

# Evaluation of Respiratory Muscle Strength in Mouth Breathers: Clinical Evidences

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## Abstract

**Introduction** The child who chronically breathes through the mouth may develop a weakness of the respiratory muscles. Researchers and clinical are seeking for methods of instrumental evaluation to gather complementary data to clinical evaluations. With this in mind, it is important to evaluate breathing muscles in the child with Mouth Breathing.

**Objective** To develop a review to investigate studies that used evaluation methods of respiratory muscle strength in mouth breathers.

**Data Synthesis** The authors were unanimous in relation to manovacuometry method as a way to evaluate respiratory pressures in Mouth Breathing children. Two of them performed with an analog manovacuometer and the other one, digital. The studies were not evaluated with regard to the method efficacy neither the used instruments.

**Conclusion** There are few studies evaluating respiratory muscle strength in Mouth Breathing people through manovacuometry and the low methodological rigor of the analyzed studies hindered a reliable result to support or refuse the use of this technique.

## Keywords

- ▶ Mouth Breathing
- ▶ muscle strength
- ▶ evaluation studies

## Introduction

The child who chronically breathes through the mouth might also have difficulties with functional capacity, compromised respiratory system, damaging lung ventilation with lower thoracic expansibility and, consequently, may develop a weakness of the respiratory muscles.<sup>1–5</sup>

Currently researchers and clinicians are increasingly seeking methods of instrumental evaluation, especially with the goal to gather data complementary to clinical evaluations because it is necessary to evaluate the breathing muscles and consequences of those respiratory changes in the Mouth Breathing child.<sup>6</sup>

Because the literature points to a physiologic relationship between Mouth Breathing standard and respiratory muscle strength and because there are few studies that evaluate the respiratory muscle strength in mouth breathers, the present study had the objective to develop a review to investigate studies that used the methods of evaluation of muscle

strength in mouth breathers. The review was made in order to gather the clinical evidence available in the literature to answer the clinical question.

## Methods

First, the research question was formulated, considering the goal of the review in this study: What are the evaluation methods of respiratory muscle strength in mouth breathers?

Next, a systematic search was made in Medline databases via PubMed, Latin American Literature in the Health Sciences (LILACS), and Scientific Electronic Library Online (SciELO), between November 2011 and October 2012, and included papers and dissertations covering the evaluation methods of RMS in inspiration and expiration during Mouth Breathing defining the eligibility criteria.

The keywords used for search followed the description of DeCS/MeSH terms, being: *muscle strength*, *Mouth Breathing*, *evaluation studies*. A search was also performed with the same

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**Table 1** Levels of evidence-based medicine<sup>a</sup>

Levels	
1	Systemic revision and random clinical trials with or without meta-analysis
2	Randomized controlled trials
3	Noncontrolled random clinical trials
4	Cohort study; case-control study; cross-sectional and quasirandomized studies
5	Case-control studies, case series
6	Expert opinions

Note: Table adapted from Oxford Centre for Evidence Based Medicine—Levels of Evidence.<sup>7</sup>

<sup>a</sup>Studies with the major strength of evidence are in the first position in the classification.

keywords in Portuguese. The combinations between those words were made in each database mentioned above, using the Boolean operator AND, without language restriction (► **Table 1**).

As for the level of scientific evidence, studies with the major strength of evidence are in the first position in the classification with a score of 1 and the lower strength with a score of 8.<sup>7</sup> Due to the lack of studies with evidence level 1, 2, 3, and 6, publications with evidence level 4 and 5 were selected for this review (► **Table 1**).

The abstracts of publications identified were evaluated according to the previously mentioned eligibility criteria. The ones selected according to the inclusion criteria had their methodologic quality evaluated by the following classification: random allocation, “blind” subjects, “blind” therapists, control groups, statistical analysis, and statistical comparison between the selected study groups (► **Table 2**). The selected studies had their methodologic quality evaluated by two independent reviewers (R.A. and D.C.) and the differences were discussed with a third reviewer (H.J.).

Currently, there are still few systematic reviews with meta-analysis available in physiotherapy and other health fields. The reasons that hamper the execution of this kind of study include the use of different research protocols and variations in methodologic quality.<sup>8</sup>

## Results

In principle, all studies were identified by the electronic search in the computer screen. Then, the studies were subse-

quently analyzed and the publications that addressed the evaluation methods of respiratory muscle strength in mouth breathers were included in the revision (one case-control study and two case studies).

Among the 13 publications initially selected in databases, 10 were excluded. Among the excluded ones, eight papers had no relation with the main subject according to their title and abstract and two were repeated (► **Fig. 1**).

To have a better presentation of results, the following were considered in the selected publications: author/year, country, sample, age average in years, methods, and equipments for evaluation of the respiratory muscle strength and results (► **Table 3**).

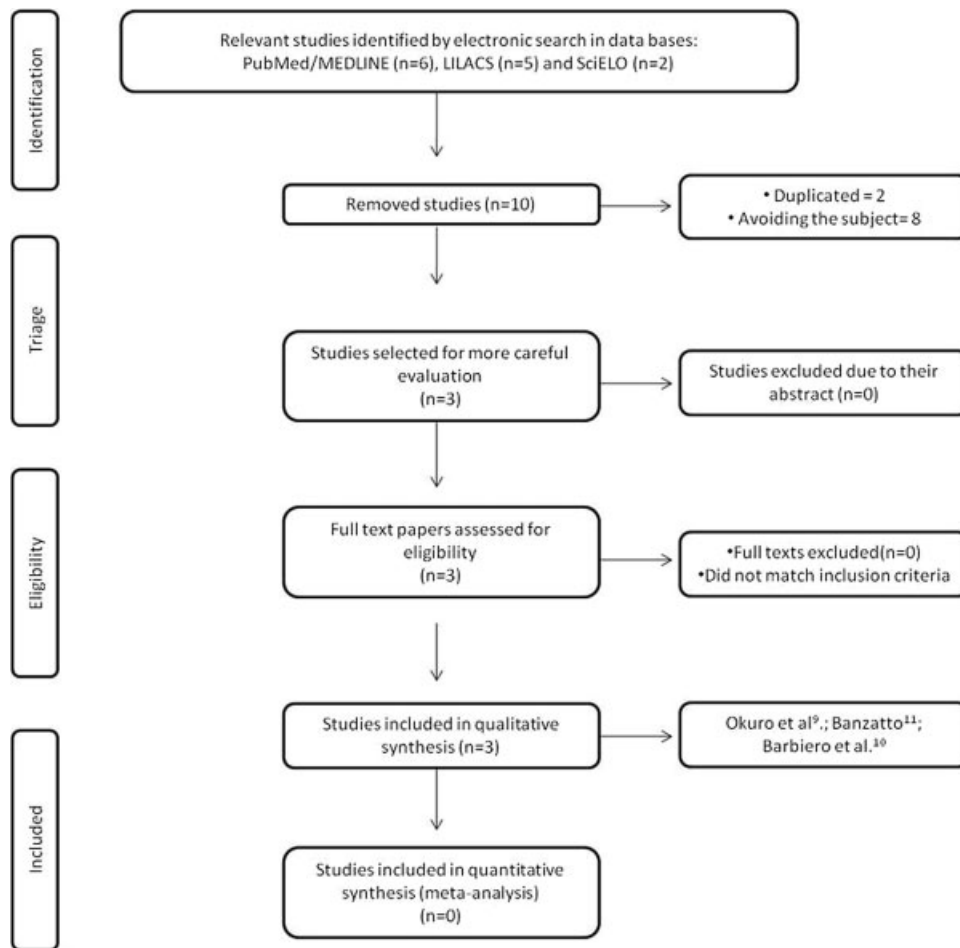
The three included studies had as population children between 6 and 13 years of age with and without Mouth Breathing.<sup>9–11</sup> The studies evaluated the respiratory muscle strength in Mouth Breathing children through the measurements of maximum static respiratory pressures (inspiratory and expiratory) by a manovacuometer. Analog and digital manovacuumeters were used.

Those studies included 144 children of both sexes: 82 with Mouth Breathing and 62 with nasal breathing (control group). A control group was included only in the study of Okuro et al.<sup>9</sup> Of them, 32 children were evaluated pre- and post-adenotonsillectomy because they had enlarged tonsils, 20 were evaluated pre- and posttreatment using biofeedback, and 92 had postural assessment and exercise (► **Table 3**).

Regarding the methodologic quality, all studies had the inclusion criteria and statistical analysis, but no one had random allocation and “blind” subjects. From the three

**Table 2** Methodological classification of selected studies

	Okuro et al, 2011 <sup>9</sup>	Banzatto, 2009 <sup>11</sup>	Barbiero et al, 2007 <sup>10</sup>
Specified inclusion criteria	Yes	Yes	Yes
Random allocation	No	No	No
“Blind” subjects	No	No	No
“Blind” therapists	Yes	No	No
Control group	Yes	No	No
Statistical analysis	Yes	Yes	Yes
Statistical comparison between groups	Yes	Yes	No



**Fig. 1** Search and selection of studies for revision according to PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses).<sup>24</sup> Abbreviation: LILACS, Latin American Literature in the Health Sciences.

publications, only the Okuro et al study had “blind” therapists and a control group.<sup>9</sup> The three studies made a statistical comparison between the mouth breathers subgroups (► **Table 2**).

One fact is that the authors were unanimous with relation to the manovacuometry method as a means to evaluate the breathing pressures pre- and posttreatment and pre- and postsurgery used to evaluate respiratory muscle strength in children with Mouth Breathing. Two of them used an analog and a digital manovacuometer. The studies were not analyzed for efficacy of both method and equipment used in Mouth Breathing children (► **Table 3**).

## Discussion

Currently, the evaluation methods of respiratory muscle strength are becoming more important because the three studies included were made from 2007, which evaluated the breathing muscles in mouth breathers in order to detect or not the improvement before and after some intervention. This clinical importance of evaluating the breathing muscles was proposed in previous publications.<sup>12,13</sup>

It is observed that Brazil was predominant in the three included studies because they were the only one that focused

in the theme of this revision, due to the search by keywords and the inclusion criteria. This discovery may be explained because the manovacuometer equipment is made in Brazil and is standardized and certified by the National Institute of Metrology, Standardization and Industrial Quality, besides its commercialization, acquisition, and maintenance being more easily accomplished in Brazilian territory. From this, the Brazilian scientists started doing several researches about Mouth Breathing, respiratory muscle strength, posture, and their relationships. However, there is still a lack of studies correlating Mouth Breathing and respiratory muscle strength.

Some studies<sup>14–17</sup> found in previous searches focused on changes of body posture or on association with the respiratory function in individuals with Mouth Breathing, given that musculoskeletal changes are the more easily identified signals. Thus, respiratory muscle strength was not usually evaluated.

Another relevant factor was the sample size. It was identified as a prevalent variation between 20 and 32 children with Mouth Breathing (9–11), and this compromises the reproducibility of those findings for the general population because of the reduced number of individuals present on studies.

In the publications selected for this review, the age of analyzed subjects was between 7 and 13 years, and according

**Table 3** Studies evaluating the evaluation methods of respiratory muscle strength in children with mouth breathing

Author/year	Country	Sample	Average age (y)	Methods and evaluation equipments of respiratory muscle strength	Results
Okuro et al, 2011 <sup>9</sup>	Brazil	92 children, from both sexes: 30 had clinical otorhinolaryngologic diagnosis of MB and 62 had NB	8–12	All participants submitted to P <sub>lmax</sub> and P <sub>Emax</sub> evaluation; averages of P <sub>lmax</sub> and P <sub>Emax</sub> obtained with an analog manovacuometer MV-120 (Ger-Ar Medical Equipment Ltd., São Paulo/SP, Brazil)	In MB group, there were no differences in averages of P <sub>lmax</sub> and P <sub>Emax</sub> . The P <sub>lmax</sub> and P <sub>Emax</sub> values were lower in MB group than in NB. MB negatively affected the respiratory biomechanics and exercise capacity.
Banzatto, 2009 <sup>11</sup>	Brazil	32 children from both sexes, with MB and enlarged tonsils pre- and post-adenotonsillectomy	6–13	Averages of P <sub>lmax</sub> and P <sub>Emax</sub> obtained with an analog manovacuometer MV-120 (Ger-Ar Medical Equipment Ltd., São Paulo/SP, Brazil) pre and post adenotonsillectomy	P <sub>lmax</sub> was lower in children with enlarged tonsils preoperatively. There was significant increase of P <sub>lmax</sub> 3–6 months postoperatively, denoting a gain in breathing muscle strength. P <sub>Emax</sub> increased postoperatively; however, this increase was not significant.
Barbiero et al, 2007 <sup>10</sup>	Brazil	20 children with functional MB, being 60% male and 40% female	Average 9.4 ± 1.1	Measurements of maximum static breathing pressures obtained with a digital manovacuometer MVD300 (Globalmed - Suport of Therapeutic Material Ltd., Porto Alegre/RS, Brazil), performed before and after RB utilization	The comparisons among maximum static breathing pressures did not show statistical significant differences in P <sub>Emax</sub> between the previous and subsequent values to the treatment with RB associated to the quiet breathing standard. There were significant differences related to P <sub>lmax</sub> after the treatment. This increased P <sub>lmax</sub> seems to show that the children started to better use their diaphragmatic muscles, reeducating their function and directly influencing the inspiratory muscle strength.

Abbreviations: MB, mouth breathing; NB, nasal breathing; P<sub>Emax</sub>, maximum expiratory pressure; P<sub>lmax</sub>, maximum inspiratory pressure; RB, respiratory biofeedback.

to the World Health Organization,<sup>18</sup> the age group from 7 to 12 years old is defined as prepubertal and was established because this period is considered of transition in breathing system development and marks the end of rapid growth and structural changes of the periphery breathing units.<sup>19</sup>

There was clinical homogeneity among the studies favoring the reliable evaluation of breathing pressures in the population set by the authors by manovacuometry. This measurement technique used by the included studies is widely found in the literature because there is a consensus in relation to the ideal method of manovacuometry to evaluate this maximum respiratory pressures (P<sub>lmax</sub> and P<sub>Emax</sub>).<sup>12</sup>

These pressures are measured in the mouth using a manovacuometer. The higher values exclude significantly clinical weakness of the breathing muscles.<sup>12</sup> Measurements are useful for differentiation between a neuromus-

cular weakness of abdominal muscles and a specific weakness of the diaphragm or others inspiratory muscles.<sup>20–22</sup>

Furthermore, it is necessary to evaluate the respiratory muscles and the consequences of this respiratory change in the Mouth Breathing child.<sup>6</sup> The child that chronically breathes through the mouth may develop changes in the respiratory system,<sup>1,2</sup> impairing lung ventilation,<sup>22</sup> demanding less strength from the breathing muscles, which would lead to muscle weakness and lower chest expansion, sagging, and abdominal protrusion.<sup>3,23</sup>

Moreover, it is possible to say that when there is a treatment with attention focused on respiratory muscle strength, there is significant increase in P<sub>Emax</sub> and P<sub>lmax</sub> values, improving this strength and all respiratory mechanics in the Mouth Breathing. The three studies show the evaluation of pressures before and/or after a clinical evaluation.

Given the few studies found for this review, it is noted that the lack of the evaluation of the respiratory muscle strength interferes in the diagnosis of some of this strength deficit, as well as in the definition of the treatment and in the reevaluation process of respiratory strength to evidence if this treatment is effective or not. In clinical practice, the delay to detect the diagnosis of Mouth Breathing and the unimportance of this clinical condition may lead to few scientific studies focused on respiratory muscle strength of the mouth breather being performed.

Thus, it is expected that further studies aimed at the methods used to evaluate respiratory muscle strength in Mouth Breathing will be performed, as studies correlating results of manovacuometry with data collected from other instruments for this evaluation, because there are many gaps to be filled in correlation studies of diagnoses in Mouth Breathing.

## Conclusion

Despite manovacuometry being used in clinical practice to evaluate the respiratory muscle strength in individuals with and without Mouth Breathing, it was found in this review that there is not yet enough evidence to support the recommendation of this technique. The low methodological rigor of the available studies hinders a truthful and reliable result to support or refute the use of manovacuometry.

Finally, it was observed that there are few studies evaluating respiratory muscle strength in Mouth Breathing people, through manovacuometry, suggesting that new research needs to be performed.

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## References

- Díaz MJE, Fariñas CMM, Pellitero RBL, Álvarez IE. La respiración bucal y su efecto sobre la morfología dentomaxilofacial. *Correo Científico Médico de Holguin*; 2005;9 [cited 2012 August 13, 2012]. Available at: <http://www.cocmed.sld.cu/no91/n91ori6.htm>. Accessed March 27, 2012
- Abreu RR, Rocha RL, Lamounier JA, Guerra AFM. Etiology, clinical manifestations and concurrent findings in mouth-breathing children. *J Pediatr (Rio J)* 2008;84:529–535
- Pires MG, Di Francesco RC, Grumach AS, Mello Júnior JF. Avaliação da pressão inspiratória em crianças com aumento do volume de tonsilas. *Rev Bras Otorrinolaringol* 2005;71:598–602
- Branco A, Ferrari GF, Weber SAT. Alterações orofaciais em doenças alérgicas de vias aéreas. *Rev Paul Pediatr* 2007;25(3):266–270
- Lemos CM, Wilhelmsen NS, Mion OdeG, Mello Júnior JF. Functional alterations of the stomatognathic system in patients with allergic rhinitis: case-control study. *Braz J Otorhinolaryngol* 2009;75:268–274
- Balbani AP, Weber SA, Montovani JC. Update in obstructive sleep apnea syndrome in children. *Braz J Otorhinolaryngol* 2005;71:74–80
- Howick J. Levels of evidence. Oxford Centre for Evidence Based Medicine. March 2009 [cited January 5, 2013]. Available at: <http://www.cebm.net/index.aspx?o=1025>. Accessed on January 21, 2012.
- Sampaio RF, Mancini MC. Estudos de revisão sistemática: um guia para síntese criteriosa da evidência científica. *Braz J Phys Ther (Impr)* 2007;11(1):83–89
- Okuro RT, Morcillo AM, Ribeiro MÂ, Sakano E, Conti PB, Ribeiro JD. Mouth breathing and forward head posture: effects on respiratory biomechanics and exercise capacity in children. *J Bras Pneumol* 2011;37:471–479
- Barbiero EF, Vanderlei LCM, Nascimento PC, Costa MM, Scalabrini Neto A. Influência do biofeedback respiratório associado ao padrão quiet breathing sobre a função pulmonar e hábitos de respiradores bucais funcionais. *Braz J Phys Ther (Impr)* 2007;11(5):347–353
- Banzatto MGP. Avaliação da função pulmonar (pressão inspiratória, expiratória e volume pulmonar) em crianças com aumento de tonsilas: pré e pós adenotonsilectomia [dissertação]. São Paulo, Brazil: Universidade de São Paulo; 2009
- Steier J, Kaul S, Seymour J, et al. The value of multiple tests of respiratory muscle strength. *Thorax* 2007;62:975–980
- Severino FG, Resqueti VR, Bruno SS, Azevedo IG, Vieira RH, Fregonezi GA. Comparison between a national and a foreign manovacuometer for nasal inspiratory pressure measurement. *Rev Bras Fisioter* 2010;14:426–431
- Andrada e Silva MA, Marchesan IQ, Ferreira LP, Schmidt R, Ramires RR. Postura, tônus e mobilidade de lábios e língua de crianças respiradoras orais. *Rev CEFAC* 2012;14(5):853–860
- Aragão W. Arago's Function Regulator, the estomatognathic system and postural changes in children. *J Clin Pediatr Dent* 1991;15(4):226–231
- Costa JR, Pereira SRA, Mitri G, Motta JC, Pignatari SSN, Weckx LLM. Relação da oclusão dentária com a postura de cabeça e coluna cervical em crianças respiradoras orais. *Rev Paul Pediatría* 2005;23(2):88–93
- Marins RS. Síndrome do respirador bucal e modificações posturais em crianças e adolescentes: a importância da fisioterapia na equipe interdisciplinar. *Fisioter Mov* 2001;14(1):45–52
- World Health Organization (WHO). Physical Status: the use and interpretation of anthropometry. Report of a WHO Expert Committee. Geneva 1995;(854):263–305
- Merkus PJ, Ten Have-Opbroek AA, Quanjer PH. Human lung growth: a review. *Pediatr Pulmonol* 1996;21(6):383–397
- Black LF, Hyatt RE. Maximal respiratory pressures: normal values and relationship to age and sex. *Am Rev Respir Dis* 1969;99(5):696–702
- Onaga FI, Jamami M, Ruas G, Di Lorenzo VAP, Jamami LK. Influência de diferentes tipos de bocais e diâmetros de traqueias na manovacuometria. *Fisioter Mov* 2010;23(2):211–219
- Cópio FCQ. A capacidade funcional da criança respiradora oral avaliada pelo teste de caminhada de seis minutos [dissertação]. Belo Horizonte: Universidade Federal de Medicina; 2008
- De Menezes VA, Leal RB, Pessoa RS, Pontes RM. Prevalência e fatores associados à Respiração Oral em escolares participantes do projeto Santo Amaro, Recife, Brasil. *Braz J Otorhinolaryngol (Impr)* 2006;72(3):394–399
- Moher D, Liberati A, Tetzlaff J, Altman DG; The PRISMA Group. Preferred reporting items for systematic reviews and meta-analyses: the PRISMA Statement (Guidelines and Guidance). *Am Rev Respir Dis* 2009;6(7):1–6