NASAL AERATION AND RESPIRATORY MUSCLE STRENGTH IN MOUTH BREATHERS' CHILDREN

Aeração nasal e força muscular respiratória em crianças respiradoras orais

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ABSTRACT

Purpose: to observe whether there is a relationship between respiratory muscle strength and degree of nasal aeration in Mouth Breathing children. **Methods:** this is an observational and a comparative cross-sectional study. 32 Mouth Breathing children with allergic rhinitis (21 boys and 11 girls) and 30 nasal breathing without allergic rhinitis (09 boys and 21 girls) participated, 7-12 years, subjected to evaluation for nasal aeration with Altmann mirror and to evaluation of respiratory muscle strength with digital manovacuometer (MVD®30). **Results:** there was no correlation between nasal aeration and respiratory muscle strength in each subgroup. There was difference comparing values of maximal expiratory pressure between mouth breathers boys and girls (p=0,0064), and between nasal breathers boys and girls (p=0,0030). There was also difference maximal inspiratory pressure between mouth breathers boys and girls (p=0,0324), and between nasal breathers boys and girls (p=0,0210). **Conclusion:** it was not possible to confirm that there is a relationship between the degree of nasal aeration and respiratory muscle strength in Mouth Breathing.

KEYWORDS: Mouth Breathing; Aeration; Muscle Strength; Respiration; Child

INTRODUCTION

For efficiently nasal breathing occurs, there needs to be a condition of air passage through the nostrils. When there is impossibility of breathing through the nasal route, that breath will occur predominantly at the mouth, being called oral breathing[1].

Due to lack of air flow passage of the stimulus through the nasal duct, do not happen the pressures and strains that ensure the correction of the maxillary sinuses. The nostrils become cracks narrow nasal with a volume and elasticity reduced by the disuse, present pale nasal mucosa, poor filtration and air heating during breathing[2].

With decreasing nasal air passage, the air will reach the lungs through mechanically shorter and easier way. Thus, the child makes less effort to breathe, aggravating the whole mechanical ventilation with the commitment of the lungs, abnormal respiratory rate, subject to the expansion and contraction of the lungs and alveolar ventilation. Thus, the diaphragm action will be reduced, as compromise their length-tension relationship, incapacitating him to produce adequate peak tension, leading to relaxation and requiring less respiratory muscle strength, which develops weakness with retraction muscular[3,4].

Changes can also happen with the abdominal muscles, which associated to constant intake of air,

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leads the oral breathing child to present a flaccid and protruding abdomen, resulting in muscle weakness both inspiratory, as expiratory[4].

Whereas, due to the change in breathing mode, orofacial changes occurs and respiration mechanism too, this study aims to observe whether there is a relationship between respiratory muscle strength and nasal aeration area in mouth breathing children.

METHODS

The research project was filed, evaluated and approved by the Ethics in Human Beings Research Committee of the Federal University Health Sciences Center of Pernambuco (CEP/CCS/UFPE) under the registration number 492/11 and CAAE 0484.0.172.000 -11. There is an observational study and cross-comparison between two groups, carried out from October 2012 to April 2013.

According to the inclusion criteria, 32 children participated in oral breathing secondary to allergic rhinitis confirmed in medical records and that breathing through the mouth into the time of the survey and 30 nasal breathing children without allergic rhinitis, of both genders, between 7 and 12 years. The volunteers were in attendance at the Allergy and the Pediatric ambulatories of Clinical Hospital of the Federal University of Pernambuco (HC/UFPE).

Were adopted as exclusion criteria for both groups: children with difficulty in understanding simple orders, evaluated by means of spontaneous conversation, or neurological changes; genetic and endocrine disorders that interfere in the growth and development; cardiovascular changes and people with severe heart disease; deviated nasal septum; cleft lip, cleft lip and palate; in use of braces; reporting respiratory infectious disease of the lower airway such as asthma; physical therapy and/or speech therapy prior or ongoing intervention.

All officials who were accompanying children at the time of evaluation were interviewed and informed of the research through the Informed Consent Free Term (TCLE).

The interview consisted of maternal and child socioeconomic data, family housing, smell conditions and aspects of the child's sleep, followed by information on the medical history of the child.

Measurement of nasal aeration area was conducted by the Altmann milimetrically nasal mirror graded from Altmann (Pro-Fono®), for a speech therapist, who was standing and ahead of the child using disposable gloves. After the air conditioning or fan were turned off, the mirror was placed just below of the nose, centrally positioned and in a 90° angle to the height of the anterior nasal volunteer spine who was seated and with your head straight, supported column on the chair and feet flat on the floor. After two quiet exhalation, nasal aeration was measured by checking with black marker blurry area on the mirror itself. The total time of this procedure ranged from five to ten minutes.

Then this labeling was transferred to a sheet of Altmann Mirror Reference Book. Each sheet of the reference block was scanned by means of an HP Photosmart printer series D110, the data having been subsequently measured through 1.46r Image J software (http://imagej.nih.gov/ij), yielding the extent cm².

After the nasal aeration, a physical therapist conducted the evaluation of respiratory muscle strength, through the maximum inspiratory and expiratory pressures (PImax and PEmax). We used a portable digital manovacueometer (MVD®300-Globalmed-Brazil), graduated in cmH_2O, with the examination mode Off-Line, which has measurement resolution of 1 cmH_20 and 480 cmH_20 full scale, coupled with a mouth scientific with a 2 mm hole in order to provide exhaust air and thus prevent the increase in the oral cavity pressure generated by of unwanted oral wall muscles contraction, minimizing the cheek effect and thereby avoiding interference in the results, according to some authors recommendations[5].

By convention and to standardize measures, children were sitting, with their spine supported in the back of the chair, upper members supported on the thighs and feet flat on the floor[6]. The PImax and PEmax measurements were recorded during maximum effort against nasal tract occluded by a nose clip, preventing air leakage through the nose, and generated the air outlet on the mouth in the inhalation and exhalation, following the previus study criteria[6,7].

During the PEmax and PImax evaluation, it was requested that the child undertake a deep inspiration or expiration until reaching the total lung capacity (CPT) or expiratory volume reserve (VR), respectively, and then exhale or inhale vigorously through the mouth piece that the children arrested with their lips to prevent air leakage around the same. The peak expiratory and inspiratory force was sustained for at least one second, with a minimum interval of one second between each peak. The children performed three to five attempts to obtain the pressures being considered the most valuable, both for PEmax as PImax, measured in cmH_2O[7]. Sometimes, in case of signs of fatigue manifestation, the assessment test of PImax and PEmax was stopped and restarted. The total time of this procedure ranged from 15 to 30 minutes.

The sample size estimate and statistical result analysis were performed through BioEstat software, 5.3 version, performing previously the Shapiro-Wilk normality test which considered the sample with normal distribution. Then sample size estimate were performed to linear correlation test, considering a 90% of power test and an alpha level of 0.05 in the ratio of 1:2, estimating a minimum sample size for the mouth breathers group: ten children were female and 185 were male and, for the nose breathers group: 20 females and 370 males. From the results of the pilot study, which tended to get close correlation between the values of the nasal aeration area and the values of maximal respiratory pressures for females, it was decided to separate by gender.

In results analyzing, it was used the chi-square test of Pearson or Fisher's exact test, when necessary, for the analysis of categorical variables. According to the result of normality test, Pearson correlation test or Spearman's correlation test was used to assess the correlations between the values of respiratory pressures (PEmax and PImax) and nose through the air outlet (nasal aeration) in both groups.

For comparison between groups, the Mann-Whitney test (Wilcoxon Rank-Sum Test) was applied to $p < 0.05$ (non-parametric data), considering analyze the data based on the median or the Student t test for $p < 0.05$ (parametric data), based on the mean and standard deviation. Differences were considered significant when $p < 0.05$ for all calculations.

This study hypothesis was that there is a relationship between the nasal aeration area and respiratory muscle strength (PEmax and PImax) in the sample.

RESULTS

It was evaluated 62 children: 32 (51.61%) for the mouth breathers group, distributed in 21 children (65.63%) for the male subgroup and 11 (34.37%) for females, and 30 children (48.39%) for the nose breathers group, distributed in 21 (70%) for the subgroup of girls and 09 (30%) for boys. The average age was 8.7 ± 1.4 years for mouth breathing group and 9.0 ± 1.3 for nose breathers group, with no difference between groups (p=0.3207).

Regarding the distribution of the sample according to housing conditions, family income, maternal variables and breastfeeding participants included, there were differences between the groups only for the variable family income (p=0.0437) (Table 1).

No difference was observed between the two groups regarding the sample distribution according to variables related to smell, taste, snoring and drooling (Table 2).

The average values were expressed, standard deviation and median for PEmax, PImax and nasal aeration between the two groups, according to the applied test (Table 3).

It is noticed that there was no correlation between nasal aeration and respiratory muscle strength (PEmax and PImax) within each subgroup (Table 4).

However, when comparing the values of the PEmax and PImax between boys and girls mouth breathers, significant differences (p=0.0064 and p=0.0324, respectively) (Table 5).

The same was true for nose breathers group, where p=0.0030 for PEmax and p=0.0210 for PImax (Table 5).

Table 1 – Distribution of the sample according to housing conditions, family income, maternal variables and breastfeeding participants

Variables	MB Group n (n%)	NB Group n (n%)	p Value
Piped water at home			
Yes	29 (90.62%)	30 (100%)	0.2385[1]
No	3 (9.38%)	0 (0%)	
Flush toilet at home			
Yes	28 (87.5%)	27 (90%)	1.000[1]
No	4 (12.5%)	3 (10%)	
Home light			
Yes	32 (100%)	30 (100%)	1.000[1]
No	0 (0%)	0 (0%)	
Family monthly income (MW)			
≤1 MW	22 (68.75%)	13 (43.33%)	0.0437[2]
>1 MW	10 (31.25%)	17 (56.67%)	
Breastfeeding			
< 4 months*	20 (66.66%)	13 (46.42%)	0.1199[2]
≥ 4 months *	10 (33.34%)	15 (53.58%)	

[1]Fisher's Exact Test; [2]Chi-Square Test; p<0,05 (statistically significant values)
Legend: n=number of children; n%=number of children in percentage; NB=nose breathers; MB=mouth breathers
MW=minimum wage; *02 participants were excluded because they were unable to answer

Table 2 – Distribution according to variables related to smell, taste, snoring and drooling

Variables	Yes n (n%)	No n (n%)	p Value
Trouble smell			
MB Group	4 (12.50%)	28 (87.50%)	0.3569[1]
NB Group	1 (6.67%)	28 (93.33%)	
Trouble feeling			
MB Group	2 (6.25%)	30 (93.75%)	1.0[1]
NB Group	2 (6.9%)	27 (93.10%)	
Snore			
MB Group	16 (51.62%)	15 (48.38%)	0.8027[2]
NB Group	15 (53.58%)	14 (46.42%)	
Drool			
MB Group	18 (56.25%)	14 (43.75%)	0.9424[2]
NB Group	17 (58.63%)	12 (41.37%)	

[1]Fisher's Exact Test; [2]Chi-Square Test; p<0,05 (statistically significant values)
Legend: n=number of children; n%=number of children in percentage; NB=nose breathers; MB=mouth breathers
01 participant was excluded because he/she were unable to answer

Table 3 – Measures of the maximum respiratory pressures and the area of nasal aeration in mouth breathers and nose breathers children

Variables	n	Average[1]	Standard Deviation[1]	Median[2]	p Value
PEmax (cmH_2O)					
MB Group	32	66	25.51	66.5	0.5740[1]
NB Group	30	62.76	18.77	64.5	
PImax (cmH_2O)					
MB Group	32	73	28.58	70.5	0.2873[1]
NB Group	30	66.23	19.99	66	
Nasal Aeration (cm^2)					
MB Group	32	16.28	5.94	15.05	0.2367[2]
NB Group	30	17.45	5.42	16.64	

[1]Student t Test; [2]The Mann-Whitney Test; p<0,05 (statistically significant values)
Legend: n=number of children; NB=nose breathers; MB=mouth breathers; PEmax=maximum expiratory pressure; PImax=maximum inspiratory pressure

Table 4 – Correlation between the area of nasal aeration and the maximum respiratory muscle strength (PEmax and PImax) in mouth breathers and nose breathers children

Variables	Girls		Boys	
	MB Group (n=11)	NB Group (n=21)	MB Group (n=21)	NB Group (n=9)
PEmax X Nasal Aeration	p=0.3106[1]	p=0.4232[2]	p=0.3942[2]	p=0.3084[1]
	rs=0.3371	r=-0.1845	r=0.1961	rs=0.3833
PImax X Nasal Aeration	p=0.307[1]	p=0.2177[2]	p=0.1821[2]	p=0.5439[1]
	rs=0.1636	r=0.2807	r=0.3028	rs=-0.2343

[1]Pearson's Correlation Test; [2]Spearman's Correlation Test; p<0,05 (statistically significant values)
Legend: p=p value; r=Pearson's correlation coefficient; rs=Spearman's correlation coefficient; n=number of children; NB=nose breathers; MB=mouth breathers; PEmax = maximum expiratory pressure; PImax=maximum inspiratory pressure

Table 5 – Comparison between the area of nasal aeration and maximum respiratory pressures (PEmax and PImax) in mouth breathers and nose breathers children

Variables	MB Group p Value	NB Group p Value
PEmax (girls) and PEmax (boys)	0.0064[1]	0.0030[2]
PImax (girls) and PImax (boys)	0.0324[1]	0.0210[1]
Nasal Aeration (girls) and Nasal Aeration (boys)	0.5922[2]	0.6672[2]

[1]Student t Test; [2]The Mann-Whitney Test; p<0,05 (statistically significant values)
Legend: PEmax=maximum expiratory pressure; PImax=maximum inspiratory pressure

DISCUSSION

There are several factors that can lead to mouth breathing, and allergic rhinitis is possibly the most common cause of chronic airway obstruction, affecting 15-20% of population[8]. In this study, we found a significantly higher number of male children with allergic rhinitis and mouth breathing.

This finding can be explained because the boys have a higher prevalence of allergic rhinitis, the main entity associated with mouth breathing, and a lower airway caliber[9]. However, according to other studies performed[8,10] there is no direct relationship from the mouth breathing, caused by allergic rhinitis, for males.

Family income is cited as an important determinant of respiratory pathologies[11]. And what we found in this study is that a good portion of respondents from mouth breathers group have monthly incomes below the minimum wage compared to the nasal breathers group and were differences between groups, corroborating the findings of other authors[12] also they found lower averages for mouth breathers group.

Given that the low-income population is evident as higher risk because it involves demographic and economic factors, undoubtedly, the prevalence of respiratory diseases in children would be reduced if they had better residence conditions[11]. The latter data contradicts some points of the results of this study, since all mouth breathing children lived in homes with light and most of them had running water and flushing toilets at home. So the more unfavorable for the socioeconomic situation, the prevalence of respiratory diseases tend to be bigger[11].

In addition, it was found, in the present study and on a study of 2007[13], that many of the children weaned before four months of life. The correct breathing pattern may be impaired by weaning before six months of life, because it compromises the proper oral motor development and the lack of physiological sucking the breast allows the installation of malocclusion, motor-oral amendment and mouth breathing[4,14].

Regarding the smell and taste, a literature review found that the mouth breathing results in the decrease in smell and taste, there is a limitation in the operation of these sense[15]. However, these findings are not consistent with the results of this study, since most mouth breathing children showed no trouble smell, as well as nose breathers group. A large number of children in both groups reported no trouble feeling like some foods. Three other authors[16] observed that a small number of volunteers had no complaints regarding taste.

Studies show that snoring and drooling relationship with mouth breathing can cause respiratory and sleep problems, caused by constant mouth opening, because the space of rinopharynx (throat region) is reduced due to nasal obstruction or allergic state[4,17]. In this study, despite snoring and drooling data have been approximated, but no difference between the two groups the mouth breathers had a higher frequency of these aspects also been observed in previus studies[8,13,16,18].

The use of Altmann millimetred mirror was nominated for this study due to its wide clinical application, playback facility and manipulation[16,19], and does not cause discomfort to paciente[20,21]. However, the subjectivity of this equipment to obtain the nasal aeration is criticized in literature, questioning the test sensitivity. The mirror does not allow the establishment of condensate, which quickly disappears, because the airflow is dynamic. In addition, you have no control over the voluntary expiration of the individual and can be seen an expiration with more or less effort, even with corrections in these cases.

The combination of the aforementioned factors coupled with the lack of precise functional diagnosis of mouth breathing may have been decisive for the values of the nasal aeration areas have not shown differences between the groups, although the mouth breathing group median (15.05 cm²) was slightly lower than that of nasal breathing. Although the values of the mean and median do not differ much from each other, we could not compare the results of the areas of the nasal aeration of the current study with those of another study[16], or with others in the literature, because they do not compare average with median due statistical test applied.

Although mirror using along with the clinical history and physical examination are considered the gold standard in Orofacial Motricity area of speech therapy, there are no studies that point predicted values of nasal aeration to normal subjects. The difficulty in standardizing protocols for characterization of mouth breath sample in this research is a factor that may also have interfered directly on the data obtained. Diagnosis of mouth breathing was defined in the medical records, often building on nasal obstruction, this factor alone that not only defines the situation of mouth breathing, given that the signs and symptoms may not have been considered.

Regarding the inspiratory and expiratory maximum pressure (PImax and PEmax), the PImax, generated from maximum expiratory efforts, measures the strength of the inspiratory muscles (diaphragm and external intercostal), while PEmax, generated from maximum inspiratory efforts, measures the strength of the expiratory muscles (abdominal and internal intercostal). The PImax and PEmax indirectly indicate the respiratory muscle strength[21].

To measure these pressures and thus quantify the strength of respiratory muscles, it used a digital manovacuometer that provides accurate result with evaluation 1 in 1 cmH_2O, record the peak pressure in the display, allowing the values remain stored on the device, besides having 2 mm hole minimizes the cheek effect. The digital is recommended rather than the analog, because the latter makes it difficult to record the peak pressure, presents scale ranges from 4 cmH_2O, easily descalibration and does not have the hole 2 mm[22].

In this study, most girls had lower values for inspiratory and expiratory pressures compared with boys in both groups. Similar results were observed in previous study[10]. This is because females have vital capacity (air volume that can expel from the lungs after maximum deep breath), decreased maximal expiratory flow and a lower surface pulmonary diffusion and airways diameter dereased[23].

The main results observed were that mouth breathing children behaved as nasal breathing when respiratory pressure variables and nasal aeration were correlated. The fact of not having found correlation between these variables can suggest that the transition from nasal breathing for mouth breathing induces changes in respiratory muscle structure, developing compensation strategies to live with the consequences of mouth breathing without the appearance of noticeable changes, favoring breathing[24,25].

As regards the muscles involved with nasal breathing (nasolabial lifters - dilates the nostrils), a study conducted an experiment in Wistar rats, which were induced mouth breathing and these muscles showed a relative decrease in fatigable 2b fiber type. This means that the nasolabial lifters were more resistant to fatigue as they adapted to the new condition of mouth breathing, allowing the maintenance of functional position of these involved muscles in this function without altering the muscle activity and consequently without altering the nasal function (nasal inspiration and exhalation)[25].

Another explanation for the lack of relationship would be that the children may have ordered the accessory muscles of inspiration (sternocleidomastoid and trapezius) along with the major muscles of inspiration (diaphragm and external intercostal) during manovacuometry[26], even with the body stabilization control by the physiotherapist during evaluations.

This accessory activation may be imperceptible to the eye of the professional, but a study in mouth breathing children, 8-12 years revealed that these same accessory muscles showed increased muscle activity, perceived by electromyography. Because of airway obstruction, a stronger diaphragm contraction happens, preceded by muscular action inspiratory accessory, shown by increased activity of the sternocleidomastoid muscle during nasal inspiration of children with mouth breathing[26]. Other authors found no significant changes among groups of mouth and nasal breathing in relation to the composition of the muscle fibers of the diaphragm, ie, this muscle was equivalent behavior in mouth and nasal breathers[25].

It is noteworthy that children up to the age of ten are in the process of alveolar multiplication and rib cage bone mineralization, which would allow greater displacement of this rib cage and with consequent expansion and contraction of the lungs and thus would provide the breathing[3].

In addition, this age due to the abdominal muscles immaturity, the compliance of this region is larger, allowing the abdomen to expand more easily and predominance during respiration (inspiration and expiration), facilitating the lung expansion[24] which justify an result without difference between groups for the PEmax.

Thus, the younger the mouth breathing children, less orofacial and lung function changes they present, suggesting that with growth, these changes can accentuate[18]. Even though there is evidence that mouth breathing children can behave as the nasal breathing because of possible muscle compensation arising from the mouth breathing, it is believed that there may be a direct relationship between the values of the nasal aeration area and the values of maximal respiratory pressures.

Much of children that chronically breathe through the mouth shows a decrease in nasal aeration, reduces the effort to inhale and exhale because the air comes quickly to the lungs without these organs to expand and retract properly and decrease the diaphragm and abdominal action. With these consequences of mouth breathing, there is a commitment in respiratory muscle strength, reducing the maximum respiratory pressures. Also, it is believed that these relationships can be better understood with the most comprehensive studies of mouth breathing functional diagnostics and more accurate equipment such as acoustic rhinometry.

The Pathophysiology of the stomatognathic system research group of this institution has invested in knowledge about this product and suggests it to better assess nasal geometry, to conduct an nasal area investigation more precise than the Altmann mirror. The rhinometry is a quantitative method that allows mapping of the nasal anatomy, measuring its volume in different points[27]. This method can improve the aerodynamic upper airway characteristics definition of mouth breathing children, contributing to the study of the relationship between the area and nasal volume and respiratory muscle strength.

In addition, the evaluation of nasal function can help the child to observe how much air flow from the nose and to encourage use it more breathing as well as the early assessment of the strength of the breathing muscles help in the lungs use awareness for expansion and lung retraction properly.

It is thinking of the existence of these relationships that we suggests a regular monitoring in mouth breathing children with assessments of nasal and lung function, in order to observe whether there is any change in the long-term respiratory component.

CONCLUSION

In this study, low family income tends to influence the development of mouth breathing.

For the values of the nasal aeration area, the group of mouth breathers had lower medians, but with no difference between groups.

For the PEmax and PImax values, the boys showed higher values than girls in both groups, with a difference.

However, it was not possible to confirm the direct relationship between the nasal aeration area values and the maximal respiratory pressures values in mouth breathing children.

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RESUMO

Objetivo: observar se existe relação entre força muscular respiratória e área da aeração nasal em crianças respiradoras orais. **Métodos:** trata-se de um estudo do tipo observacional, transversal comparativo entre dois grupos. Participaram 32 crianças com Respiração Oral secundária à rinite alérgica (21 meninos e 11 meninas) e 30 respiradoras nasais sem rinite alérgica (09 meninos e 21 meninas), 7 a 12 anos, submetidas à avaliação da aeração nasal com o espelho de Altmann e à avaliação da força muscular respiratória com o manovacuômetro digital (MVD®30). **Resultados:** não houve correlação entre aeração nasal e força muscular respiratória em cada subgrupo. Houve diferença comparando-se valores das pressões expiratórias máximas entre meninos e meninas respiradores orais (p=0,0064) e entre meninos e meninas respiradores nasais (p=0,0030). Também houve diferença das pressões inspiratórias máximas entre meninos e meninas respiradores orais (p=0,0324) e entre meninos e meninas respiradores nasais (p=0,0210). **Conclusão:** não foi possível confirmar a relação entre a área de aeração nasal e a força muscular respiratória nos respiradores orais.

DESCRITORES: Respiração Bucal; Aeração; Força Muscular; Respiração; Criança

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