Nasal Breathing
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- The physiologic breathing mode in the human being is nasal, regardless of age.
- Any factor leading to the upper airway (UA) obstruction causes nasal breathing to be replaced by mouth breathing, among which mechanical events, allergic and nonallergic inflammatory diseases, congenital malformation and tumoral lesions.
To identify the prevalence of mouth breathing in children at primary school ages from 6-9 years, researchers in Portugal examined 496 answered questionnaires from parents. It was found that 56.8% of children in this study breathed through their mouth.

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- Randomized sample of the town's population (23,596 inhabitants).
- Children were selected by lots according to a random number table until 370 had been enrolled; this number had been determined by statistical calculation.
- 370 children enrolled. Clinical assessment carried out
- 55% of the children involved in the study were found to be mouth breathers

150 children in the sample, with ages ranging from 8 to 10 years.

two tests were carried out:

• test 1 - breathe steam against a mirror

• test 2 - water remains in the mouth with lips closed for 3 minutes.

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% X 5.7%), fallen eyes (40.0% X 1.4%), High palate (38.8% X 2.9%), Anterior open bite (60.0% Versus 30.0%), Hypotonic lips (3.8% X 0.0%), Circles under the eyes (97.5% Versus 77.1%).

- Valdenice Aparecida De Menezes\textsuperscript{a}, Rossana Barbosa Leal\textsuperscript{b}, Rebecca Souza Pessoa\textsuperscript{c}, Ruty Mara E. Silva Pontes\textsuperscript{d}. Prevalence and factors related to mouth breathing in school children at the Santo Amaro project-Recife, 2005 \textit{Brazilian Journal of Otorhinolaryngology}. \textit{Volume 72, Issue 3}, May–June 2006, Pages 394–398
Oral deleterious habits are often called harmful or parafunctional and include thumb sucking, bottle feeding, tongue thrusting, nail biting, lip biting and the mouth-breathing pattern. These habits have direct influence on quality of life and can affect the stomatognathic system of the body.

51% of the children are involved in one or more than one oral harmful habits and the finding are in agreement with the results of Gildasya et al in children aged 6-12 years. Where as Motta LJ et al found preschoolers with 87.4% habits. Lower prevalence had been reported by Quashie-Williams as 34.1% in school going children, Shetty et al, (1998) and Kharbanda et al (2003) observed prevalence as 29.7% & 25.5% respectively in south and north Indian children.

Bhayya DP et al found tongue thrusting and mouth breathing as the most prevalent oral habits.

A questionnaire was given to parents/guardians at 13 nurseries in Tokushima City. There were 468 valid responses (45.2%). We defined a subject as a mouth breather in daytime (MBD) if they had 2 or more positive items among the 3 following items: “breathes with mouth ordinarily,” “mouth is open ordinarily,” and “mouth is open when chewing.”

We defined subjects as mouth breathers during sleep (MBS) if they had 2 or more positive items among the following 3 items: “snoring,” “mouth is open during sleeping,” and “mouth is dry when your child gets up.”

The prevalence's of MB Day and MB Sleep were 35.5% and 45.9%, respectively. There were significant associations between MBD and atopic dermatitis.

Functions of the nose
Dr. Maurice Cottle, who founded the American Rhinologic Society in 1954, your nose performs at least 30 functions, all of which are important supplements to the roles played by the lungs, heart, and other organs.

Timmons B.H., Ley R. Behavioral and Psychological Approaches to Breathing Disorders. 1st ed. Springer; 1994
Mouth breathing has been studied since the beginning of the twentieth century, with scientific publications directed to the scope of dentistry emphasizing the occlusal consequences.

To evaluate diaphragmatic amplitude (DA) in nasal and mouth-breathing adults. The study evaluated 38 mouth-breathing (MB group) and 38 nasal-breathing (NB group) adults, from 18 to 30 years old and both sexes.

Diaphragmatic amplitude and accessory inspiratory muscle activity in nasal and mouth breathing adults: a cross-sectional study. 2015; Journal of electromyography and kinesiology 25. 463-468,
Mouth breathing reflected on lower recruitment of the accessory inspiratory muscles during fast inspiration and lower diaphragmatic amplitude, compared to nasal breathing.

Diaphragmatic amplitude and accessory inspiratory muscle activity in nasal and mouth breathing adults: a cross-sectional study. 2015; Journal of electromyography and kinesiology 25. 463-468,
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• Pharyngeal airway dimensions are higher in nasal-breathers than mouth-breathers

Three-dimensional assessment of pharyngeal airway in nasal- and mouth-breathing children
Alves, M, et.al., Int J Ped ORL 75 (2011) 1195–1199

Mouthbreathers have significantly smaller airway space.
(measurements PAS-OcCL, PAS-UP, airway volume, area and minimum axial area)
Mouth breathers show cognitive impairment as well as attention deficit hyperactive disorder (memory, concentration, attention, learning disability, low perception and sensorimotor integration). It has been shown that children with excessive daytime sleepiness appear to have almost 10 times the risk of learning difficulties.

Sao Paulo Med J. 2014 Sep 26;
• Oral breathing modifies head position. The significant increase of the craniocervical angles in patients with this altered breathing pattern suggests an elevation of the head and a greater extension of the head compared with the cervical spine.

• Breathing pattern and head posture: changes in craniocervical angles. Minerva Stomatol. 2015 Apr; 64(2):59-74.
Respiratory biomechanics and exercise capacity were negatively affected by Mouth Breathing.

The presence of moderate forward head position acted as a compensatory mechanism in order to improve respiratory muscle function.

Nasal Resistance & Breath Holding
Recent studies have suggested that the inhalation of cold air through the nose is associated with the subsequent release of mediators of immediate hypersensitivity.

To determine if mucosal surface heat and water loss influence the nasal functional response to cold air, we measured nasal resistance by posterior rhinomanometry.

During the challenge period, the subjects breathed either in and out of the nose or in through the nose and out through the mouth.

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- No changes in nasal resistance developed when subjects breathed exclusively through the nose;

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• However, when subjects breathed in through the nose and out through the mouth, nasal resistance was increased 200% at 1 min (P less than 0.01) after the challenge and returned to baseline values by 10 min after cessation of the challenge.

To compare the difference in respiratory water loss during expiration through the nose and through the mouth, in healthy subjects.

The study included 19 healthy, non-smoking volunteers without any present history of non-infectious rhinitis, presenting with symptoms of rhinitis, asthma or previous nasal surgery.

This study showed that the net water loss increased by 42% when the breathing mode was switched from nasal to oral expiration during tidal breathing in healthy subjects. Increased water and energy loss by oral breathing could be a contributing factor to the symptoms seen in patients suffering from nasal obstruction.

• The response of nasal airway resistance (Rn) to various degrees of hypoxia and hypercapnia was measured in six subjects using active posterior mask rhinomanometry.

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- Hypercapnia, induced by breathing gas mixtures of various contents of carbon dioxide, significantly decreased Rn. The reduction in Rn was proportional to the inspired partial pressure of carbon dioxide over a range of 0 to 50 torr.

Breathing gas mixtures of high and low contents of oxygen produced no significant change in $R_n$. These results indicate that the nasal airway is actively involved in the respiratory response to hypercapnia but not to moderate hypoxia.

A group of 51 patients were studied to assess the influence of breath holding, hyperventilation and exercise on nasal resistance. It was found that holding of the breath for 30 seconds or longer helped to open up the nose to make breathing easier in most of the subjects tested. Furthermore, it was found that physical exercise also decreased nasal resistance.

Posterior mask rhinomanometry was used to measure nasal resistance during exercise and hypercapnia in 10 healthy adult volunteers. Exercise was produced by peddling a stationary bicycle at three loads. Hypercapnia was produced by breathing O2 mixtures containing 5%, 6%, and 8% CO2.

The results showed that nasal resistance decreases linearly as expired CO2 levels and exercise levels increase.

The constant relationship between nasal resistance and minute ventilation during hypercapnia and exercise suggests that nasal resistance is regulated by the respiratory center to match the level of respiratory demand.

Results suggested that breath holding increased the nasal volume, due to shrinkage of nasal membrane promptly and evenly within the nasal cavity.

- The effect of breath holding on nasal membrane
- shrinkage analyzed by acoustic rhinometry
Nasal airway resistance was decreased during breath holding in man and during experimentally induced asphyxia in animals.

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• When nasal breathing takes place in the presence of significant obstruction, there is an increase in FCO2, a decrease in FO2, and a decrease in nasal airway resistance. In other words, when nasal breathing is forced to push against significant obstruction, the effect of this obstruction appears to be that of decreasing the nasal resistance.

• Arch Otorhinolaryngol (1988) 245 : 112-115
Temporomandibular (TMD)
Neck accessory respiratory muscles and mouth breathing suggest a direct relationship among asthma, Temporomandibular (TMD) and Cervical Spine (CSD) Disorders. This study was performed to evaluate and correlate TMD, CSD in asthmatic and non-asthmatic.

Thirty asthmatic children (7.1 ± 2.6 years old), 30 non-asthmatic predominantly mouth breathing children (Mouth Breathing Group - MBG) (8.80 ± 1.61 years) and 30 non-asthmatic predominantly nasal breathing children (Nasal breathing Group – NBG) (9.00 ± 1.64 years) participated in this study and they were submitted to clinical index to evaluate stomatognathic and cervical systems.

• Significant frequency of palpatory tenderness of temporomandibular joint (TMJ), TMJ sounds, pain during cervical extension and rotation, palpatory tenderness of sternocleidomastoids and paravertabrae muscles and a severe reduction in cervical range of motion were observed in AG.

Both AG and MBG groups demonstrated palpatory tenderness of posterior TMJ, medial and lateral pterygoid, and trapezius muscles when compared to NBG. Results showed a positive correlation between the severity of TMD and CSD signs in asthmatic children ($r = 0.48$).

No child was considered normal to CSD and cervical mobility. The possible shortening of neck accessory muscles of respiration and mouth breathing could explain the relationship observed between TMD, CSD signs in asthmatic children and emphasize the importance of the assessment of temporomandibular and cervical spine regions in asthmatic children.

Nitric Oxide

PATRICK MCKEOWN MA
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NO concentrations of 50–200 parts per billion (ppb) are transported to the lungs with every nasal inhalation compared with 10 ppb during oral breathing.

Furthermore, autoinhalation of endogenous NO from the nasal airways has been shown to improve arterial oxygenation and reduce pulmonary vascular resistance.

Compared with oral breathing, inhalation of NO (endogenous or exogenous) caused an overall significant blood flow shift from the base of the lung toward the apex, resulting in a more homogeneous blood flow distribution along the height of the lung.

The biological significance of nasal breathing, which improved peripheral oxygenation by 5–15% in healthy volunteers compared with oral breathing

The transition to bipedalism is that it would also result in an increased susceptibility to some pulmonary infections, most notably tuberculosis. Therefore, upper airway NO could have emerged in bipedal mammals not only to improve gas exchange but also to provide some protection against infection.

Hyperventilation Syndrome
14 patients 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.

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.
Conclusion: HVS should be included in the differential diagnosis of patients presenting with nasal congestion, particularly after failed nasal surgery.

"That's all Folks"