a statistically significant correlation between the evaluations of samples assessed with the OMES and OMES-E protocols. The following values were obtained according to the examiners: E1 ($r = 0.81$, $p < 0.01$), E2 ($r = 0.79$, $p < 0.01$) and E3 ($r = 0.94$, $p < 0.01$). The reliability between protocols was good for E1 (0.89) and E2 (0.88) and excellent for E3 (0.97).

Table 2
OMES-E maximum scores by category, range and means obtained by children with and without OMD, sample distribution according to presence and absence of OMD.

N = 50 (E1)	Posture/apperance	Mobility	Breathing	Deglutition	Mastication	Total
Maximum value by OMES-E	56[a]	114	4	28	22	224
Children with OMD						
Number of children	32	36	17	33	36	38
Mean	47	86	3	23	17	176
Maximum	51	104	3	25	21	210
Minimum	40	52	1	20	13	200
Standard deviation	3.39	11.16	0.59	1.28	2.29	13.12
Children without OMD						
Number of children	18	14	33	17	14	12
Mean	53	106	4	26	21	210
Maximum	55	112	4	28	24	217
Minimum	52	102	4	26	22	153
Standard deviation	1.18	3.18	0	0.87	0.53	4.90

[a] Maximum value expect by OMES-E protocol, without to consider the palate.

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3.2. Analysis of reliability and agreement

The test–retest correlation and reliability coefficients with the OMES-E were: E1 ($r = 0.86$, 0.93), E2 ($r = 0.75$, 0.86), and E3 ($r = 0.80$, 0.89). The correlation and reliability coefficients between examiners with the OMES-E were: E1 × E2 ($r = 0.74$, 0.84), E1 × E3 ($r = 0.70$, 0.83), all with $p < 0.01$.

Considering the results as a whole, *Kw* values showed predominantly moderate and good agreement strengths in the test–retest with the OMES-E protocol and between examiners. The percentage of coefficients with "moderate, good and very good" strengths was 100% for the test–retest of E1 and 76.4% for E3. In the test–retest of E2, coefficients with reasonable strength (70.59%) predominated, whereas "moderate and good" strengths corresponded to 29.4%. Agreement between E1 and E3 was "moderate and good" for 76.47% of the items analyzed and agreement between E1 and E2 was "moderate and good" for 35.29% of the items and reasonable for 52.94%.

3.3. Analysis of sensitivity, specificity, predictive values, and prevalence

Mean coefficients of sensitivity and specificity of 0.91 and 0.77, respectively, and mean positive predictive values of 0.87 and negative predictive values of 0.85 were obtained for the OMES-E protocol. The mean prevalence of OMD detected was 0.58. The results for each category studied and the mean values are presented in Table 1.

Table 2 shows the OMES-E maximum scores by category, means obtained by children with and without OMD, sample distribution according to presence and absence of OMD.

4. Discussion

The clinical evaluation of the structures and functions of the stomatognathic system is the basis for the diagnosis of OMD. According to his goals, the professional may opt for a screening protocol [8,15,21] or for an assessment protocol that can be applied within a short period of time [3]. However, under certain circumstances a more detailed protocol may be necessary for the diagnosis of OMD and for the monitoring of the effectiveness of treatment.

To this end, the expanded OMES protocol was elaborated and its validity assessed.

The validity of an instrument can be estimated as its ability to really measure what one proposes to measure [22], i.e., how well the instrument acts as an indicator of the veracity of the test [23–25]. For clinical conditions such as those related to the stomatognathic system, it is also necessary to consider the difficulties of the measurements and whether the scores proposed can adequately characterize the complex nature of the disorder [26].

Criterion validation involves a systematic assessment of the instrument to be validated by comparing it to another instrument recognized as the "gold standard", frequently using statistical tests [27]. At times, the gold standard is the clinical diagnosis or some type of criterion previously established as a reference standard [25,27].

The validity of the proposed OMES-E protocol was assessed by comparing this instrument to the validated OMES protocol [3]. According to the results of the correlation and reliability tests, which ranged from good to excellent, the OMES-E permits to evaluate the items for which it was proposed, i.e., the orofacial myofunctional conditions, thus satisfying the validity criterion. Also, the OMES-E was found to be a reliable instrument when multiple applications were compared (test–retest), with reliability between examiners. Indeed, without this analysis, the usefulness of clinical measurements may be questioned [28].

The examiners who participated in the present study were previously trained, but differences were observed between them. According to the results, the predominant strengths of concordance of Kw′ for the application of the OMES-E protocol were moderate and good both for test–retest analysis with the same examiner, and for inter-examiner analysis, a fact that confers reliability to the evaluation procedure [29]. Predominance of coefficients with reasonable strength was showed only by E2.

Bakke et al. [15] detected Kappa values of 0.42–0.44 for inter-examiner analysis with the NOT-S protocol. The Kappa coefficient is indicated for studies with nominal scales, while the weighted Kappa used here can be applied based on ordinal scales.

The reliability and agreement between other examiners with different experiences from those presented here should be evaluated, and other samples should be evaluated.

In addition to receiving theoretical training, the examiner needs to experience the clinical situation in order to develop perception and the ability to judge, in addition to being trained with the protocol to be used.

The values obtained showed that that, on average, the sensitivity of the OMES-E was higher than its specificity, with respective values of 0.91 and 0.77. Care was taken to avoid both false-positive and false-negative results. Thus, the cut-off point should establish a high sensitivity, so that the result would not be negative for a patient who actually presented the problem (false-negative). Similarly, the cut-off point should establish a high specificity so that the result would not lead to the indication of a more complex procedure for patients who would not need it (false-positive).

The mean prevalence of OMD in the population studied was 0.58. These disorders are relatively common in the population of children in the age range assessed [5]; thus, the more common the prevalence of a given alteration, the greater should be the sensitivity of the test [27].

On the basis of the mean positive predictive value, it was possible to predict that 87% of the subjects with a positive diagnosis of OMD actually presented OMD and, on the basis of the mean negative predictive value, it was possible to predict that 85% of the subjects diagnosed as being free of OMD actually did not present the problem.

When a diagnostic test is validated and has good sensitivity, specificity and good predictive values for this alteration, the diagnosis becomes more precise and therefore can favor the decision-making process regarding treatment planning and patient follow-up during and after treatment.

5. Conclusion

The results permitted us to conclude that the OMES-E protocol is valid and reliable for orofacial myofunctional evaluation within the limits of the selected items, with high sensitivity for the diagnosis of OMD, good specificity and good predictive values.

Conflict of interest statement

None.

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Appendix A

Protocol of orofacial myofunctional evaluation with expanded scores (Omes-E).

Date:_____/_____/_____
Name:_____
Birthday: ___/____/____ Age:_____
Address: _____

Appearance and posture.

Face				Scores
Symmetry between right and left side	Normal			(4)
Asymmetry	Light dysfunction			(3)
	Moderate dysfunction			(2)
	Severe dysfunction			(1)
Increased side	Right	Left		
Proportion between thirds of the face	Normal			(4)
Altered proportion	Light dysfunction			(3)
	Moderate dysfunction			(2)
	Severe dysfunction			(1)
Increased third of the face	Inferior	Middle	Superior	
Nasolabial sulcus	Normal for age			(4)
Marked nasolabial sulcus	Light dysfunction			(3)
	Moderate dysfunction			(2)
	Severe dysfunction			(1)
Result				
Maximum score = 12				

Cheek appearance				Scores
Volume	Normal			(4)
Increased volume	Light dysfunction			(3)
	Moderate dysfunction			(2)
	Severe dysfunction			(1)
Increased side	Right	Left	Right and left	
Tension/configuration	Normal			(4)
Flaccid/drooping	Light dysfunction			(3)
	Moderate dysfunction			(2)
	Severe dysfunction			(1)
Result				
Maximum score = 08				

Mandible/maxilla relation				Scores
Vertical mandibular posture—with free way space		Normal posture		(4)
Altered vertical relation—without free way space				
Occlusion of the teeth	Without apparent tension	Light dysfunction		(3)
	Apparent tension	Moderate dysfunction		(2)
	Apparent tension	Severe dysfunction		(1)
Open mouth—exceeds the free way space (more than 4 mm)		Light dysfunction		(3)
		Moderate dysfunction		(2)
		Severe dysfunction		(1)
Anteroposterior relation		Normal		(4)
Altered anteroposterior relation		Light dysfunction		(3)
		Moderate dysfunction		(2)
		Severe dysfunction		(1)
Overjet		Positive	Negative	
Relation with the midline		Normal		(4)
Altered (lateral deviation)		Light dysfunction		(3)
		Moderate dysfunction		(2)
		Severe dysfunction		(1)
Deviation side		To right	To left	
Result				
Maximum score = 12				

Lips		Scores
Resting lips function		
Normal lips closure	Normal lips function	(4)
Dysfunction		
Lips closure with effort (Presence of lips function, but with increased activity of lips and *mentalis* muscle)	Light dysfunction	(3)
	Moderate dysfunction	(2)
	Severe dysfunction	(1)

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Appendix A (*Continued*)

Lips				Scores
Absence of lips closure	Light dysfunction (half-open)			(3)
	Moderate dysfunction			(2)
	Severe dysfunction			(1)
Volume and configuration	Normal			(4)
Reduced volume and stretched	Light dysfunction			(3)
	Moderate dysfunction			(2)
	Severe dysfunction			(1)
Increased volume	Light dysfunction			(3)
	Moderate dysfunction			(2)
	Severe dysfunction			(1)
Labial commissures				
At the level of the rima of the mouth and symmetry between sides	Normal			(4)
Below of the rima of the mouth (depressed) and/or asymmetrics	Light dysfunction			(3)
	Moderate dysfunction			(2)
	Severe dysfunction			(1)
Side below the rima of the mouth	Right	Left	Both	
Result				
Maximum score = 12				

Mentalis muscle		Scores
Contraction not apparent (with lips closure)	Normal	(4)
Increased activity	Light dysfunction	(3)
	Moderate dysfunction	(2)
	Severe dysfunction	(1)
Result		
Maximum score = 4		

Tongue				Scores
Position/appearance				
Contained in the oral cavity	Normal			(4)
Compressed by tense dental occlusion	Clenching			(3)
Compressed and with marks	Clenching			(2)
Between dental arches (or margins)				
	At limit of the incisal surfaces, with reduced vertical dimension of occlusion (VDO)			(3)
	At limit of the incisal surfaces or on the floor of mouth, with normal free way space			(2)
	Exceeds the incisal surfaces/or vestibular cusps			(1)
Between the dental arches, when present overbite or overjet	At limit of the incisal surfaces			(3)
	Exceeds the incisal surfaces			(2)
	Greatly exceeds the incisal and/or vestibular surfaces			(1)
Local of the interposition	Right	Left	Both	
	Anterior	Posterior	Total	
Appearance/volume				
Volume compatible with the oral cavity	Normal			(4)
Volume increased and/or widened	Light dysfunction			(3)
	Moderate dysfunction			(2)
	Severe dysfunction			(1)
Result				
Maximum score = 8				

Palate appearance		Scores
Width	Normal	(4)
Decreased width (narrow)	Light dysfunction	(3)
	Moderate dysfunction	(2)
	Severe dysfunction	(1)
Height	Normal	(4)
Increased height (deep)	Light dysfunction	(3)
	Moderate dysfunction	(2)
	Severe dysfunction	(1)
Result		
Maximum score = 08		

Mobility.

Performance	Lip movements				
	Protrusion	Retrusion	Lateral to right	Lateral to left	Scores
Normal	(6)	(6)	(6)	(6)	
Insufficient ability	(5)	(5)	(5)	(5)	
Insufficient ability with associated movements	(4)	(4)	(4)	(4)	
Insufficient ability with tremor	(3)	(3)	(3)	(3)	

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Appendix A (*Continued*)

Performance	Lip movements				
	Protrusion	Retrusion	Lateral to right	Lateral to left	Scores
Insufficient ability with associated movements and tremor	(2)	(2)	(2)	(2)	
Absence of ability (does not perform)	(1)	(1)	(1)	(1)	
Result (Sum)					
Maximum sum = 24					

Performance	Tongue movements						
	Protrusion	Retrusion	Lateral to right	Lateral to left	Raising	Lowering	Scores
Normal	(6)	(6)	(6)	(6)	(6)	(6)	
Insufficient ability	(5)	(5)	(5)	(5)	(5)	(5)	
Insufficient ability with associated movements	(4)	(4)	(4)	(4)	(4)	(4)	
Insufficient ability with tremor	(3)	(3)	(3)	(3)	(3)	(3)	
Insufficient ability with associated movements and tremor	(2)	(2)	(2)	(2)	(2)	(2)	
Absence of ability (does not perform)	(1)	(1)	(1)	(1)	(1)	(1)	
Result (Sum)							
Maximum sum = 36							

Performance	Cheek movements				
	To inflate	To suck	To retract	To transfer the air from right to left	Scores
Normal	(6)	(6)	(6)	(6)	
Insufficient ability	(5)	(5)	(5)	(5)	
Insufficient ability with associated movements	(4)	(4)	(4)	(4)	
Insufficient ability with tremor	(3)	(3)	(3)	(3)	
Insufficient ability with associated movements and tremor	(2)	(2)	(2)	(2)	
Absence of ability (does not perform)	(1)	(1)	(1)	(1)	
Result (Sum)					
Maximum sum = 24					

Performance	Jaw movements					
	Opening	Closing	Right laterality	Left laterality	Protrusion	Scores
Normal	(6)	(6)	(6)	(6)	(6)	
Insufficient ability	(5)	(5)	(5)	(5)	(5)	
Insufficient ability with associated movements	(4)	(4)	(4)	(4)	(4)	
Insufficient ability with deviations	(3)	(3)	(3)	(3)	(3)	
Insufficient ability with associated movements and deviations	(2)	(2)	(2)	(2)	(2)	
Absence of ability (does not perform)	(1)	(1)	(1)	(1)	(1)	
Result (Sum)						
Maximum sum = 30						

Functions.

Breathing: mode		Scores
Nasal breathing	Normal	(4)
Mouth breathing	Light dysfunction	(3)
	Moderate dysfunction	(2)
	Severe dysfunction	(1)
Result		

Deglutition: lips behavior		Scores
Lips closure without effort	Normal	(6)
Lips closure with effort or with tongue between dental arches	Light dysfunction	(4)
	Moderate dysfunction	(3)
	Severe dysfunction	(2)
Absence of lips closure	Does not perform the function	(1)
Result		

Deglutition: tongue behavior				Scores
Contained in the oral cavity	Normal			(4)
Between dental arches (or alveolar margins)	At limit of the incisal surfaces, with reduced VDO			(3)
	At limit of the incisal surfaces, with normal VDO			(2)
	Exceeds the incisal surfaces and/or vestibular cusps			(1)
Interposed with the teeth, when present overbite or overjet	At limit of the incisal surfaces			(3)
	Exceeds the incisal surfaces and/or vestibular cusps			(2)
	Greatly exceeds the incisal surfaces or vestibular cusps			(1)
Local interposition	Right	Left	Both	
	Anterior	Posterior	Total	
Result				
Maximum score = 10				

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Deglutition: other behaviors and change signs	Scores	
	Present	Absent
Movements of the head or of other parts of the body	(1)	(2)
Mandible sliding	(1)	(2)
Facial muscle tension	(1)	(2)
Food escape	(1)	(2)
Choking	(1)	(2)
Noise	(1)	(2)
Result		

Deglutition: efficiency	Scores
Solidy bolus	
No more than one repetition of the deglutition	(3)
Two or three repetitions	(2)
Multiple deglutitions	(1)
Liquid bolus	
No more than one repetition of the deglutition	(3)
Two or three repetitions	(2)
Multiple deglutitions	(1)
Result	
Total deglutition result	

Mastication: bite		Scores
Incisors	Normal	(4)
Canines-premolars		(3)
Molars		(2)
Does not bite		(1)
Result		

Mastication: type			Scores
Bilateral	Alternated (50%/50% to 40%/60%)		(10)
	Simultaneous (vertical)		(8)
Unilateral	Preference – grade 1 – (61–77%)		(6)
	Preference – grade 2 – (78–94%)		(4)
	Chronic (95–100%)		(2)
Preferred side	Right	Left	
Anterior	Trituration on the incisors		(2)
Does not perform the function	Does not triturate		(1)
Result			

Mastication: other behaviors and change signs	Scores	
	Present	Absent
Movements of the head or of other parts of the body	(1)	(2)
Altered posture of the head or of other parts of the body	(1)	(2)
Food escape	(1)	(2)
Result		

Total mastication result
Time spent to ingest food =

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