CoDAS
ISSN 2317-1782 (Online version)

Original Article
Artigo Original

Variables associated with mouth breathing diagnosis in children based on a multidisciplinary assessment

Variáveis associadas ao diagnóstico de respiração oral baseado em uma avaliação multidisciplinar

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Keywords

Mouth Breathing
Nasal Obstruction
Diagnosis
Rhinitis
Child
Logistic Model

ABSTRACT

Purpose*:* This study was conducted to identify variables associated with mouth breathing diagnosis in children, based on multidisciplinary domains. **Methods:** 119 children, six to 12 years old, underwent anamnesis, speech therapy (orofacial structures and stomatognathic functions), otorhinolaryngologic (OTRL) with clinical and endoscopic examinations, dental (occlusion) and physiotherapy (body posture and nasal patency) assessments. Nasal patency was evaluated using Peak Nasal Inspiratory Flow (PNIF) and the Nasal Obstruction Symptom Evaluation (NOSE) scale. A multiple logistic regression was performed considering breathing mode as the dependent variable and the co-variables from each multidisciplinary assessment as associated variables. **Results**: Association with MB diagnosis was found in each professional domain with: nasal obstruction report (Odds ratio - OR=5.55), time of pacifier use (OR=1.25), convex facial type (OR=3.78), obtuse nasal angle (OR=4.30), half-open or open lip posture (OR=4.13), tongue position on the mouth floor (OR=5.88), reduced hard palate width (OR=2.99), unexpected contraction during mastication (OR=2.97), obstructive pharyngeal tonsils (OR=8.37), Angle Class II malocclusion (OR=10.85) and regular gingival maintenance (OR=2.89). **Conclusion**: We concluded that a multidisciplinary diagnosis is important, given that each evaluation domain, including OTRL, dental and speech therapy, presented variables associated with MB diagnosis. Body posture and nasal patency variables were not associated with MB.

Descritores

Respiração Bucal
Obstrução Nasal
Diagnóstico
Rinite
Criança
Modelos Logísticos

RESUMO

Objetivo: Este estudo foi conduzido para identificar as variáveis associadas ao diagnóstico de respiração oral em crianças, baseado nos domínios multidisciplinares. **Método**: Cento e dezenove crianças, de seis a 12 anos, realizaram uma avaliação abrangente composta por uma anamnese e exames fonoaudiológico (estruturas orofaciais e funções estomatognáticas), otorrinolaringológico (avaliação clínica e endoscópica), odontológico (conservação oral e oclusão) e fisioterapêutico (postura corporal e permeabilidade nasal). A permeabilidade nasal foi aferida utilizando-se o Pico de Fluxo Inspiratório Nasal (PFIN) e a escala NOSE (*Nasal Obstruction Symptom Evaluation*). Foi realizada uma regressão logística múltipla, considerando o modo respiratório como variável dependente e as covariáveis de cada avaliação multidisciplinar como variáveis associadas. **Resultados**: Foi encontrada uma associação do diagnóstico de respiração oral com variáveis de cada domínio profissional: relato de obstrução nasal (*Odds ratio* - OR=5,55), tempo de uso de chupeta (OR=1,25), tipo facial convexo (OR=3,78), ângulo nasolabial obtuso (OR=4,30), postura de lábios entreabertos e abertos (OR=4,13), postura de língua no assoalho oral (OR=5,88), largura do palato duro reduzida (OR=2,99), contrações inesperadas durante a mastigação (OR=2,97), tonsilas faríngeas obstrutivas (OR=8,37), má oclusão classe II de Angle (OR=10,85) e estado gengival regular (OR=2,89). **Conclusão**: Concluiu-se que o diagnóstico multidisciplinar é importante, uma vez que as avaliações dos domínios fonoaudiológico, otorrinolaringológico e odontológico obtiveram variáveis associadas ao diagnóstico de respiração oral. As variáveis relacionadas à postura corporal e permeabilidade nasal não foram associadas ao diagnóstico de respiração oral.

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Received: April 20, 2017

Accepted: July 31, 2017

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Financial support: nothing to declare.

Conflict of interests: nothing to declare.

INTRODUCTION

Mouth breathing (MB) has been an object of interest in various studies during recent decades[1-5] and has been considered a public health problem in Brazil, with prevalence in school-age children varying between 55 and 60%[6]. MB etiologic factors may be obstructive, such as palatine and pharyngeal tonsillary hypertrophy and nasal septum deviation. They can also be described as functional, when resulting from prolonged oral habits, muscular alterations, transitory edema of nasal mucosa such as intermittent rhinitis, and repaired airway obstruction[7-9]. Understanding its etiology may be decisive to obtain a clear MB clinical picture[4].

MB consequences may include not only craniofacial changes, but also changes throughout the whole body[3,4]. The most commonly described characteristics are an increased lower third of the face, deep and narrow palate, Angle Class II malocclusion, posterior crossbite, anterior openbite, shortened upper lip, everted lower lip and forward head posture[3,4,9,10]. Nevertheless, the association of some of these alterations with mouth breathing has still not been completely verified.

MB diagnosis is predominantly clinical, given that it is a condition including several organic systems. Some exams and tests may be complementary, identifying its etiologic factors[6]. There are uncertainties regarding MB diagnosis, given that etiologic factors may be concomitant, acting intermittently or continuously, in addition to the complexity of quantifying its magnitude/severity[11,12]. A recent study has investigated MB perception by orthodontists, as well as proposed and tested guidelines for MB recognition, through visual assessment, semi-structured interview and breathing tests[11].

A lack of standardization of MB diagnosis makes it hard to establish a comparison between studies and the application of a global clinical approach. Some relevant factors have been found to define this diagnosis, which may consist of predictors for MB recognition, such as a lack of lip sealing associated with typical signs and symptoms[9,13], as well as multidisciplinary evaluation[1,4] or association of these items with respiratory tests, such as graded mirror or water retention tests[5,8].

This study was conducted to identify variables associated with MB diagnosis, based on multidisciplinary domains, including anamnesis, speech therapy, otorhinolaryngologic, odontologic and physiotherapeutic assessments.

METHODS

The present study has an observational and cross-sectional design. It was derived from a Project titled "Integrated characterization and evaluation of orofacial motricity and body posture diseases – phase II", approved by the Ethics and Research Committee of the aforementioned institution, under protocol 08105512.0.0000.5346.

Sample size calculation, based on the prevalence of approximately 55% of mouth breathers in school-age children[6], and with a significance level of 0.05 and absolute precision of 0.08, resulted in an expected number of 149 subjects.

Study participants were recruited from an elementary school, by written invitation sent to parents. To meet the ethics requirements, children's parents or tutors were informed about the study objective and procedures, in addition to signing the Consent Form, according to 466/12 resolution of *Conselho Nacional de Saúde* (CNS).

The inclusion criteria consisted of: age six to 12 years old, mixed or permanent dentition and normal ventilatory function, verified by spirometry. The spirometric evaluation (One Flow – Clement Clarke) was carried out, according to the American Thoracic Society[14] and *Sociedade Brasileira de Pneumologia e Tisiologia*[15]. The exclusion criteria were: signs and symptoms of exacerbated rhinitis; antihistaminic or corticoid therapy (oral or topic) in the last thirty days; currently undergoing or having undergone orthodontic treatment, physiotherapy or speech therapy; facial surgery or trauma or evident signs of neurological disease and/or craniofacial malformation.

Participants underwent speech therapy, otorhinolaryngologic (OTRL), dental and physiotherapy assessments. Breathing mode was defined by the agreement of three conditions: parent report[1,4] and OTRL[16] and speech therapist[1,4] assessments, without taking into account orofacial and postural features. The following aspects were considered for mouth breathing categorization: report of open mouth throughout the majority of the day, open mouth at night, nocturnal drooling or snoring for more than six months and breathing through the mouth, confirmed by speech therapist and OTRL examinations.

An anamnesis investigating problems related to nasal obstruction, by NOSE scale, and clinical history from MBGR orofacial protocol[17] was carried out. The following aspects were investigated: physical activity, frequent cold, throat problems, halitosis, asthma/bronchitis, pneumonia, restless and fragmented sleep, artificial and breastfeeding time, oral habits (pacifier, baby bottle and finger sucking), learning difficulties, lack of attention and concentration, difficulty at school or in relationships. Children answered five questions of the NOSE scale with the help of their parents, related to nasal obstruction and how much it represented a problem during the month prior. NOSE scale scores vary from zero (no problem) to 100 (highest severity problem)[18].

The sample selection, evaluation methods and analyzed data of the study are shown in Figure 1 (Flowchart).

A stomatognathic system exam carried out by an experienced speech therapist in orofacial motricity using MBGR protocol[17], evaluated structures and masticatory, deglutition and speech functions. Procedural guidelines were followed, and photographs and filming were made (Sony Cyber Shot 7.2 Megapixels). Nasal expiratory flow testing was carried out using a graduated mirror (ProFono®, Brazil). Disposable items such as procedural gloves, cotton, tongue depressor and transparent glass were also used.

Children were also examined by an otorhinolaryngologist, who considered aspects such as palatine and pharyngeal tonsillary hypertrophy, nasal septum deviation and nasal mucosa

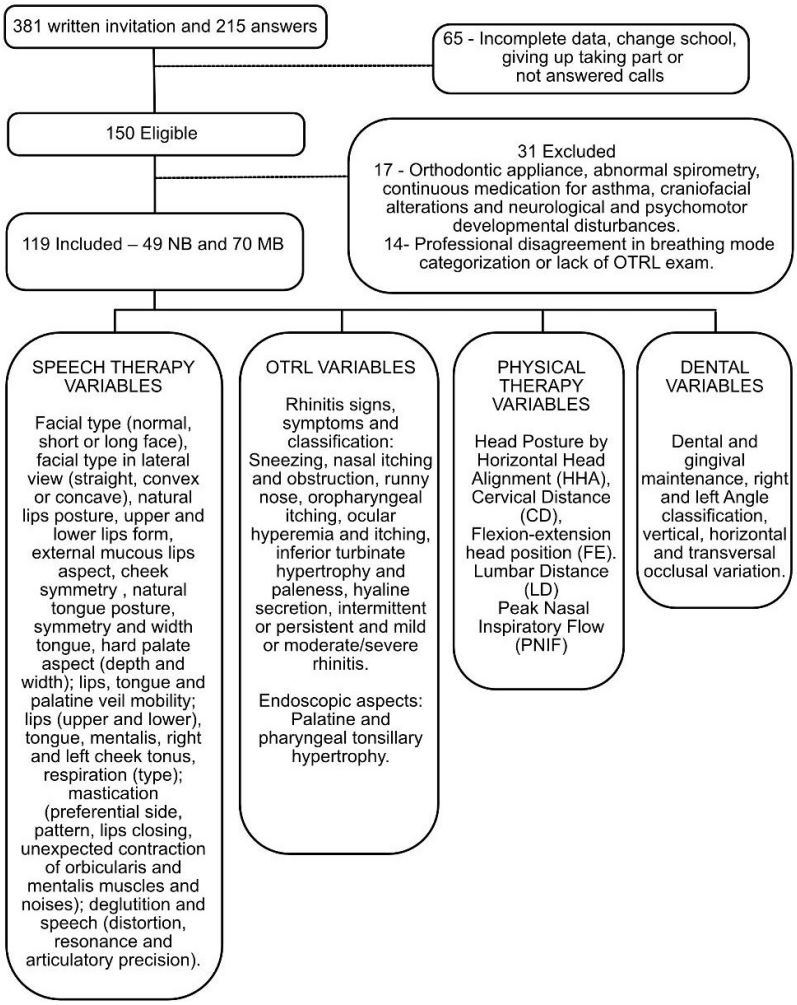

Figure 1. Flowchart with selection, evaluation methods and variables

edema, using oroscopy and anterior rhinoscopy. Exams such as nasoendoscopy or lateral cavum X-ray were carried out, depending on the child's acceptance. The palatine and pharyngeal tonsil assessments adopted Brodsky and Koch[19] and Parikh et al.[20] classifications, respectively. Rhinitis signs and symptoms were also investigated and, for rhinitis classification, ARIA (Allergic Rhinitis and its Impact on Asthma) initiative[21], related to frequency (intermittent or persistent) and symptom intensity (mild or moderate/severe), was used.

Dental evaluation was carried out by an experienced orthodontist based on MBGR protocol criteria. The examination was carried out at school, with the child sitting on a normal chair, following the items described in the flowchart.

The Peak Nasal Inspiratory Flow (PNIF) measure was used for objective nasal patency assessment. PNIF was evaluated by a physical therapist using InCheck Inspiratory Flow Meter (Clement Clarke International, the United Kingdom). A Residual Volume (RV) technique was performed, i.e., a complete expiration followed by a nasal deep inspiration as fast and as strong as possible, with closed mouth and well-fitted mask to face. The highest value obtained from three repetitions was considered[9]. The values obtained were transformed into a percentage of predicted values of PNIF, established by Ibiapina et al.[22], according to sex and stature.

Selected children were evaluated using photographic records with biophotogrammetric analysis, using the Software of Postural Evaluation (SAPo v.0.68). Body posture evaluation (photographs and analyses) was performed by an experienced physiotherapist. The photographs were obtained in orthostatic posture in right lateral view[3,23]. The postural measures used for analysis are shown in Figure 2.

Data analysis

For data analysis, *STATISTICA* 9.1 (Statistica for Windows – release 9.1 Stat Soft) and SPSS 13.0 (Statistical Package for the Social Sciences) software programs were used. Data related to sex, age and BMI were presented by descriptive measures. The data homogeneity between groups was tested by Chi-squared for sex and t-Student for age and BMI.

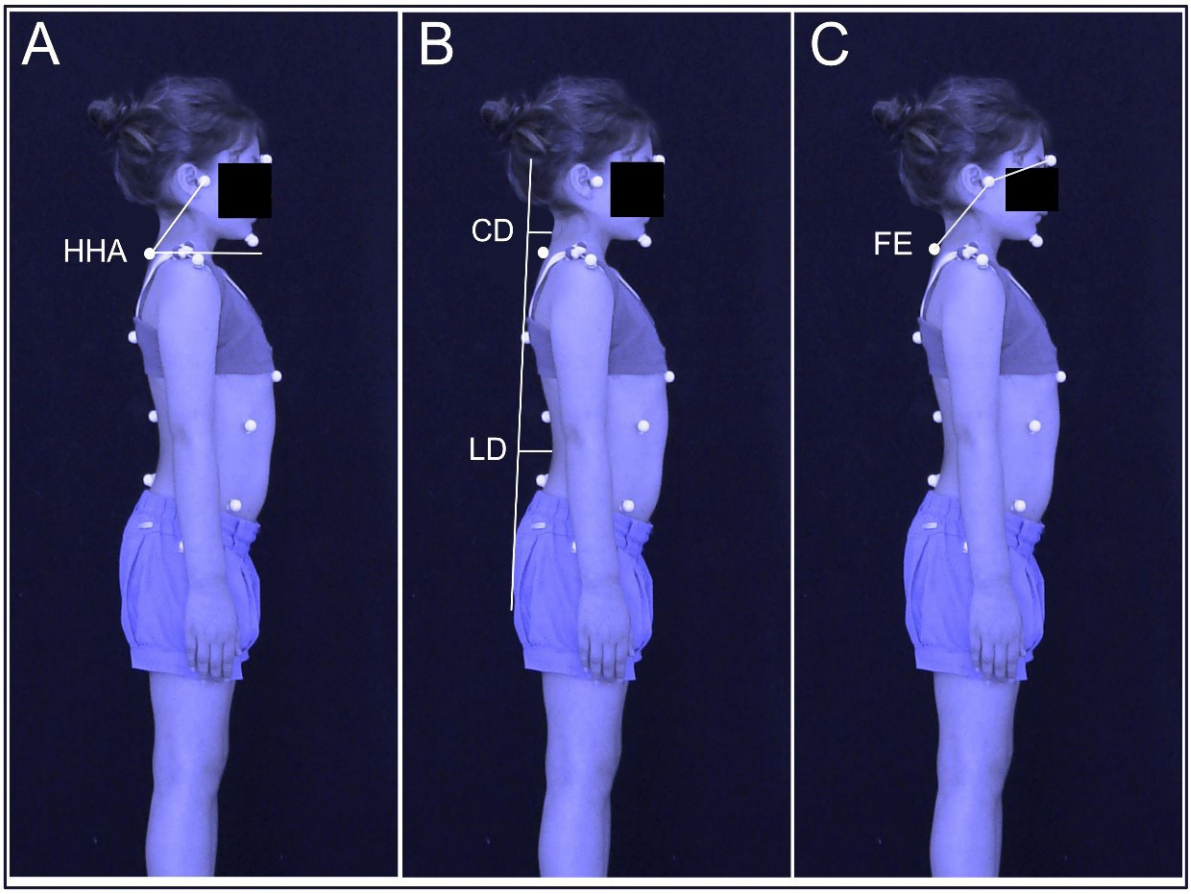

Figure 2. Postural Measures. (A) HHA: Horizontal Head Alignment; (B) CD: Cervical Distance; LD: Lumbar Distance; (C) FE: Flexion-extension head position

A multiple logistic regression was carried out considering breathing mode (nasal or mouth) as the dependent variable (outcome) and co-variables related to anamnesis (26 items), OTRL exam (11 items), speech therapist evaluation (78 items), dental evaluation (9 items) and physiotherapeutic assessment (11 items) as independent variables (associated factors).

For selection of independent variables suitable for the multiple model, a 5% significance level was adopted. Four multiple model proposals were elaborated, using "enter" method, one for each evaluated professional domain. A 5% significance level was adopted.

RESULTS

Multiple models were elaborated with a total sample of 119 children with mean age of 8.5 ± 1.62 years old, 64 boys and 55 girls. The nasal breathing group was constituted by 49 children and the mouth breathing group by 70 children. Both groups were homogeneous relative to age (p=0.377), sex (p=0.210) and BMI (p=0.245).

Four multiple models, one for each multidisciplinary domain, were elaborated. In the physiotherapy domain, single regression did not present any variable suitable for a multiple model.

Table 1 shows a multiple model proposal based on anamnesis for MB diagnosis. Six variables were selected for single regression and, of these, two remained in the multiple model, which were nasal obstruction (OR 5.55) and pacifier use (OR 1.25), both associated with MB diagnosis.

The multiple model proposal related to the speech therapy evaluation (Table 2) showed a greater number of variables associated with the MB diagnosis. According to the results, convex facial type (OR 3.78), obtuse nasolabial angle (OR 4.30), half-open or open lip posture (OR 4.13), habitual tongue position on the mouth floor (OR 5.88), reduced hard palate width (OR 2.99) and unexpected contractions during mastication (OR 2.97) were associated with MB diagnosis.

Table 3 presents the multiple model proposal derived from the OTRL exam variables, with obstructive pharyngeal tonsils (OR 8.37) and report of nasal obstruction (OR 7.95) showing an association with MB diagnosis.

Table 4 presents the multiple model proposal for dental variables, with Angle Class II subdivision 1 malocclusion on left (OR 10.85) and regular gingival maintenance (OR 2.89) showing an association with MB diagnosis .

Table 1. Anamnesic data associated with mouth breathing diagnosis

Variables	n	Single Regression			p-to-exit	Multiple Regression		
		p value	OR	95% CI		p value	OR	95% CI
Throat Problems								
No	85	0.042	2.47	1.03-5.91	0.433	-	-	-
Yes	34							
Nasal Obstruction								
No	58	<0.001	5.11	2.31-11.32	-	<0.001	5.55	2.44-12.64
Yes	61							
Nasal itching								
No	60	0.020	2.43	1.15-5.16	0.178	-	-	-
Yes	59							
Runny Nose								
No	72	0.017	2.61	1.19-5.75	0.814	-	-	-
Yes	47							
Pacifier (years)	119	0.045	1.21	1.00-1.46	-	0.029	1.25	1.02-1.53
NOSE Score	119	0.017	1.03	1.00-1.05	0.172	-	-	-

Caption: OR: Odds Ratio; CI: Confidence Interval; NOSE: Nasal Obstruction Symptom Evaluation

Table 2. Speech therapy variables associated with mouth breathing diagnosis

Variables	n	Single Regression			p-to-exit	Multiple Regression		
		p value	OR	95% CI		p value	OR	95% CI
Lateral Facial Pattern								
Straight	57	0.002	3.42	1.56-7.49	-	0.006	3.78	1.45-9.82
Convex /Type I	58							
Concave/ Type II	4							
Nasolabial Angle								
Normal - 90 - 110°	79	0.010	4.634	1.452-14.79	-	0.032	4.30	1.10-16.84
Acute (<90°)	16							
Obtuse (>110°)+	24							
Lip Posture								
Close	67	<0.001	7.66	2.829-20.744	-	0.030	4.13	1.15-14.79
Close with tension	13							
Half-Open/ Open+	39							
Superior Lip Form								
Normal	84	0.011	3.22	1.31-7.89	0.198	-	-	-
Gull wing	35							
Tongue Posture								
Not visible	82	0.027	3.4	1.14-10.08	-	0.036	5.88	1.12-30.82
On the mouth floor+	22							
Between the teeth	15							
Tongue Width								
Normal	86	0.029	2.73	1.09-6.76	0.205	-	-	-
Reduced	1							
Increased+	32							
Hard Palate Width								
Normal	49	0.005	3.257	1.43-7.41	-	0.045	2.99	1.02-8.74
Increased (wide)	2							
Reduced (narrow)+	68							
Inferior Lip Tonus								
Normal	66	0.012	2.69	1.25-5.80	0.881	-	-	-
Decreased+	53							
Increased	0							
Mentual Tonus								
Normal	89	0.002	7.84	2.19-28.00	0.675	-	-	-
Decreased	4							
Increased+	26							
Unexpected Contraction*								
Absent	79	0.012	2.92	1.26-6.78	-	0.044	2.97	1.03-8.60
Present	40							

*Excessive contraction of orbicularis and mentalis muscles during Mastication; + Category with statistical significance
Caption: OR: Odds Ratio; CI: Confidence Interval

Table 3. Otorhinolaryngological variables associated with mouth breathing diagnosis

Variables	n	Single Regression			p-to-exit	Multiple Regression		
		p value	OR	95% CI		p value	OR	95% CI
Pharyngeal Tonsils*								
No obstruction	44	0.007	6.33	1.66-24.14	-	0.005	8.37	1.89-37.06
Obstructive	28							
Sneezing								
No	38	0.034	2.34	1.06-5.13	0.993	-	-	-
Yes	81							
Nasal Obstruction								
No	54	<0.001	11.66	4.87-27.90	-	0.001	7.95	2.29-27.6
Yes	65							
Rhinitis Frequency								
No	16	<0.001	25.20	5.83-108.83	0.357	-	-	-
Intermittent	56							
Persistent+	47							
Rhinitis Intensity								
No	16	<0.001	40.00	7.837-204.16	0.773	-	-	-
Mild	60							
Moderate/Severe+	43							

*Missing data: 47; + Category with statistical significance
Caption: OR: Odds Ratio; CI: Confidence Interval

Table 4. Dental variables associated with mouth breathing diagnosis

Variables	n	Single Regression			p-to-exit	Multiple Regression		
		p value	OR	95% CI		p value	OR	95% CI
Right Angle Class								
Class I	90							
Class II subdivision 1+	24	0.004	6.40	1.78-22.99	0.932	-	-	-
Class II subdivision 2	4							
Class III	1							
Left Angle Class								
Class I	89							
Class II subdivision 1+	24	0.002	10.28	2.28-46.36	-	0.002	10.85	2.37-49.61
Class II subdivision 2	6							
Class III	0							
Gingival Maintenance								
Good	82	0.050	2.59	1.99-6.79	-	0.039	2.89	1.06-7.93
Regular+	27							
Bad	10							

+ Category with statistical significance
Caption: OR: Odds Ratio; CI: Confidence Interval

DISCUSSION

Given that there is no consensus in the literature concerning MB diagnosis, a comprehensive and careful multidisciplinary clinical evaluation was conducted. A multiple model proposal for each professional area was elaborated.

Based on anamnesis, an association between nasal obstruction and MB was verified, i.e., children with nasal obstruction presented a likelihood 5.55-times higher of MB diagnosis, compared to children without obstruction. Regarding pacifier use, for each year of use, the probability of MB diagnosis increased by 25%. Another study observed higher nasal resistance in mist (oronasal) breathing children, concluding that it leads to mouth breathing[24]. Nevertheless, it was not always the case that a mouth breather will have higher nasal resistance, as an MB child may have prolonged oral habits, which are also etiological factors for this breathing mode[25].

Pacifier use was associated with reduced maxillary intercanine distance and altered resting tongue position, showing that this habit may be associated with alterations in hard palate shape. An association of resting lip position (partially closed at rest/closed with tension), posterior crossbite and inadequate swallowing with pacifier was also observed, demonstrating a need for awareness about the risks of prolonged pacifier-use[25].

The literature describes a wide range of characteristics commonly attributed to mouth breathers. The most frequent are dolichofacial type or long face[4,5], convex facial profile[26], deep and narrow hard palate[5,9], open lip posture and lowered tongue[26], everted lower lip[10], Angle Class II and posterior crossbyte malocclusion[1,4], changes in stomatognathic functions[27] and postural misalignments[3]. Nevertheless, concerning the MB mode, which affects various body systems and craniofacial growth, there was no agreement to describe this condition.

In the present study, it was observed that the main features associated with mouth breathing diagnosis confirmed the literature findings. The probability of a mouth breathing (MB) diagnosis was 3.78-times higher in children with convex facial related to straight profile and 4.30-times higher in children with obtuse nasolabial compared to neutral angle (90 to 110˚). A cephalometric study found no difference between mouth and nasal breathing children in nasolabial angle, however convex facial type and diagnosis for MB were associated[8]. Convex facial type was associated with mouth and mist breathing mode, chronic unilateral masticatory pattern, excessive contraction of mentalis and perioral musculature during mastication and forward tongue and head movement during swallowing[26].

MB diagnosis was 4.13-times higher in children with half-open or open lip posture and 5.88-times higher in children with tongue position on the mouth floor. Open, lowered or forward lip posture or with inadequate tongue tonus were also observed in a study with MB children[2]. Another study, which induced mouth breathing in rats, demonstrated that a partial nasal obstruction may produce a forward tongue position to improve nasal patency and, combined with the lip incompetence, contribute to morphological changes to the craniofacial complex[28].

In children presenting reduced hard palate width, MB diagnosis is 2.99-times higher compared to those with normal width. Authors found a strong association of narrow and deep hard palate with MB[5,9]. A narrower and deeper hard palate was observed in MB adults than in nasal breathing adults. Such findings were explained by the lack of expansion function of the tongue and reduced orofacial muscle tonus in MB individuals[9]. In the present research, hard palate depth was not related to MB diagnosis. However, it should be emphasized that these features were clinically assessed rather than using quantitative measurements as was the case in the study mentioned.

Among stomatognathic functions, only mastication presented one variable associated with MB diagnosis, that is, the presence of unexpected contraction of orbicularis and mentalis muscles during mastication with a 2.97-times greater probability for this outcome. As mentioned above, chronic unilateral masticatory pattern and excessive contraction of mentalis and perioral musculature during mastication were related to convex facial type, an MB characteristic also found in the present study[26]. During mastication, unsystematic lip sealing, tongue interposition and tension in mentalis and orbicularis oris muscles, necessary to keep food inside the mouth for swallowing, were also observed in the MB child group[27].

The OTRL variables that showed greatest association with MB diagnosis were nasal obstruction and obstructive pharyngeal tonsils, with MB diagnosis being 8.37 and 7.95 - times more likely, respectively. The highest nasal flow resistance, due to cold, nasal allergies, prolonged rhinitis and adenoid hypertrophy, impairs posterior palatal sealing by soft palate and tongue, hampering airflow passing through the mouth[29]. Therefore, it is clear that nasal obstruction, resulting from adenoid hypertrophy or rhinitis, seems to have an important role in MB diagnosis, with a greater impact stemming from the first condition.

Regarding dental examination, the multiple model proposal included two variables. Angle Class II subdivision 1 (on the left side) malocclusion and regular gingival maintenance presenting, respectively, a 10.85 and 2.89-times greater chance of MB diagnosis. A current study with 487 children, 5-12 year old, has investigated an association between dental and skeletal variables and MB[12], finding Angle class II malocclusion, mandibular retrusion and short mandible as factors that increase the probability of MB diagnosis. Previous studies also found an association between Angle Class II and MB[1,4].

Postural measurements, evaluated by a physiotherapist, showed no association with MB diagnosis. Nevertheless, despite no association being observed, it should be highlighted that postural changes, mainly in the craniocervical region, represent important clinical aspects for an MB therapeutic approach, given that respiratory and postural adaptations may increase the chance of mouth breathing persistence[16]. Postural adaptations are also considered a compensatory mechanism to assist the breathing function[30]. In cases of MB diagnosis, children should be referred for physiotherapy evaluation.

Concerning subjective and objective nasal obstruction measurements, NOSE scale and PNIF, respectively, only the NOSE scores were associated with MB diagnosis in single regression. Peak Nasal Inspiratory Flow (PNIF) is an objective, reliable and easy-to-use instrument, applicable by any health professional[9,22]. The volitional character of PNIF exam, mainly with children, should be considered. Additionally, presence of nasal obstruction was associated with MB diagnosis in the multiple model. These results indicate that subjective aspects seem to be more related to MB diagnosis. However, in a previous study, a negative and moderate correlation between PNIF and NOSE scale was found in MB adults[9].

Some variables related to swallowing, speech, body posture and nasal patency showed no association with MB. It is noticeable that orofacial and postural compensations deriving from MB may vary among children, besides being influenced by genetic factors and craniofacial growth.

The observational and qualitative nature of orofacial evaluation may be a limitation in this study, however MBGR consists of a systematic and standardized procedure used for MB evaluation. In addition, no quantitative parameters were determined for this evaluation. Due to the diversity of variables and professionals involved in the assessments, the expected sample size was not achieved. Therefore, some variables of this study presented a wide confidence interval, suggesting care in the interpretation of the results.

The criteria used for MB and nasal breathing group definition were nocturnal drooling, snoring and breathing through mouth throughout the majority of the day and night, according to parent

reports. These aspects were not included as suitable variables for the multiple model, as they are set as MB typical characteristics.

Based on these findings, in addition to the typical characteristics, the variables that constituted the multiple models presented in this research are suggested for MB diagnosis.

CONCLUSION

Variables associated with MB diagnosis in each professional domain were: nasal obstruction report, time of pacifier use, convex facial type, obtuse nasal angle, half-open or open lip posture, tongue position on the mouth floor, reduced hard palate width, unexpected contraction of orbicularis and mentalis muscles during mastication, obstructive pharyngeal tonsils, Angle Class II malocclusion and regular gingival maintenance.

Therefore, we concluded that a multidisciplinary diagnosis is important, given that each evaluation domain, including OTRL, dental and speech therapy, presented variables associated with MB diagnosis. Body posture and nasal patency variables were not associated with MB.

ACKNOWLEDGEMENTS

The authors would like to thank Kátia Sebalhos and Shalina Cecchin for the English revision.

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Author contributions

JMM assessed the study participants, classified and analyzed the data, and participated in the writing and correction of the manuscript; LCB evaluated the study participants and collaborated on the writing and correction of the manuscript; MM assessed the study participants and participated in the writing and correction of the manuscript; LHS assessed the study participants and participated in the writing and correction of the manuscript; ABM classified and analyzed the data, and participated in the writing and correction of the manuscript; AMTS was the study co-adviser, analyzed the data and collaborated on the correction of the manuscript; ECRC was the study adviser, analyzed the data and collaborated on the correction of the manuscript.