

J Laryngol Otol. 1987 Jun;101(6):558-63.

Rediscovering the importance of nasal breathing in sleep or, shut your mouth and save your sleep.

Lavie P.

Recent research, stimulated by the growing awareness of the sleep apnea syndrome, has shown that nasal breathing plays a major role in the regulation of respiration in sleep. These observations are not new; they confirm century-old clinical findings on the importance of nasal breathing in sleep. The earliest account of the deleterious effects of mouth breathing in sleep was made by Lemnius Levinus towards the end of the sixteenth century. Two hundred years later, Catlin dedicated an entire book to the superiority of nasal breathing over mouth breathing in sleep; and in the late 1800's, Cline, Wells, Griffin and others showed that obstructed nasal breathing causes sleep disorders.

Am J Rhinol. 2005 Nov-Dec;19(6):607-11.

Nasal congestion and hyperventilation syndrome.

Bartley J.

This article evaluates the prevalence of hyperventilation syndrome (HVS) in patients who continue to complain of ongoing nasal congestion, despite an apparently adequate surgical result and appropriate medical management.

METHODS:

Prospective case series of 14 patients from June 2002 to October 2003 was performed. Patients, who presented complaining of nasal congestion after previous nasal surgery and who appeared to have an adequate nasal airway with no evidence of nasal valve collapse, were evaluated for HVS. When appropriate, nasal steroids and oral antihistamines also had been tested without success. Three patients had end-tidal P(CO₂) levels measured and five patients underwent breathing reeducation.

RESULTS:

All patients had an elevated respiratory rate (>18 breaths/minute) with an upper thoracic breathing pattern. Twelve of the 14 patients complaining of nasal obstruction had an elevated Nijmegen score indicative of HVS. An average number of 2.5 procedures had been performed on each patient. End-tidal P(CO₂) levels were < or = 35 mmHg in the three patients who had expired P(CO₂) levels measured. Breathing retraining was successful in correcting the nasal congestion in two of five patients. **CONCLUSION: HVS should be included in the differential diagnosis of patients presenting with nasal congestion, particularly after failed nasal surgery. One possible explanation is increased nasal resistance secondary to low arterial P(CO₂) levels.** Another possible explanation is reduced alae nasae muscle activity secondary to the reduced activity of serotonin-containing raphe neurons. Additional surgery may not necessarily be the answer in HVS patients complaining of nasal congestion.

Gen Dent. 2010 Jan-Feb;58(1):18-25; quiz 26-7, 79-80.

Mouth breathing: adverse effects on facial growth, health, academics, and behavior.

Jefferson Y.

The vast majority of health care professionals are unaware of the negative impact of upper airway obstruction (mouth breathing) on normal facial growth and physiologic health. Children whose mouth breathing is untreated may develop long, narrow faces, narrow mouths, high palatal vaults, dental malocclusion, gummy smiles, and many other unattractive facial features, such as skeletal Class II or Class III facial profiles. These children do not sleep well at night due to obstructed airways; this lack of sleep can adversely affect their growth and academic performance. Many of these children are misdiagnosed with attention deficit disorder (ADD) and hyperactivity. It is important for the entire health care community (including general and pediatric dentists) to screen and diagnose for mouth breathing in adults and in children as young as 5 years of age. If mouth breathing is treated early, its negative effect on facial and dental development and the medical and social problems associated with it can be reduced or averted.

Cien Saude Colet. 2010 Mar;15(2):437-44.

[Prevalence of mouth breathing in children from an elementary school].

[Article in Portuguese]

Felcar JM, Bueno IR, Massan AC, Torezan RP, Cardoso JR.

The objective of this article is to identify the prevalence of mouth breathing in children from an elementary school. 496 questionnaires were answered by 1st and 4th grade children's parents or sponsors in order to identify mouth-breathing. There were questions about habits, sleeping, behavior, eating, personal care and breathing. Mann-Whitney and the Chi-square tests were used to compare the variables between mouth-breathing and nose-breathing among the groups. To measure the exposure effect of the explanatory variables on mouth breathing, the test of logistic regression was used and its magnitude was calculated through Odds Ratio. The statistical significance was set at 5%, and the rate of returned questionnaires was 84.5%. The prevalence of the mouthbreathing over this population was 56.8%. The average age was 7 years old (6-9). There was no significant statistical difference between genders, considering 49.1% male and 50.9% female. The final model of logistic regression identified the variables dribble, sleeps well (negative association) and snores as factors that predict the occurrence of the mouth-breathing. The prevalence of mouthbreathing was similar to related in the literature. The variables dribble, sleeps well (negative association) and snores may be factors that predict the occurrence of mouth-breathing.

Int J Orofacial Myology. 2009 Nov;35:44-54.

Quantitative evaluation of the orofacial morphology: anthropometric measurements in healthy and mouth-breathing children.

Cattoni DM, Fernandes FD, Di Francesco RC, De Latorre Mdo R.

The anthropometric orofacial measurements of mouth-breathing children were compared to those of children with no history of speech-language disorders, according to age. Methods: 100 children participated, both males and females, with ages ranging from 7 to 11 years and 11 months, leukoderm, in mixed dentition period, with a mouth-breathing diagnosis. The control group was comprised of 254 children, of both sexes, with ages ranging from 7 to 11 years and 11 months, leukoderm, in mixed dentition period, with no history of speech-language disorders. The control group did not demonstrate any mouth-breathing. The children were submitted to anthropometric assessment and the orofacial measurements obtained were upper lip, lower lip, philtrum, upper face, middle face, lower face, and sides of the face. The instrument used was the electronic digital sliding caliper Starrett Series 727. **There was statistically significant difference between the majority of the orofacial measurements of mouth-breathing children and the measurements of children with no history of speech-language disorders.** Some orofacial measurements were different in the studied populations. The possibility of comparing orofacial measurements of children with and without mouth-breathing behavior allows the clinician to determine normal and altered structures of the orofacial morphology. The main advantages of the anthropometry are its noninvasive nature, its technological simplicity, low cost and objective analysis. The anthropometric procedures also have clinical applications in myofunctional assessment and therapy.

Int J Orofacial Myology. 2000 Nov;26:13-23.

Relationship between mouth breathing and postural alterations of children: a descriptive analysis.

Krakauer LH, Guilherme A.

The research within this article seeks to verify and demonstrate the consequences of mouth breathing versus nasal respiration and to view supposed postural alterations in groups of children within specific age ranges. **The authors state that children with nasal respiration, age 8 and above, present with better posture than those who continue oral breathing beyond age 8.** The importance of picture documentation is stressed in order to provide the most information regarding postural changes. A review of research and literature is provided in the article.

Orthod Fr. 2000 Jan;71(1):27-35.

[Could mouth breathing lead to obstructive sleep apnea syndromes. A preliminary study].

[Article in French]

Raskin S, Limme M, Poirier R.

The aim of this preliminary work is to determine an easy method to diagnose "buccal breather" children and "nasal breather" children. Then, to establish a possible connection with the syndrome of obstructive sleep apnea. 22 children agreed to participate. Clinical, orthophonic, orthodontic, postural and polysomnographical exams have been carried out. The proposed clinical exam turns out to be a good means of diagnosing between buccal breathers and nasal breathers. **The aerophonoscope reveals velar inadequacies in buccal breathers. The latter also present osseous discrepancies mainly in the mandible. The polysomnography reveals a higher apnea/hypopnea index and more agitated sleep in buccal breathers. Mandibular lowering movements are more frequent and similar to those of adults suffering from apnea. These elements similar to those encountered in adults suffering from apnea make us think that buccal breathing could be the origin of obstructive sleep apnea, several decades later.**

Int J Pediatr Otorhinolaryngol. 2010 Sep;74(9):1021-7. Epub 2010 Jun 20.

Cranio cervical posture and hyoid bone position in children with mild and moderate asthma and mouth breathing.

Chaves TC, de Andrade e Silva TS, Monteiro SA, Watanabe PC, Oliveira AS, Grossi DB.

INTRODUCTION:

The objective of the present study was to assess the cranio cervical posture and the positioning of the hyoid bone in children with asthma who are mouth breathers compared to non-asthma controls.

METHODS:

The study was conducted on 56 children, 28 of them with mild (n=15) and moderate (n=13) asthma (14 girls aged 10.79+/-1.31 years and 14 boys aged 9.79+/-1.12 years), matched for sex, height, weight and age with 28 non-asthma children who are not mouth breathers. The sample size was calculated considering a confidence interval of 95% and a prevalence of 4% of asthma in Latin America. Eighteen variables were analyzed in two radiographs (latero-lateral telerradiography and lateral cervical spine radiography), both obtained with the head in a natural position. The independent t-test was used to compare means values and the chi-square test to compare percentage values (p<0.05). Intraclass correlation coefficient (ICC) was used to verify reliability.

RESULTS:

The Craniovertebral Angle (CVA) was found to be significantly smaller in asthma than in control children (106.38+/-7.66 vs. 111.21+/-7.40, p=0.02) and the frequency of asthma children with an absent or inverted hyoid triangle was found to be significantly higher compared to non-asthma children (36% vs. 7%, p=0.0001). The values of the inclination angles of the superior cervical spine in relation to the horizontal plane were significantly higher in moderate than in mild asthma children (CVT/Hor: 85.10+/-7.25 vs. 90.92+/-6.69, p=0.04 and C1/Hor: 80.93+/-5.56 vs. 85.00+/-4.20, p=0.04).

CONCLUSIONS:

These findings revealed that asthma children presented higher head extension and a higher frequency of changes in hyoid bone position compared to non-asthma children and that greater the asthma severity greater the extension of the upper cervical spine.

Hyoid bone and atlas vertebra in established mouth breathers: a cephalometric study.

Kumar R, Sidhu SS, Kharbanda OP, Tandon DA.

The position of hyoid bone and atlas vertebra in 29 established mouth breathers (17 boys and 12 girls) in the age group of 10-14 years were cephalometrically evaluated and compared with 23 nose breathers (11 boys and 12 girls). The children of both the groups were selected on the basis of history and clinical examination. The comparisons were made using univariate analysis for male and female groups separately as well as combined. **It was observed that mouth breathers do maintain an extended head posture, which was evident from a decrease in distance between the occiput and dorsal arch of atlas vertebra.** However the results of the present study did not reveal any distinct characteristics of hyoid bone and atlas vertebra that can be used to predict or associate the craniofacial pattern of mouth breathers.

J Clin Sleep Med. 2009 Dec 15;5(6):554-61.

Polysomnographic findings are associated with cephalometric measurements in mouth-breathing children.

Juliano ML, Machado MA, de Carvalho LB, Zancanella E, Santos GM, do Prado LB, do Prado GF.

OBJECTIVES:

Children with adenotonsillar hypertrophy and those with an abnormal craniofacial morphology are predisposed to having sleep disordered breathing; many of these children are mouth breathers. The aim of this study was to determine whether an association exists between polysomnographic findings and cephalometric measures in mouth-breathing children.

METHODS:

Twenty-seven children (15 mouth-breathing children and 12 nose-breathing children [control subjects]), aged 7 to 14 years, took part in the study. Polysomnographic variables included sleep efficiency, sleep latency, apnea-hypopnea index, oxygen saturation, arousal index, number of periodic limb movements in sleep, and snoring. Cephalometric measures included maxilla and mandible position, occlusal and mandibular plane inclination, incisor position, pharyngeal airway space width, and hyoid bone position.

RESULTS:

As compared with nose-breathing children, mouth breathers were more likely to snore ($p < 0.001$) and to have an apnea-hypopnea index greater than 1 ($p = 0.02$). Mouth-breathing children were also more likely to have a retruded mandible, more inclined occlusal and mandibular planes, a smaller airway space, and a smaller superior pharyngeal airway space ($p < 0.01$). The apnea-hypopnea index increased as the posterior airway space decreased ($p = 0.05$).

CONCLUSIONS:

Our study showed an association between polysomnographic data and cephalometric measures in mouth-breathing children. Snoring was the most important variable associated with abnormal craniofacial morphology. Orthodontists should send any mouth-breathing child for an evaluation of sleep if they find that the child has a small superior pharyngeal airway space or an increased ANB (the relationship between the maxilla and mandible), NS.PIO (occlusal plane inclination in relationship to the skull base), or NS.GoGn (the mandibular plane inclination in relation to the skull base), indicating that the child has a steeper mandibular plane.

J Pediatr (Rio J). 2010 May-Jun;86(3):202-8. Epub 2010 May 6.

The impact of speech therapy on asthma and allergic rhinitis control in mouth breathing children and adolescents.

Campanha SM, Fontes MJ, Camargos PA, Freire LM.

OBJECTIVE:

To determine the impact of speech therapy on asthma and allergic rhinitis control in mouth breathing children and adolescents.

METHODS:

This was a quasi-experimental randomized study of 24 mouth breathing patients with asthma and allergic rhinitis, aged from 6 to 15 years. All patients were taking beclomethasone dipropionate through oral inhalation at the start of the study. **At enrollment on the study, oral inhalation was substituted with exclusively nasal inhalation** and 1 month later half of the patients began speech therapy. They attended 16 speech therapy sessions in 8 weeks and continued taking beclomethasone dipropionate through **exclusively nasal inhalation (BDT group)**. The comparison group received only beclomethasone dipropionate through exclusively nasal inhalation (BDI group). Both groups were assessed five times. Clinical scores were calculated for allergic rhinitis and asthma, an adapted version of the Marchesan orofacial myofunctional assessment protocol was applied, and parents/guardians' observations were recorded, in addition to spirometry measurements of peak inspiratory and peak expiratory flow.

RESULTS:

There were significant improvements in the BDT group: clinical asthma score at T5 ($p = 0.046$); peak inspiratory flow at T4 ($p = 0.030$); peak expiratory flow at T3 ($p = 0.008$); breathing mode and lip position ($p = 0.000$) from T3 onwards; and parents/guardians' observations at T2, T4, and T5 ($p = 0.010$; $p = 0.027$; $p = 0.030$).

CONCLUSIONS:

Speech therapy in combination with beclomethasone dipropionate through exclusively nasal inhalation resulted in earlier and longer-lasting clinical and functional control of asthma, allergic rhinitis, and mouth breathing than was achieved in the group that only took beclomethasone dipropionate.

Clinics (Sao Paulo). 2011;66(6):939-42.

Association between halitosis and mouth breathing in children.

Motta LJ, Bachiega JC, Guedes CC, Laranja LT, Bussadori SK.

OBJECTIVE:

To determine whether there is a correlation between halitosis and mouth breathing in children.

STUDY DESIGN:

Fifty-five children between 3 and 14 years of age were divided into two groups (nasal and mouth breathing) for the assessment of halitosis. A descriptive analysis was conducted on the degree of halitosis in each group. The chi-square test was used for comparison between groups, with a 5% level of significance.

RESULTS:

There was a significantly greater number of boys with the mouth-breathing pattern than girls. A total of 23.6% of the participants had no mouth odor, 12.7% had mild odor, 12.7% had moderate odor and 50.9% had strong odor. There was a statistically significant association between halitosis and mouth breathing.

CONCLUSIONS:

The occurrence of halitosis was high among the children evaluated, and **there was a statistically significant association between halitosis and mouth breathing.**

Braz J Otorhinolaryngol. 2006 May-Jun;72(3):394-9.

Prevalence and factors related to mouth breathing in school children at the Santo Amaro project-Recife, 2005.

De Menezes VA, Leal RB, Pessoa RS, Pontes RM.

AIM:

To determine the prevalence of mouth breathing children at the Santo Amaro project/ esef/ upe, and study their main facial and behavior alterations.

STUDY DESIGN:

transversal study.

MATERIAL AND METHODS:

there were 150 children in the sample, with ages ranging from 8 to 10 years. Data was collected by means of a questionnaire and clinical examinations. As for their breathing assessment, two tests were carried out: test 1 - breath steam against a mirror; and test 2 - water remains in the mouth with lips closed for 3 minutes.

RESULTS:

mouth breathing prevalence was of 53.3%. There was no significant difference between gender, age and type of breathing. Facial alterations were: incomplete lip closure (58.8%X5,7%), fallen eyes (40.0%X1.4%), High palate (38.8%X2.9%), Anterior open bite (60.0% Versus 30.0%), Hypotonic lips (3.8%X0.0%), Circles under the eyes (97.5% Versus 77.1%).

CONCLUSION:

high mouth breathing prevalence without significant statistical difference between genders, age and type of mouth breathing. There was no association between behavior characteristics and type of breathing. **There were significant differences between physical traits and breathing pattern.**

Otolaryngol Head Neck Surg. 1981 Sep-Oct;89(5):804-10.

Sleep and breathing disturbance secondary to nasal obstruction.

Olsen KD, Kern EB, Westbrook PR.

The purpose of this study was to determine the effect of acute nasal obstruction on sleep and breathing in eight normal persons. The subjects were randomized into two groups. **One night the subject was studied with the nose open and a second night with the nose obstructed.** The electroencephalogram, electrocardiogram, inspiratory effort, nasal and oral airflow, and oxygen saturation were monitored. Sleep proved to be both subjectively and objectively disturbed. **The subjects with the nose obstructed awoke more often, had a greater number of changes in sleep stage, had a prolongation of rapid-eye-movement (REM) latency, and spent a greater amount of time in stage I non-REM sleep (light sleep).** Acute nasal obstruction caused a statistically significant increase in the number of partial and total obstructive respiratory events (obstructive hypopnea and obstructive apnea). **Sleep apnea developed in one subject during this study merely on the basis of acute nasal obstruction.**

Am Rev Respir Dis. 1981 Aug;124(2):158-60.

Disturbed sleep and prolonged apnea during nasal obstruction in normal men.

Zwillich CW, Pickett C, Hanson FN, Weil JV.

Anecdotal observations suggested that poor quality of sleep is a frequent complaint during upper respiratory infections (URI). Nasal obstruction occurs frequently during URI and causes sleep apnea in some infants. Sleep apnea disrupts normal sleep and could explain the complaints of poor sleep quality during URI in adults. Accordingly, 10 normal men had full night recordings of sleep stages and breathing rhythm before and during nasal obstruction. The order of obstructed and nonobstructed nights was randomized after a standard acclimatization night. During nasal obstruction, time spent in the deep sleep stages decreased from 90 +/- 11.2 (SEM) to 71 +/- 12.9 min (p less than 0.05), whereas significantly more time was spent in Stage 1 sleep (p less than 0.03). This loss of deep sleep during obstruction was associated with a twofold increase in sleep arousals and awakening (p less than 0.01) resulting from an increased (p less than 0.02) number of apneas (34 +/- 19 during control sleep versus 86 +/- 34 during obstructed sleep). Apneas of 20 to 39 s in duration became 2.5 times more frequent (p less than 0.05) during obstruction. Oxygen saturation was studied in the last 4 subjects using an ear oximeter. Desaturation (SaO₂ less than 90%) occurred 27 times during control sleep

compared with 255 times during obstructed sleep. These desaturation episodes occurred only during apneas. **All men complained of poor sleep quality during nasal obstruction. We concluded that apneas, sleep arousals and awakenings, and loss of deep sleep occur during nasal obstruction and may explain complaints of poor sleep quality during URI.**

J Pediatr (Rio J). 2011 Jul-Aug;87(4):357-63. Epub 2011 Jul 18.

Assessment of the body posture of mouth-breathing children and adolescents.

Conti PB, Sakano E, Ribeiro MA, Schivinski CI, Ribeiro JD.

OBJECTIVE:

To investigate associations between mouth breathing (MBr), nose breathing (NBr) and body posture classification and clinical variables in children and adolescents, by comparing patients with mouth breathing syndrome with a control group of similar age.

METHODS:

This was an observational, analytical, controlled, cross-sectional study conducted at a university hospital. Children aged 5 years or more were recruited to one of two groups: healthy controls (NBr) or an MBr group. The MBr group comprised patients with a diagnosis of mouth breathing syndrome confirmed by clinical examination by a physician plus nasal endoscopy. The control group comprised healthy volunteers of the same age, with NBr confirmed by medical examination. All participants underwent postural assessment. Data were analyzed using the Mann-Whitney nonparametric test, the chi-square test and Fisher's exact test, to a significance level of 0.05%.

RESULTS:

A total of 306 MBr and 124 NBr were enrolled. **Mouth breathers were more likely to be male ($p = 0.0002$), have more frequent and more severe nasal obstruction and larger tonsils ($p = 0.0001$) than NBr. Mouth breathers also exhibited higher incidence rates of allergic rhinitis ($p = 0.0001$), of thoracic respiratory pattern ($p = 0.0001$), high-arched palate ($p = 0.0001$) and unfavorable postural classifications ($p = 0.0001$) with relation to the control group. Postural classification scores were directly proportional to nasal obstruction ($p = 0.0001$) and male sex ($p = 0.0008$).**

CONCLUSIONS:

Postural problems were significantly more common among children in the group with mouth breathing syndrome, highlighting the need for early interdisciplinary treatment of this syndrome.

J Pediatr (Rio J). 2008 Nov-Dec;84(6):529-35.

Etiology, clinical manifestations and concurrent findings in mouth-breathing children.

[Article in English, Portuguese]

Abreu RR, Rocha RL, Lamounier JA, Guerra AF.

OBJECTIVE:

To investigate the etiology, main clinical manifestations and other concurrent findings in mouth-breathing children aged 3 to 9 years and resident in the urban area of Abaeté (MG), Brazil.

METHODS:

This study was based on a representative random sample of the town population, of 23,596 inhabitants. Clinical diagnosis of mouth-breathing was defined as a combination of snoring, sleeping with mouth open, drooling on the pillow and frequent or intermittent nasal obstruction. Children with a clinical diagnosis of mouth-breathing underwent nasal endoscopy, allergy skin tests and X ray of the rhinopharynx, full blood tests, eosinophil counts, total IgE assay and fecal parasitology. Data were analyzed using SPSS version 10.5.

RESULTS:

The main causes of mouth-breathing were: allergic rhinitis (81.4%), enlarged adenoids (79.2%), enlarged tonsils (12.6%), and obstructive deviation of the nasal septum (1.0%). The main clinical manifestations of mouth breathers were: sleeping with mouth open (86%), snoring (79%), itchy nose (77%), drooling on the pillow (62%), nocturnal sleep problems or agitated sleep (62%), nasal obstruction (49%), and irritability during the day (43%).

CONCLUSION:

Certain clinical manifestations are very common among mouth-breathing children. These manifestations must be recognized and considered in the clinical diagnosis of mouth-breathing.

Laryngoscope. 2010 Oct;120(10):2089-93.

The effect of mouth breathing versus nasal breathing on dentofacial and craniofacial development in orthodontic patients.

Harari D, Redlich M, Miri S, Hamud T, Gross M.

OBJECTIVES/HYPOTHESIS:

To determine the effect of mouth breathing during childhood on craniofacial and dentofacial development compared to nasal breathing in malocclusion patients treated in the orthodontic clinic.

STUDY DESIGN:

Retrospective study in a tertiary medical center.

METHODS:

Clinical variables and cephalometric parameters of 116 pediatric patients who had undergone orthodontic treatment were reviewed. The study group included 55 pediatric patients who suffered from symptoms and signs of nasal obstruction, and the control group included 61 patients who were normal nasal breathers.

RESULTS:

Mouth breathers demonstrated considerable backward and downward rotation of the mandible, increased overjet, increase in the mandible plane angle, a higher palatal plane, and narrowing of both upper and lower arches at the level of canines and

first molars compared to the nasal breathers group. The prevalence of a posterior cross bite was significantly more frequent in the mouth breathers group (49%) than nose breathers (26%), ($P = .006$). Abnormal lip-to-tongue anterior oral seal was significantly more frequent in the mouth breathers group (56%) than in the nose breathers group (30%) ($P = .05$).

CONCLUSIONS:

Naso-respiratory obstruction with mouth breathing during critical growth periods in children has a higher tendency for clockwise rotation of the growing mandible, with a disproportionate increase in anterior lower vertical face height and decreased posterior facial height.

Arq Neuropsiquiatr. 2009 Sep;67(3B):860-5.

Mouth breathing children have cephalometric patterns similar to those of adult patients with obstructive sleep apnea syndrome.

Juliano ML, Machado MA, Carvalho LB, Prado LB, do Prado GF.

OBJECTIVE:

To determine whether mouth breathing children present the same cephalometric patterns as patients with obstructive sleep apnea syndrome (OSAS).

METHOD:

Cephalometric variables were traced and measured on vertical lateral cephalometric radiographs. The cephalometric measurements of 52 mouth and 90 nose breathing children were compared with apneic patients. The children had not undergone adenoidectomy or tonsillectomy and had not had or were not receiving orthodontic or orthopedic treatment.

RESULTS:

Mouth breathing children showed same cephalometric pattern observed in patients with OSAS: a tendency to have a retruded mandible ($p=0.05$), along with greater inclination of the mandibular and occlusal planes ($p<0.01$) and a tendency to have greater inclination of the upper incisors ($p=0.08$). The nasopharyngeal and posterior airway spaces were greatly reduced in mouth breathing children, as observed in patients with apnea ($p<0.01$).

CONCLUSION:

Mouth breathing children present abnormal cephalometric parameters and their craniofacial morphology resembles that of patients with OSAS.

Epilepsy Behav. 2008 Aug;13(2):284-9. Epub 2008 May 27.

Mouth breathing increases the pentylenetetrazole-induced seizure threshold in mice: a role for ATP-sensitive potassium channels.

Niaki SE, Shafaroodi H, Ghasemi M, Shakiba B, Fakhimi A, Dehpour AR.

Nasal obstruction and consequent mouth breathing have been shown to change the acid-base balance, producing respiratory acidosis. Additionally, there exists a large body of evidence maintaining that acidosis affects the activity of ATP-sensitive potassium (K(ATP)) channels, which play a crucial role in the function of the central nervous system (CNS), for example, in modulating seizure threshold. Thus, in the study described here, we examined whether mouth breathing, induced by surgical ligation of nostrils, could affect the seizure threshold induced by pentylenetetrazole in male NMRI mice. Using the selective K(ATP) channel opener (diazoxide) and blocker (glibenclamide), we also evaluated the possible role of K(ATP) channels in this process. Our data revealed that seizure threshold was increased 6 to 72 hours after nasal obstruction, reaching a peak 48 hours afterward, compared with either control or sham-operated mice ($P<0.01$). There was a significant decrease in pH of arterial blood samples and increase in CO₂ partial pressure (PCO₂) during this time. Systemic injection of glibenclamide (1 and 2mg/kg, ip, daily) significantly prevented the increase in seizure threshold in 48-hour bilaterally nasally obstructed mice, whereas it had no effect on seizure threshold in sham-operated mice. Systemic injection of diazoxide (25mg/kg, ip, daily) had no effect on seizure threshold in all groups, whereas higher doses (50 and 100mg/kg, ip, daily) significantly increased seizure threshold in both 48-hour-obstructed and sham-operated mice. The decrease in seizure threshold induced by glibenclamide (2mg/kg, ip, daily) was prevented by diazoxide (25mg/kg, ip, daily). These results demonstrate for the first time that mouth breathing, which could result in respiratory acidosis, increases seizure threshold in mice and K(ATP) channels may play a role in this effect.

Respirology. 2008 Jun;13(4):553-8.

Enforced mouth breathing decreases lung function in mild asthmatics.

Hallani M, Wheatley JR, Amis TC.

BACKGROUND AND OBJECTIVE:

Nasal breathing provides a protective influence against exercise-induced asthma. We hypothesized that enforced oral breathing in resting mild asthmatic subjects may lead to a reduction in lung function.

METHODS:

Asymptomatic resting mild asthmatic volunteers ($n = 8$) were instructed to breathe either nasally only (N; tape over lips) or orally only (O; nose clip) for 1 h each, on separate days. Lung function (% predicted FEV₁) was measured using standard spirometry at baseline and every 10 min for 1 h. 'Difficulty in breathing' was rated using a Borg scale at the conclusion of the N and O periods.

RESULTS:

Baseline FEV₁ on the N (101.2 +/- 3.8% predicted) and O (102.7 +/- 3.9% predicted) days was not significantly different ($P > 0.3$). At 60 min, FEV₁ on the O day (96.5 +/- 4.1% predicted) was significantly less than on the N day (101.0 +/- 3.5% predicted; $P < 0.009$).

On the N day, FEV(1) did not change with time ($P > 0.3$), whereas on the O day, FEV(1) fell progressively (slope = $-0.06 \pm 0.01\%$ FEV(1)/min, $P < 0.0001$; linear mixed effects modelling). Three subjects experienced coughing/wheezing at the end of the O day but none experienced symptoms at the end of the N day. Subjects perceived more 'difficulty breathing in' at the end of the O day (1.5 ± 0.4 arbitrary units) than on the N day (0.4 ± 0.3 arbitrary unit; $P < 0.05$). **CONCLUSIONS: Enforced oral breathing causes a decrease in lung function in mild asthmatic subjects at rest, initiating asthma symptoms in some. Oral breathing may play a role in the pathogenesis of acute asthma exacerbations.**

Chest. 1999 Dec;116(6):1646-52.

Route of breathing in patients with asthma.

Kairaitis K, Garlick SR, Wheatley JR, Amis TC.

STUDY OBJECTIVES:

To measure route of breathing in chronic asthmatic patients during and after an acute severe exacerbation.

PATIENTS OR PARTICIPANTS:

Thirteen asthmatic patients were studied during hospital admission for acute asthma and, in 9 patients, again when asymptomatic. Nine healthy subjects were also studied.

INTERVENTIONS:

Spontaneous route of breathing was qualitatively assessed using oral and nasal thermistor probes, and was then quantified using a dual compartment face mask with attached pneumotachographs.

MEASUREMENTS AND RESULTS:

All asthmatic patients had severe bronchoconstriction initially (FEV(1), $46 \pm 3\%$ of predicted) that had resolved at follow-up (FEV(1), $91 \pm 6\%$ of predicted). No healthy subject had evidence of bronchoconstriction (FEV(1), $102 \pm 5\%$ of predicted). During acute asthma, 11 asthmatics were spontaneously breathing oronasally, as assessed using thermistor probes, while all 13 breathed oronasally via face mask. When assessed using thermistor probes, seven of nine asymptomatic asthmatic patients studied were breathing exclusively via the nose; however, all breathed oronasally via face mask. In contrast, while eight of nine healthy subjects were also breathing exclusively via the nose when assessed using thermistor probes, all breathed nasally only via face mask.

CONCLUSIONS:

Thus, when asymptomatic and at rest, asthmatic patients breathe exclusively via the nose. However, during acute exacerbations of asthma, these patients switch to oronasal breathing. Unlike healthy subjects, chronic asthmatic patients also switch to oronasal breathing when wearing a face mask, irrespective of the degree of bronchoconstriction. We speculate that asthmatics may have an increased tendency to switch to oral breathing, a factor that may contribute to the pathogenesis of their asthma.

Int J Pediatr Otorhinolaryngol. 2009 Feb;73(2):227-36. Epub 2008 Dec 3.

Orientation and position of head posture, scapula and thoracic spine in mouth-breathing children.

Neiva PD, Kirkwood RN, Godinho R.

OBJECTIVE:

Mouth-breathing is a common clinical condition among school-age children and some studies have correlated this condition with quality of life and postural alterations. Therefore, the objective of this study was to investigate the orientation and position of the scapula, thoracic spine and head posture among mouth-breathing (MB) children and nasal-breathing (NB) children.

METHODS:

Twenty-one male MB children and 21 male NB children between 8 and 12 years of age participated in the study. Data were obtained through a stereophotogrammetry system that uses passive markers over anatomical landmarks to capture the position of the segments. Internal rotation, upward rotation, anterior tilt, scapular elevation and abduction were measured bilaterally as well as thoracic kyphosis, forward head position and shoulder protrusion.

RESULTS:

The MB children showed increased scapular superior position in relation to the NB group.No statistically significant differences were found between groups regarding the angular and linear measurements of the scapula. To verify reliability, three measurements were taken for each variable in the study. The intraclass correlation coefficient (ICC) showed results above 0.8 for all the variables except for the internal rotation angle (I-Rot), below 0.5, probably due to uncertainty in the palpation of the inferior angle of the scapula. **Ninety-five percent of the NB children and 58% among the MB children had been breastfed, this difference was statistically significant.** There were statistically significant differences between groups regarding the domains of the Autoquestionnaire Qualité de Vie Enfant Imagé (AUQEI) scale and body mass index, which was higher among the NB children.

CONCLUSIONS:

MB children increased scapular superior position in comparison to NB children due probably to the position of forward head, leading to an alteration in the positioning of the mandible. The absence of significant difference in posture pattern between groups in the present study could be attributed to height-weight development in this age, as the posture of children changes in order to adapt to new body proportions, regardless of health status. The results observed in this study demonstrate the importance of using reliable measurements in the postural assessment of MB and NB children helping physical therapists to focus their strategies during rehabilitation in more specific conditions.

J Pediatr (Rio J). 2008 Mar-Apr;84(2):171-7.

The relationship between excursion of the diaphragm and curvatures of the spinal column in mouth breathing children.

Yi LC, Jardim JR, Inoue DP, Pignatari SS.

OBJECTIVE:

To investigate the relationship between excursion of the diaphragm muscle and spinal curvatures in mouth breathing children.

METHODS:

A total of 52 children of both sexes, aged from 5 to 12 years, were studied. After otorhinolaryngological assessment, the children were divided into two groups: mouth breathers and nose breathers. All of the children underwent videofluoroscopic examination of the diaphragm muscle and postural assessment. Diaphragm excursion was analyzed using Adobe Photoshop software, and postural assessment was recorded using photographs in left lateral view, which were then analyzed using SAPO postural assessment software.

RESULTS:

The groups studied exhibited statistically significant differences in terms of spinal curvatures (cervical lordosis: $p = 0.003$; lumbar lordosis: $p = 0.001$; thoracic kyphosis: $p = 0.002$; position of the pelvis: $p = 0.001$) and diaphragm excursion (right side diaphragm: $p = 0.001$; left side diaphragm: $p = 0.001$). **The mouth breathing group exhibited reduced cervical lordosis, increased thoracic kyphosis, increased lumbar lordosis and the position of the pelvis was tilted forward. The distance traveled outwards by the diaphragm muscles of mouth breathing children was shorter than that traveled by the muscles of nose breathing children.** The relationship between the behavior of spinal curvatures and diaphragm excursion had no statistical significance.

CONCLUSION:

There was no relationship between spinal curvatures and diaphragm excursion in the groups studied here.

Pro Fono. 2007 Oct-Dec;19(4):347-51.

[Characteristics of the stomatognathic system of mouth breathing children: anthroposcopic approach].

[Article in Portuguese]

Cattoni DM, Fernandes FD, Di Francesco RC, Latorre Mdo R.

BACKGROUND:

the use of anthroposcopy in the assessment of posture and morphology of the stomatognathic system of mouth breathing children.

AIM:

to describe the postural and morphologic characteristics of the stomatognathic system of mouth breathing children, according to age.

METHOD:

participants were 100 children, of both genders, with ages ranging from 7 to 11 years and 11 months, leukoderms, in mixed dentition and with the diagnosis of mouth breathing. The investigated postural and morphologic characteristics of the stomatognathic system were labial and lingual resting position, possibility of labial occlusion, hyperfunction of the mentalis muscle during labial occlusion, bite and morphology of the lower lip, cheeks and hard palate, using the anthroposcopy methodology.

RESULTS:

the results referring to the characterization of the studied population, according to the most frequent otorhinolaryngologic diagnosis, was of enlarged pharyngeal and palatine tonsils. A statistically significant difference was found between the percentages of each otorhinolaryngologic diagnosis, according to age. **The results of the characteristics of the stomatognathic system indicated that the most common aspects in the studied sample were: half-open lips when in the resting position, tongue lowered on the mouth's floor in the resting position, possibility of labial occlusion, hyperfunction of the mentalis muscle during labial occlusion, alterations of bite, labioverted, symmetry of the cheeks and alteration of the hard palate.** All of the studied characteristics presented the same frequency with the increase in age, with no statistically significant difference.

CONCLUSION:

mouth breathing children presented pathologic adaptations in the postural and morphological characteristics of the stomatognathic system. This suggests the importance of early diagnosis in order to avoid orofacial alterations.

Aust J Sci Med Sport. 1995 Sep;27(3):51-5.

Comparison of maximal oxygen consumption with oral and nasal breathing.

Morton AR, King K, Papalia S, Goodman C, Turley KR, Wilmore JH.

The major cause of exercise-induced asthma (EIA) is thought to be the drying and cooling of the airways during the 'conditioning' of the inspired air. Nasal breathing increases the respiratory system's ability to warm and humidity the inspired air compared to oral breathing and reduces the drying and cooling effects of the increased ventilation during exercise. This will reduce the severity of EIA provoked by a given intensity and duration of exercise. The purpose of the study was to determine the exercise intensity (%VO₂ max) at which healthy subjects, free from respiratory disease, could perform while breathing through the nose-only and to compare this with mouth-only and mouth plus nose breathing. Twenty subjects (11 males and 9 females) ranging from 18-55 years acted as subjects in this study. They were all non-smokers and non-asthmatic. At the time of the study, all subjects were involved in regular physical activity and were classified, by a physician, as free from nasal polyps or other nasal obstruction. **The percentage decrease in maximal ventilation with nose-only breathing compare to mouth and mouth plus nose breathing was three times the percentage decrease in maximal oxygen consumption. The pattern of nose-only breathing at maximal work showed a small reduction in tidal volume and large reduction in breathing frequency. Nasal breathing resulted in a reduction in FE_{O2} and an increase in FE_{CO2}. While breathing through the nose-only, all subjects could attain a work intensity great enough to produce an aerobic training effect (based on heart rate and percentage of VO₂ max).**

