CoDAS
ISSN 2317-1782 (Online version)

Original Article
Artigo Original

Relationship between mouth breathing etiology and maximum tongue pressure

Relação entre a etiologia da respiração oral e a pressão máxima da língua

Tiago Costa Pereira[1]
Renata Maria Moreira Moraes Furlan[2]
Andréa Rodrigues Motta[1]

Keywords

Evaluation Studies as Subject
Tongue
Muscle Strength
Mouth Breathing
Child

ABSTRACT

Purpose: To verify the relationship between maximum tongue pressure and the etiology of oral breathing in oral breathing children attended at the Oral Respiratory Outpatient Clinic. **Methods:** A descriptive and analytical cross-sectional study was accomplished with 59 mouth breathing children aged 3 to 12 years (mean age 6.5 years and SD: standard deviation= 2.4). To collect tongue pressure, the *Iowa Oral Performance Instrument* (IOPI) was used and data regarding the etiology of oral breathing and dental occlusion were collected in the records of these patients for analysis. The associations between the maximum tongue pressure and the etiology of oral breathing, age, gender and dental occlusion were verified by the T test, ANOVA, Spearman's coefficient and Tuckey's test, using a significance level of 5%. **Results:** There was a moderate and positive correlation between age and maximum pressure, it was verified that there was a statistically significant difference between the maximum tongue pressure and the variables pharyngeal tonsil hypertrophy and palatine tonsil hypertrophy. There were no statistical differences between the other variables. Conclusion: It was concluded that mechanical obstructions, among them the pharyngeal and palatine tonsil hypertrophy alter the maximum tongue pressure in oral breathing children.

Descritores

Estudos de Avaliação como Assunto
Língua
Força Muscular
Respiração Bucal
Criança

RESUMO

Objetivo: Verificar a existência de relação entre pressão máxima da língua e a etiologia da respiração oral em crianças respiradoras orais atendidas em um Ambulatório do Respirador Oral. **Método:** Foi conduzido um estudo transversal observacional descritivo e analítico com 59 crianças respiradoras orais com idades entre três e 12 anos (média de 6,5 anos e DP=2,4). Para a coleta da pressão de língua, foi utilizado o *Iowa Oral Performance Instrument* – (IOPI) e dados sobre a etiologia da respiração oral e oclusão dentária foram coletados nos prontuários desses pacientes para análise. As associações entre a pressão máxima da língua e a etiologia da respiração oral, idade, gênero e oclusão dentária foram verificadas pelo teste T, ANOVA, coeficiente de Spearman e Teste de Tuckey, utilizando-se nível de significância de 5%. **Resultados:** Houve correlação moderada e positiva entre idade e pressão máxima, verificou-se que houve diferença estatisticamente significativa entre a pressão máxima da língua e as variáveis hipertrofia da tonsila faríngea e hipertrofia das tonsilas palatinas. Não foram verificadas diferenças estatísticas entre as outras variáveis. **Conclusão:** Conclui-se que as obstruções mecânicas, dentre elas a hipertrofia das tonsilas faríngea e palatinas alteram a pressão máxima de língua em crianças respiradoras orais.

Correspondence address:
Andréa Rodrigues Motta
Departamento de Fonoaudiologia, Faculdade de Medicina, Universidade Federal de Minas Gerais – UFMG
Av. Alfredo Balena, 190, sala 249, Belo Horizonte (MG), Brasil, CEP: 30130-100.
E-mail: andreamotta@ufmg.br

Received: May 16, 2018

Accepted: August 14, 2018

Study conducted at Universidade Federal de Minas Gerais – UFMG - Belo Horizonte (MG), Brasil.
[1] Universidade Federal de Minas Gerais – UFMG - Belo Horizonte (MG), Brasil.
[2] Centro Universitário Metodista Izabela Hendrix - Belo Horizonte (MG), Brasil.

Financial support: nothing to declare.
Conflict of interests: nothing to declare

INTRODUCTION

Respiratory function is vital for the organism and must occur preferably through the nasal route, so that the air is purified, heated and humidified before reaching the lungs. This way, there is the protection of the lower airways and the oxygenation is favored[1]. In addition, nasal breathing (NB) is characterized as fundamental for the adequate growth and development of the individual's craniofacial complex and for the proper functioning of the other stomatognathic structures[1].

Oral breathing (OB) arises by replacing NB (nasal breathing) due to genetic factors, inadequate oral habits or nasal obstruction of variable severity and duration[2]. There are several causes of OB (oral breathing), however, they can be grouped into two classes: mechanical obstructive, in other words, when there is a mechanical impediment of air passage in the airways; and the non-obstructive[2,3]. Among the obstructive mechanics, the hypertrophy of the palatine and pharyngeal tonsils and deviations or deformities of the nasal septum are defined[4-6].

Physiologically, the pharyngeal tonsil is present in all immunologically healthy children from birth and reaches a peak of growth between 4 and 5 years, to afterwards undergo a process of atrophy that is completed around 10 years[4]. In some conditions, the pharyngeal tonsil may increase in size and totally or partially obstruct the nasal breathing. Similarly, the palatine tonsils may increase to the point of invading the nasopharynx or extend inferiorly to the region of the hypopharynx[4]. Hypertrophy of pharyngeal and palatine tonsils of an irreducible character is involved in the pathophysiology of NB (nasal breathing) obstruction, otitis media, sinusitis and nasopharyngitis and is considered the primary cause of sleep-related respiratory alteration, compromising the child's physical and cognitive development[4]. But the deviations of the nasal septum are frequent and originate in the prenatal period, in childbirth or during growth. They may be symptomatic (with nasal obstruction) or asymptomatic (without nasal obstruction)[4].

Other conditions such as presence of foreign body, tumors, traumas, polyps, atresia, hypertrophic nasal conchae and chronic rhinitis may cause oral breathing. Among rhinitis, allergic rhinitis is highlighted because it has been pointed out as one of the causes of the installation and maintenance of Chronic Oral Respiration[4]. It is defined as an inflammatory process of the nasal mucosa that results in unilateral or bilateral nasal obstruction, with intermittent or persistent obstruction from the hypertrophy of the inferior, middle or superior turbinates[7], with great impact on the child's quality of life[4,8].

The installation and maintenance of oral breathing may cause changes in the child speech, facial deformities, poor tooth positioning, inadequate body posture, and changes in the respiratory system[2].

Other consequences frequently reported in studies involving oral breathing children refer to the presence of deleterious oral habits, orthodontic changes and orofacial structures, such as the tongue[1,9-11].

Although the tongue is often described as compromised in children who have oral breathing[6,9,10,12-16], during the bibliographic survey carried out, researches that had studied the relation between the etiology of Oral Breathing

and maximum tongue pressure were not found. Thus, the objective of the present study was to verify the relation between the maximum pressure values exerted by the tongue and the etiology of oral breathing in oral breathing children, age, gender and dental occlusion.

METHODS

This is an observational, descriptive, cross-sectional study with 59 children aged 3 to 12 years (mean of 6.5 years, SD: standard deviation = 2.4) treated at the Oral Respirator Outpatient Clinic of the Hospital das Clínicas (HC) of the Federal University of Minas Gerais (UFMG) for evaluation and otorhinolaryngological treatment. The research was approved by the Research Ethics Committee of UFMG (Federal University of Minas Gerais) (CAAE - Presentation Certificate for Ethical Appreciation) opinion 36663614.8.0000.5149).

In this outpatient clinic, the process of diagnosis of Oral Breathing is performed in a multiprofessional way. Patients are evaluated the same day by professionals in the areas of Allergology, Physiotherapy, Speech Therapy, Dentistry, Otorhinolaryngology and Pediatrics, and the diagnosis of oral breathing, its etiology and comorbidities are solved at the end of all the visits.

The following inclusion criteria were considered in the study: to be a patient at the HC-UFMG (Hospital das Clínicas - Federal University of Minas Gerais) Oral Respiratory Outpatient Clinic; to be between three and twelve years of age; absence of neurological or cognitive alterations reported in the medical records. Exclusion criteria were: patient who did not complete the data collection; patient who did not have at least one of the upper central incisors during the evaluation period; patient who did not present the etiological diagnosis of the defined oral breathing, such as: allergic rhinitis, nonallergic rhinitis, hypertrophy of pharyngeal tonsils, palatine or both.

The individuals who composed the sample were approached during the speech-language evaluation at the HC-UFMG Oral Respirator Outpatient Clinic. The parents or guardians were invited to participate in the study and received the Informed Consent Form and have had the time they thought necessary to reflect and decide on participation in the research. Each literate child was also given a Term of Assent.

To collect the maximum tongue pressure, *Iowa Oral Performance Instrument* was used – (IOPI), a portable device to the battery in which the pressure of the tongue is measured by means of a pressure transducer, and it is analyzed, the maximum value that an individual can exercise against an air filled bulb and calibrated, with approximately 3 cm x 1.5 cm x 1 cm by pressing it against the hard palate[8,17]. The pressure peak produced, in kilopascal (kPa), is displayed on an LCD screen, accurate to 2 kPa[18].

Measurements were performed with the patients seated, with their backs and feet leaned. For the initial evaluation, the bulb was placed in the alveolar papilla of the upper incisor teeth and each evaluated patient was asked to push it with maximum force and that this contraction was maintained for 3 seconds,

according to the researched literature[17]. Three measures were taken for each participant[19], in addition to an initial training. The rest time intervals of 30 seconds were established for all sample groups. As maximum pressure, the highest peak of force obtained in the three tests, as well as the average of these values were considered.

It was also collected, in the records of these participants, the information related to allergy, odontological and otorhinolaryngological evaluations. In the dental evaluation, in the case of absence of the first permanent molars, the professional used the classification by terminal plane (straight step, mesial step and distal step). To analyze the data, it was made a group with the Angle classification, using Angle's terminology. Some variables had to be grouped for analysis. The variables are: grade III and grade IV palatine tonsils; class II and Angle class III.

The results found were encoded and stored in a virtual database organized in Excel (2013 version). Descriptive analysis of the data, addressing measures of central tendency and dispersion were made. The Kolmogorov-Smirnov analysis indicated that the data distribution is normal, thus, the association between oral etiology and maximum tongue pressure was verified by the T test, ANOVA and multiple Tuckey comparisons. The relationship between peak pressure and age was analyzed using the Spearman correlation coefficient.

For all tests, the *Statistical Package for Social Sciences* - SPSS version 19 was used, adopting the significance level 5%.

RESULTS

The descriptive analysis of the data of minimum and maximum pressure of the tongue can be verified in Table 1. It was observed that there is an increase of the pressure exerted by the tongue to each subsequent measure.

In Table 2, the values of maximum tongue pressure were stratified by age and it can be verified that they also increase as the individuals age increases, except for the ages of 8 and 9 years. Spearman's coefficient analysis showed a moderate and positive correlation between age and maximum pressure ($r = 0.653$, $p < 0.001$).

In stratification by gender, the statistical analysis by means of the T test, showed no significant difference ($p = 0.0982$).

The data also did not indicate a statistical difference between the variables related to dental occlusion and maximum tongue pressure (Table 3). It is important to note that two charts did not contain data on sagittal occlusion, and three other charts did not contain data from the vertical occlusion evaluation.

In Table 4, it was verified that there was a statistically significant difference between the maximum tongue pressure and the Group variables palatine tonsils and pharyngeal tonsil.

In the case of the palatine tonsils, it was analyzed through the Tuckey test, adjusted by the Bonferroni method, the pairs of answers for locating the difference presented. In this case, the difference occurred between the grade 0 and I classification groups, in relation to grade II hypertrophy ($p = 0.009$).

Table 1. Measures of central tendency and dispersion of data

Tongue pressure (kPa)	Minimum	Maximum	Mean	Median	Standard deviation
1ª measure	3.0	66.0	33.4	33.0	15.0
2º measure	5.0	70.0	34.2	34.0	15.6
3ª measure	6.0	62.0	35.1	35.5	15.3
Maximum pressure	6.0	70.0	37.8	38.5	15.3
Measures' average	4.6	66.0	34.3	34.6	14.9

Caption: kPa = quilopascal

Table 2. Values Average of tongue pressure in each age group, according to gender

Age group	Femame – percentage n (%)	Male – percentage n (%)	Total – percentage n (%)	Maximum pressure (kPa)	Standard deviation
3:0-3:11	2 (3.3)	5 (8.4)	7 (11.8)	21.0	10.7
4:0-4:11	4 (6.7)	4 (6.7)	8 (13.5)	27.1	10.6
5:0-5:11	4 (6.7)	4 (6.7)	8 (13.5)	30.0	7.0
6:0-6:11	2 (3.3)	6 (10.1)	8 (13.5)	42.2	13.6
7:0-7:11	1 (1.6)	5 (8.4)	6 (10.1)	45.1	10.3
8:0-8:11	3 (5.0)	7 (11.8)	10 (1.0)	41.2	19.0
9:0-9:11	1 (1.6)	3 (5.0)	4 (6.7)	39.0	1.8
10:0-10:11	1 (1.6)	2 (3.3)	3 (5.0)	54.3	3.5
11:0-11:11	2 (3.3)	2 (3.3)	4 (6.7)	57.7	3.8
12:0-12:11	0	1 (1.6)	1 (1.6)	44.3	2.5
Total	20 (33)	39 (67)	59 (100)	-	-

Caption: kPa = quilopascal; n = number of participants

Table 3. Measures of central tendency and dispersion of data

The variables	Percentage n (%)	Maximum pressure (kPa)	p - value
Sagittal occlusion			
Class I	49 (86.0)	38.2	0.737*
Classes II and III	8 (14.0)	40.4	
Vertical occlusion			
Normal	35 (62.5)	38.8	0.098*
Open bite	16 (27.1)	40.6	
Deep bite	5 (8.5)	23.0	
Transverse Occlusion			
Normal	49 (86.0)	37.7	0.343**
Crossed	8 (14.0)	43.2	

*ANOVA
**Test –T
Caption: kPa = quilopascal; n = number of participants

Table 4. Statistical relationship between maximum pressure and the etiology of oral breathing

The variables		Percentage n (%)	Maximum pressure (kPa)	p - value
Mechanical obstruction	Tonsils Palatines			
	Grade 0 and I	22 (37.9)	45.3	**0.008***
	Grade II	20 (34.4)	31.2	
	Grade III and IV	16 (27.5)	35.0	
	Pharyngeal Tonsil			
	≤70	41 (70.6)	40.4	**0.043****
	>70	17 (29.3)	31.4	
Non-mechanical obstruction	Presence of Rhinitis - ORL			
	Yes	47 (83.9)	36.4	0.766**
	No	9 (16.0)	38.1	
	Allergological assessment			
	Allergic rhinitis (positive T.A.)	26 (52.0)	36.8	0.986*
	Non-allergic rhinitis	15 (30.0)	36.8	
	No allergy test	5 (10.0)	39.0	
	Negative allergic test	4 (8.0)	38.7	
Conduct	Kind			
	Medication	42 (76.3)	37.7	0.355**
	Surgery	13 (23.6)	33.3	

*ANOVA; **Test – T
Caption: Presence of Rhinitis – ORL: presence of rhinitis according to the otorhinolaryngologist's evaluation; TA - allergic test; KPa = kilopascal; n = number of participants

DISCUSSION

To know the values of the maximum pressure exerted by the tongue on oral breathing children and verifying the relation between these and the aetiology of the respiratory alteration can help in the better understanding of the dysfunctions of the stomatognathic system in these individuals. This way, it will be possible to contribute to an individualized therapeutic planning, serving as a basis for a more punctual treatment and even actions to be developed in primary care.

In the data concerning the pressure exerted by the tongue, measurements 1, 2 and 3 were very close. Considering the similarity of the data and the results obtained in the statistical analysis, it was chosen to present only the results of the maximum pressure of the tongue. The data does not differ by more than 2 kPa, which is the limit defined in the instrument manual. However, it is considered important to include three measurements, seeing that, this way it is possible to identify errors in the measurement process. It was also verified that the values of maximum pressure and mean pressure did not exceed 2 kPa. Thus, in the present study only the maximum pressure was analyzed. The high values for the standard deviation found may be associated to the individual differences of each participant, seeing that in the grouped data, the mean and median values presented proximity, suggesting a consistency

of findings. When comparing the standard deviation values of the sample with the literature[14], it was observed that the values are close, which subsidizes the hypothesis of the interference of the individual characteristics. It is important to note that the values of maximum tongue pressure also presented close to the literature base of this research, which presents the values stratified by gender and age[14].

The statistical analysis employed did not indicate differences between genders. Regarding age, the mean maximum pressure of the tongue increased according to the age of the children. The literature shows that, between 3 and 12 years of age, there are no differences between the values of maximum tongue pressure in genders and that the values of maximum pressure, actually increase minimally according to age[14]. Some authors[19,20] pointed out that findings for 3-year-old children would not be as reliable because of the size of the standard bulb and maturity to understand the command. However, in this study, only two children of that age (3% of the initial sample) were excluded because they did not complete the task. In another study[14], 99% of children of the age of 3 years did not have problems with the standard bulb or in performing the order, either.

The dental occlusion was analyzed in relation to the maximum pressure of the tongue, on the hypothesis that there was some association between them. However, in this study, this was not confirmed, indicating that there was no influence of occlusion (sagittal, vertical or transverse) on tongue pressure in the sample studied.

It was also verified that 77% of the sample had allergic rhinitis associated with the etiology of oral breathing; 61.0%, palatine tonsil hypertrophy; and 28.8%, pharyngeal tonsil hypertrophy. These findings are also in agreement with the literature that highlights rhinitis as the major cause of oral breathing[21]. It is important to emphasize that allergic rhinitis is indicated as the most frequent cause of rhinopathies[21], but the most common allergens are household dust, animal hair and mold[22]. However, for this research, the most prevalent causes of cutaneous test results in the recruited individuals were not raised. Although the skin test is simple and easy to perform, the literature emphasizes that the measurement of specific IgE is the most important method and that it has a meaningful agreement with the cutaneous allergic test[23].

In the analysis of the data, it was verified that the pharyngeal tonsil and the palatine tonsils presented a statistically significant association in relation to the maximum pressure of the tongue, in these cases, they are smaller. Concerning the palatine tonsils, the difference was found between the grade 0 and I classification groups in relation to grade II hypertrophy. It is believed that there was no difference involving grade III and IV classification because of the small sample size, seeing that there is a significant difference in relation to the averages. Although the prevalence of individuals with allergic rhinitis was higher, there was no statistically significant relation to the maximum tongue pressure. On the other hand, there are studies in the literature that point to hypertrophy of the pharyngeal tonsils and palatine tonsils, as important causes of upper airway obstruction in children[24,25], and these structures have greater impact for the case.

An important data that was identified in this study is that the evaluation of the otorhinolaryngologist and the allergist showed a disagreement among them for the diagnostic hypothesis of allergic rhinitis. Statistical analysis was performed with both evaluations, and although it did not indicate an association between the diagnostic hypotheses of the two professional classes and the maximum pressure of the tongue, in view of the prevalence of rhinitis in the population, it is important to highlight this data. After all, an accurate early diagnosis can promote a more punctual treatment and thus determine a better prognosis.

Likewise, there was no statistically significant difference between the practices that were accomplished (medication / surgical treatment) and maximum tongue pressure. It is believed that this finding is due to the fact that some children from the HC-UFMG Oral Respiratory Outpatient Clinic, although they present hypertrophy of the pharyngeal and palatine tonsils, they are initially treated with medication.

This study has its importance justified, because the literature indicates that the maintenance of pressure / strength of the tongue contributes to the adequacy of the function and the reorganization of the postural pattern of this organ [2]. Other studies describe the relationship between tongue and oral breathing, pointing to the negative repercussion on swallowing and speech functions[14,15]. Therefore, confirmation of this relationship may contribute to a more individualized evaluation proposal and therefore serve as the basis for other research that focuses on the definition of specific speech therapy strategies for the population surveyed.

Limitations were considered in this study: the sample size; the lack of data and some evaluations in the medical records.

CONCLUSION

Mechanical obstructions, such as pharyngeal tonsil hypertrophy and palatine tonsils were related to the decrease in maximum tongue pressure in oral breathing children. The maximum tongue pressure increased as the participants' age increased. There was no difference in maximum tongue pressure between genders or between different kinds of dental occlusion and bite.

REFERENCES

1. Hennig TR, Silva AMT, Busanelo AR, Almeida FL, Berwig LC, Boton LM. Swallowing of oral and nose breathers: speech-language and electromyography assessment. Rev CEFAC. 2009;11(4):618-23. http://dx.doi.org/10.1590/S1516-18462009000800010.
2. Abreu RR, Rocha RL, Lamounier JA, Guerra ÂFM. Etiology, clinical manifestations and concurrent findings in mouth-breathing children. J Pediatr. 2008;84(6):529-35. http://dx.doi.org/10.1590/S0021-75572008000700010. PMid:19060979.
3. Lemos CM, Wilhelmsen NSW, Mion OG, Mello JF Jr. Functional alterations of the stomatognathic system in pacients with allergic rhinitis: case-control study. Arq Int Otorrinolaringol. 2007;11(4):380-6.
4. Marchesan IQ. The speech pathology treatment with alterations of the stomatognathic system. Int J Orofacial Myology. 2000;26:5-12. PMid:11307349.
5. Frasson JMD, Magnani MBBA, Nouer DF, Siqueira VCV, Lunardi N. Comparative cephalometric study between nasal and predominantly mouth breathers. Rev Bras Otorrinolaringol. 2006;72(1):72-81. http://dx.doi.org/10.1590/S0034-72992006000100012. PMid:16917556.

6. Souza JF, Grechi TH, Anselmo-Lima WT, Trawitzki LVV, Valera FCP. Mastication and deglutition changes in children with tonsillar hypertrophy. Rev Bras Otorrinolaringol (Engl Ed). 2013;79(4):424-8. http://dx.doi.org/10.5935/1808-8694.20130076. PMid:23929140.

7. Jardini RSR. Uma outra possibilidade para a adequação/reeducação da forma/função da musculatura da língua [tese de doutorado] Campinas (SP): Universidade Estadual de Campinas - Faculdade de Ciências Médicas; 2007. 150 p.

8. Clark H. Specificity of training in the lingual musculature. J Speech Lang Hear Res. 2012;55(2):657-67. http://dx.doi.org/10.1044/1092-4388(2011/11-0045). PMid:22215031.

9. Motta AR, César CC, Bommarito S, Chiari BM. Axial force of the tongue in different age groups. J Soc Bras Fonoaudiol. 2011;23(2):201-5. http://dx.doi.org/10.1590/S2179-64912011000300004. PMid:22012153.

10. Perilo TVC, Motta AR, Las Casas EB, Saffar JME, Costa CG. Objective evaluation of axial forces produced by the tongue of oral breathing children. Rev Soc Bras Fonoaudiol. 2007;12(3):184-90. http://dx.doi.org/10.1590/S1516-80342007000300005.

11. Rodrigues FV, Monção FRC, Moreira MBR, Motta AR. Variability of orofacial measures. Rev Soc Bras Fonoaudiol. 2008;13(4):332-7. http://dx.doi.org/10.1590/S1516-80342008000400006.

12. Hitos SF, Arakaki R, Solé D, Weckx LLM. Oral breathing and speech disorders in children. J Pediatr. 2013;89(4):361-5. http://dx.doi.org/10.1016/j.jped.2012.12.007. PMid:23809686.

13. Polit DF, Beck CT. The content validity index: are you sure you know what's being reported? Critique and recommendations. RINA. 2006;29(5):489-97. PMid:16977646.

14. Potter NL, Short R. Tongue strength in children and adolescents. Dysphagia. 2009;24(4):391-7. http://dx.doi.org/10.1007/s00455-009-9215-2. PMid:19390891.

15. Silva JB, Giglio LD, Regalo SH, Mello-Filho FV, Trawitzki LVV. Effect of dentofacial deformity on maximum isometric tongue strength. J Oral Rehabil. 2013;40(4):247-51. http://dx.doi.org/10.1111/joor.12020. PMid:23216277.

16. Almeida LD, Furlan RMMM, Las Casas EB, Motta AR. Influence of height, weight and body mass index in the axial tongue force. J Soc Bras Fonoaudiol. 2012;24(4):381-5. http://dx.doi.org/10.1590/S2179-64912012000400015. PMid:23306690.

17. Adams V, Mathisen B, Baines S, Lazarus C, Callister R. A systematic review and meta-analysis of measurements of tongue and hand strength and edurance using the Iwoa Oral Performance Instrument. Dysphagia. 2013;28(3):350-69. http://dx.doi.org/10.1007/s00455-013-9451-3. PMid:23468283.

18. IOPI Medical. IOPI User Manual [Internet]. Woodinville: IOPI Medical LLC; 2016 [citado em 2016 Abr 20]. Disponível em: www.iopimedical.com

19. Bradford A, Murdoch B, Thompson E, Stokes P. Lip and tongue function in children with developmental speech disorders: a preliminary investigation. Clin Linguist Phon. 1997;11(5):363-87. http://dx.doi.org/10.1080/02699209708985201.

20. Murdoch BE, Attard MD, Ozanne AE, Stokes PD. Impaired tongue strength and endurance in developmental verbal dyspraxia: a physiological analysis. Eur J Disord Commun. 1995;30(1):51-64. http://dx.doi.org/10.3109/13682829509031322. PMid:7647392.

21. Borges WG, Burns DA, Felizola ML, Oliveira BA, Hamu CS, Freitas VC. Prevalence of allergic rhinitis among adolescentes from Distrito Federal, Brazil: comparison between ISAAC phases Iand III. J Pediatr. 2006;82(2):137-43. http://dx.doi.org/10.2223/JPED.1461. PMid:16614769.

22. Kara CO, Ergin H, Koçak G, Kılıç İ, Yurdakul M. Prevalence of tonsillar hypertrophy and associated oropharyngeal symptoms in primary school children in Denizli, Turkey. Int J Pediatr Otorhinolaryngol. 2002;66(2):175-9. http://dx.doi.org/10.1016/S0165-5876(02)00247-1. PMid:12393253.

23. Godinho R, Lanza M, Godinho A, Rodriques A, Assiz TML. Frequency of positive skin tests for airborne allergic agents. Rev Bras Otorrinolaringol. 2003;69(6):824-8. http://dx.doi.org/10.1590/S0034-72992003000600016.

24. DiFranceso RC, Passerotii G, Paulucci B, Miniti A. Mouth breathing in children: different repercussions according to the diagnosis. Rev Bras Otorrinolaringol. 2004;70:665-70.

25. Di Francesco RC, Junqueira PA, Frizzarini R, Zerati FE. Weight and height development in children after adenotonsillectomy. Rev Bras Otorrinolaringol. 2003;69:193-6. http://dx.doi.org/10.1590/S0034-72992003000200008.

Author contributions

All the authors had a meaningful contribution in this work. The ARM, TCP participated mainly in the collection and analysis of data and article writing; RMMMF participated in the analysis of the data and the writing of the article.