

Selected publications about health impacts of mouth breathing and the use of oropharyngeal exercises in improving these conditions

Index

A. Health impacts of mouth breathing:

1. Prevalence of upper respiratory tract infections in mouth breathing kids Page 1
2. Mouth breathing: A risk factor for dental erosion and caries Page 2
3. Association between mouth breathing and sleep apnea Page 3
4. Mouth breathing: A risk factor for Asthma Page 4
5. Mouth breathing association with dermatitis Page 5
6. Association between mouth breathing and malocclusion Page 6
7. The influence of mouth breathing on face morphology in late childhood Page 7
8. The breathing pattern impacts tongue pressure development Page 8
9. The effect of mouth breathing on chewing efficiency Page 9
10. Reduced Tongue strength and swallowing difficulty Page 10

B. The use of oropharyngeal exercises for rehabilitation of tongue, throat and oral muscles:

1. Myofunctional Therapy for treatment of tongue thrust Page 11
2. Myofunctional therapy for mouth breathing Page 12
3. Oropharyngeal exercises for treatment of snoring and sleep apnea
 - i. *Effects of Oropharyngeal Exercises on Patients with Moderate Obstructive Sleep Apnea Syndrome* Page 13
 - ii. *Functional treatment of snoring based on the tongue-repositioning manoeuvre* Page 14
 - iii. *Effects of oropharyngeal exercises on snoring* Page 15
 - iv. *Oropharyngeal and tongue exercises (myofunctional therapy) for snoring: a systematic review and meta-analysis* Page 16
 - v. *Obstructive sleep apnea: focus on myofunctional therapy* Page 17
4. Tongue Strengthening Exercises in Dysphagia Rehabilitation
 - vi. *Effects of Strengthening Exercises on Swallowing Musculature and Function in Senior Healthy Subjects: a Prospective Effectiveness and Feasibility Study.* Page 18
 - vii. *Tongue Strength is Associated with Grip Strength and Nutritional Status in Older Adult Inpatients of a Rehabilitation Hospital.* Page 19
5. Effect of tongue position on postural stability Page 20

A. Health impacts of mouth breathing:

1. Prevalence of upper respiratory tract infections in mouth breathing kids

Kukwa, W. et al., *Int J Pediatr Otorhinolaryngol.* 2018, 107, 37-41,

DOI: [10.1016/j.ijporl.2018.01.022](https://doi.org/10.1016/j.ijporl.2018.01.022)

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Prevalence of upper respiratory tract infections in habitually snoring and mouth breathing children



Wojciech Kukwa^{a,*}, Christian Guilleminault^b, Magdalena Tomaszewska^c, Andrzej Kukwa^d, Antoni Krzeski^a, Ewa Migacz^a

^a Department of Otorhinolaryngology, Faculty of Medicine and Dentistry, Medical University of Warsaw, 19/25 Stepinska Street, 00-739 Warsaw, Poland

^b Stanford University Sleep Medicine Division, Stanford, Outpatient Medical Center, 450 Broadway, MC5704, Redwood City, 94063 CA, USA

^c Children's Memorial Health Institute, 20 Dzieci Polskich Av., 04-730 Warsaw, Poland

^d Department of Otolaryngology and Head and Neck Disease, University of Warmia and Mazuria School of Medicine, 30 Warszawska Street, 10-082 Olsztyn, Poland

ABSTRACT

Objectives: The aim of the study was to investigate the prevalence of upper respiratory tract infections (URI) – as indicated by rhinosinusitis (RS), ear infections (EI), and antibiotic consumption – in a general pediatric population and evaluate the relationship between these conditions and habitual snoring and mouth breathing during sleep. **Methods:** A population-based cross-sectional study was performed in three medium-sized Polish cities from 2011 to 2015.

Results: 4837/6963 questionnaires (69.5%) were completed, returned and analyzed. Mean age of studied group was 7.07 ± 0.72 and 7.14 ± 0.73 in girls and boys, respectively. Habitual mouth breathing during sleep (MB) was reported in 907 (18.7%) children and habitual snoring (HS) in 290 (6.0%). 230/290 (79.3%) of children with HS were also MB. Both HS and MB were more prevalent in boys than in girls ($p=0.027$ and $p < 0.0001$, respectively) and neither was associated with BMI ($p=0.11$ and $p=0.07$, respectively). Habitual snoring and habitual mouth breathing were highly associated with more frequent bouts of rhinosinusitis, ear infections, and antibiotic use ($p < 0.0001$ for each parameter).

Conclusions: Higher rates of rhinosinusitis, ear infections, and antibiotic consumption were similarly associated with HS and MB. MB is over three times more prevalent in the pediatric population relative to HS, therefore it might be considered as a risk factor for URI and may be included in history of URI.

2. Mouth breathing: A risk factor for dental erosion and caries

Choi, J. E., et al., *J Oral Rehabil*, 2016, 43(5), 356-63. DOI: [10.1111/joor.12372](https://doi.org/10.1111/joor.12372)



Intraoral pH and temperature during sleep with and without mouth breathing

J. E. CHOI, J. N. WADDELL, K. M. LYONS & J. A. KIESER *Faculty of Dentistry, Sir John Walsh Research Institute, University of Otago, Dunedin, New Zealand*

ABSTRACT

To measure and compare the intraoral pH and temperature of individuals during sleep with and without mouth breathing. Ten healthy participants [mean age = 25.8 (\pm 4.3)] wore a custom-made appliance fitted with a pH probe and thermocouple for two sets of 48 h. Continuous pH and temperature measurements were taken from the palatal aspect of the upper central incisors. To simulate mouth breathing during sleep, participants wore a nose clip for two nights of the four, with the first group (n = 5) wearing the nose clip during the first night and the rest (n = 5) wearing the nose clip during the second night of sleep to balance any potential bias from the wearing sequence. Both qualitative and quantitative analyses were conducted. The mean intraoral pH during daytime was 7.3 (\pm 0.4) and during sleep was 7.0 (\pm 0.5). The mean intraoral pH during sleep with mouth breathing was 6.6 (\pm 0.5), which was statistically significant compared with the normal sleep condition ($P < 0.01$). The intraoral pH decreased slowly over the hours of sleep in all participants. When sleeping with forced mouth breathing, intraoral pH showed a greater fall over a longer period of time. The mean intraoral temperature was 33.1 °C (\pm 5.2) during daytime and 33.3 °C (\pm 6.1) during sleep, with no statistical significance between sleep with and without mouth breathing ($P > 0.05$). The results suggest that mouth breathing during sleep is related to a decrease in intraoral pH compared with normal breathing during sleep, and this has been proposed as a causal factor for dental erosion and caries.

3. Association between mouth breathing and sleep apnea

Cioffi Izu, S. et al., *Braz J Otorhinolaryngol*, 2010; 76(5), 552-6, PMID: 20963335.

Braz J Otorhinolaryngol.
2010;76(5):552-6.

ORIGINAL ARTICLE

BJORL.org

Obstructive sleep apnea syndrome (OSAS) in mouth breathing children

Sucmy Cioffi Izu ¹, Caroline Harumi Itamoto ², Márcia Pradella-Hallinan ³, Gilberto Ulson Pizarro ⁴, Sérgio Tufik ⁵, Shirley Pignatari ⁶, Reginaldo Raimundo Fujita ⁷

ABSTRACT

It is well known that mouth breathing is associated with adenotonsillar hypertrophy - which is the main cause of obstructive sleep apnea among children. Despite the importance of this matter, there are only a handful of studies showing the relationship between OSAS and mouth breathing.

Aim: to determine the prevalence of obstructive sleep disorders in mouth breathing children and study its correlation with otorhinolaryngological findings.

Study design: Retrospective cohort study.

Method: Data analysis from 248 medical charts of mouth breathing children seen at the Pediatric Otolaryngologic Division of a large medical institution between the years of 2000 and 2006. All patients had nasofibroscopy and or Cavum radiographs and polysomnographic exams. According to the Apnea index, patients were classified as primary snorers (AI<1); and as OSAS (≥ 1).

Results: From 248 patients included in the study, 144 (58%) were primary snorers and 104 (42%) had OSAS. The most prevalent otorhinolaryngological findings were adenotonsillar hypertrophy (n=152; 61.2%), tonsillar hypertrophy (n=17; 6.8%), adenoid hypertrophy (n=37; 14.9%), rhinitis (n=155; 62.5%) and secretory otitis (n=36; 14.5%).

Conclusions: primary snoring and OSAS are frequent findings in mouth breathing children. The most frequent otorhinolaryngological disorder in children with OSAS is adenotonsillar hypertrophy with or without rhinitis.

4. Mouth breathing: A risk factor for Asthma

Izuhara, Y. et al. *Allergy* 2016; 71: 1031–1036. DOI: [10.1111/all.12885](https://doi.org/10.1111/all.12885)



Allergy

ORIGINAL ARTICLE

AIRWAY DISEASES

Mouth breathing, another risk factor for asthma: the Nagahama Study

Y. Izuhara¹, H. Matsumoto¹, T. Nagasaki¹, Y. Kanemitsu¹, K. Murase¹, I. Ito¹, T. Oguma¹, S. Muro¹, K. Asai², Y. Tabara³, K. Takahashi², K. Bessho², A. Sekine^{4,5}, S. Kosugi⁶, R. Yamada³, T. Nakayama⁷, F. Matsuda³, A. Niimi^{1,8}, K. Chin⁹ & M. Mishima¹ on behalf of the Nagahama Study Group

¹Department of Respiratory Medicine; ²Department of Oral and Maxillofacial Surgery; ³Center for Genomic Medicine; ⁴Pharmacogenomics Project, Kyoto University Graduate School of Medicine, Kyoto; ⁵Center for Preventive Medical Science, Chiba University, Chiba; ⁶Department of Medical Ethics and Medical Genetics; ⁷Department of Health Informatics, Kyoto University School of Public Health, Kyoto; ⁸Department of Respiratory Medicine Allergy and Clinical Immunology, Nagoya City University School of Medical Sciences, Aichi; ⁹Department of Respiratory Care and Sleep Control Medicine, Kyoto University Graduate School of Medicine, Kyoto, Japan

ABSTRACT

Background: Allergic rhinitis, a known risk factor for asthma onset, often accompanies mouth breathing. Mouth breathing may bypass the protective function of the nose and is anecdotally considered to increase asthma morbidity. However, there is no epidemiological evidence that mouth breathing is independently associated

with asthma morbidity and sensitization to allergens. In this study, we aimed to clarify the association between mouth breathing and asthma morbidity and allergic/eosinophilic inflammation, while considering the effect of allergic rhinitis.

Methods: This community-based cohort study, the Nagahama Study, contained a self-reporting questionnaire on mouth breathing and medical history, blood tests, and pulmonary function testing. We enrolled 9804 general citizens of Nagahama City in the Shiga Prefecture, Japan.

Results: Mouth breathing was reported by 17% of the population and was independently associated with asthma morbidity. The odds ratio for asthma morbidity was 1.85 (95% CI, 1.27–2.62) and 2.20 (95% CI, 1.72–2.80) in subjects with mouth breathing alone and allergic rhinitis alone, which additively increased to 4.09 (95% CI, 3.01–5.52) when mouth breathing and allergic rhinitis coexisted. Mouth breathing in nonasthmatics was a risk for house dust mite sensitization, higher blood eosinophil counts, and lower pulmonary function after adjusting for allergic rhinitis.

Conclusion: Mouth breathing may increase asthma morbidity, potentially through increased sensitization to inhaled allergens, which highlights the risk of mouthbypass breathing in the ‘one airway, one disease’ concept. The risk of mouth breathing should be well recognized in subjects with allergic rhinitis and in the general population.

5. Mouth breathing association with dermatitis

Yamaguchi, H. et al., *PLoS One*. 2015; 10(4), e0125916, DOI: [10.1371/journal.pone.0125916](https://doi.org/10.1371/journal.pone.0125916);



RESEARCH ARTICLE

Association between Mouth Breathing and Atopic Dermatitis in Japanese Children 2–6 years Old: A Population-Based Cross-Sectional Study

Harutaka Yamaguchi¹, Saaya Tada¹, Yoshinori Nakanishi², Shingo Kawaminami³, Teruki Shin¹, Ryo Tabata¹, Shino Yuasa², Nobuhiko Shimizu¹, Mitsuhiro Kohno¹, Atsushi Tsuchiya⁴, Kenji Tani^{1*}

1 Department of General Medicine, Institute of Health Biosciences, The University of Tokushima Graduate School, Tokushima City, Japan, **2** Tokushima Prefecture Naruto Hospital, Naruto City, Japan, **3** Outpatient Facility Kameda Clinic, Tateyama City, Japan, **4** Department of Civil and Environmental Studies, Faculty of Integrated Arts and Sciences, The University of Tokushima Graduate School, Tokushima City, Japan

* taniken@tokushima-u.ac.jp



ABSTRACT

As mouth breathing is associated with asthma and otitis media, it may be associated with other diseases. Therefore, this population-based cross-sectional study evaluated the association of mouth breathing with the prevalences of various diseases in children. Preschool children older than 2 years were included. 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 prevalences of MBD and MBS were 35.5% and 45.9%, respectively. There were significant associations between

MBD and atopic dermatitis (odds ratio [OR]: 2.4, 95% confidence interval [CI]: 1.4–4.2), MBS and atopic dermatitis (OR: 2.4, 95% CI: 1.3–4.2), and MBD and asthma (OR: 2.2, 95% CI: 1.2–4.0). After adjusting for history of asthma and allergic rhinitis; family history of atopic dermatitis, asthma, and allergic rhinitis; and nasal congestion; both MBD (OR: 2.6, 95% CI: 1.3–5.4) and MBS (OR: 4.1, 95% CI: 1.8–9.2) were significantly associated with atopic dermatitis. In preschool children older than 2 years, both MBD and MBS may be associated with the onset or development of atopic dermatitis.

6. Association between mouth breathing and malocclusion

Grippaudo, C. et al., *Acta Otorhinolaryngol Ital* 2016;36:386-394. DOI: [10.14639/0392-100X-770](https://doi.org/10.14639/0392-100X-770)

ACTA OTORHINOLARYNGOLOGICA ITALICA 2016;36:386-394; doi: 10.14639/0392-100X-770

ORAL PATHOLOGY

Association between oral habits, mouth breathing and malocclusion

Associazione fra abitudini viziate, respirazione orale e malocclusione

C. GRIPPAUDO¹, E.G. PAOLANTONIO¹, G. ANTONINI¹, R. SAULLE², G. LA TORRE², R. DELI¹

¹ Catholic University of Sacred Heart, Dental Institute; ² Department of Public Health and Infectious Diseases, Sapienza University of Rome, Italy

ABSTRACT

The ratio of bad habits, mouth breathing, and malocclusion is an important issue in view of prevention and early treatment of disorders of the craniofacial growth. While bad habits can interfere with the position of the teeth and normal pattern of skeletal growth, on the other hand obstruction of the upper airway, resulting in mouth breathing, changes the pattern of craniofacial growth causing malocclusion. Our cross-sectional study, carried out on 3017 children using the ROMA index, was developed to verify if there was a significant correlation between bad habits/mouth breathing and malocclusion. The results showed that an increase in the degree of the index increases the prevalence of bad habits and mouth breathing, meaning that these factors are associated with more severe malocclusions. Moreover, we found a significant association of bad habits with increased overjet and open-bite, while no association was found with crossbite. Additionally, we found that mouth breathing is closely related to increased overjet, reduced overjet, anterior or posterior crossbite, open-bite and displacement of contact points. Therefore, it is necessary to intervene early on these aetiological factors of malocclusion to prevent its development or worsening and, if already developed, correct it by early orthodontic treatment to promote eugenic skeletal growth.

7. The influence of mouth breathing on face morphology in late childhood

Al Ali A., et. al., *BMJ Open* 2015;5:e009027. DOI: [10.1136/bmjopen-2015-009027](https://doi.org/10.1136/bmjopen-2015-009027)

Open Access

Research

BMJ Open The influence of snoring, mouth breathing and apnoea on facial morphology in late childhood: a three-dimensional study

Ala Al Ali,¹ Stephen Richmond,¹ Hashmat Papat,¹ Rebecca Playle,¹
Timothy Pickles,¹ Alexei I Zhurov,¹ David Marshall,² Paul L Rosin,²
John Henderson,³ Karen Bonuck⁴

ABSTRACT

Objective: To explore the relationship between the prevalence of sleep disordered breathing (SDB) and face shape morphology in a large cohort of 15-year-old children.

Design: Observational longitudinal cohort study

Setting: Avon Longitudinal Study of Parents and Children (ALSPAC), South West of England.

Participants: Three-dimensional surface laser scans were taken for 4784 white British children from the ALSPAC during a follow-up clinic. A total of 1724 children with sleep disordered breathing (SDB) and 1862 healthy children were identified via parents' report of sleep disordered symptoms for their children. We excluded from the original cohort all children identified as having congenital abnormalities, diagnoses associated with poor growth and children with adenoidectomy and/or tonsillectomy.

Main outcome measures: Parents in the ALSPAC reported sleep disordered symptoms (snoring, mouth breathing and apnoea) for their children at 6, 18, 30, 42, 57, 69 and 81 months. Average facial shells were created for children with and without SDB in order to explore surface differences.

Results: Differences in facial measurements were found between the children with and without SDB throughout early childhood. The mean differences included an increase in face height in SDB children of 0.3 mm (95% CI -0.52 to -0.05); a decrease in mandibular prominence of 0.9° (95% CI -1.30 to -0.42) in SDB children; and a decrease in nose prominence and width of 0.12 mm (95% CI 0.00 to 0.24) and 0.72 mm (95% CI -0.10 to -0.25), respectively, in SDB children. The odds of children exhibiting symptoms of SDB increased significantly with respect to increased face height and mandible angle, but reduced with increased nose width and prominence

Conclusions: The combination of a long face, reduced nose prominence and width, and a retrognathic mandible may be diagnostic facial features of SDB that may warrant a referral to specialists for the evaluation of other clinical symptoms of SDB.

8. The breathing pattern impacts tongue pressure development

Azevedo, N. D., et al., *J Oral Rehabil*, 2018;45(8):612-617. DOI: [10.1111/joor.12653](https://doi.org/10.1111/joor.12653)

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DOI: 10.1111/joor.12653

ORIGINAL ARTICLE

WILEY *Journal of Oral Rehabilitation*

Tongue pressure measurement in children with mouth-breathing behaviour

N. D. Azevedo¹ | J. C. Lima¹ | R. M. M. M. Furlan²  | A. R. Motta³

ABSTRACT

The tongue plays an important role in oral functions. Reduced tongue strength is often noted among children with mouth-breathing behaviour. The purposes of this study were to measure the tongue pressure in children with mouth-breathing behaviour, to compare these values to those of children with nasal-breathing behaviour and to analyse the relationship between age and tongue pressure in children with a mouth-breathing pattern and in children with a nasal-breathing pattern. In this cross-sectional analytical observational study, we enrolled 40 children aged 5-12 years who either exhibited mouth-breathing behaviour (n = 20) or nasal-breathing behaviour (gender-and age-matched [± 2 years] controls; n = 20). Tongue pressure was evaluated using the Iowa Oral Performance Instrument; 3 measurements were recorded for each participant, with a 30-seconds rest interval. The average tongue pressure in the mouth-breathing group was lower than that in the nasal-breathing group. There was no difference in tongue pressure between genders. There was a strong and direct correlation between tongue pressure and age in the nasal-breathing group. The breathing pattern impacts tongue pressure development.

9. The effect of mouth breathing on chewing efficiency

Nagaiwa, M. et. al., *Angle Orthod.* 2016, 86(2), 227-34. DOI: [10.2319/020115-80.1](https://doi.org/10.2319/020115-80.1)

Original Article

The effect of mouth breathing on chewing efficiency

Miho Nagaiwa^a; Kaori Gunjigake^b; Kazunori Yamaguchi^c

ABSTRACT

Objective: To examine the effect of mouth breathing on chewing efficiency by evaluating masticatory variables.

Materials and Methods: Ten adult nasal breathers with normal occlusion and no temporomandibular dysfunction were selected. Subjects were instructed to bite the chewing gum on the habitual side. While breathing through the mouth and nose, the glucide elution from the chewing gum, number of chewing strokes, duration of chewing, and electromyography (EMG) activity of the masseter muscle were evaluated as variables of masticatory efficiency.

Results: The durations required for the chewing of 30, 60, 90, 120, 180, and 250 strokes were significantly ($P < .05$) longer while breathing through the mouth. There was no significant difference in the glucide elution rate (%) for each chewing stroke between nose and mouth breathings. The glucide elution rates for 1- and 3-minute chewing were significantly ($P < .05$) lower while breathing through the mouth. However, there was no significant difference in the glucide elution rate for 5-minute chewing between nose and mouth breathings. While chewing for 1, 3, and 5 minutes, the chewing stroke and EMG activity of the masseter muscle were significantly ($P < .05$) lower during mouth breathing.

Conclusions: It takes a longer amount of time to complete chewing to obtain higher masticatory efficiency when breathing through the mouth. Therefore, mouth breathing will decrease the masticatory efficiency if the duration of chewing is restricted in everyday life.

10. Reduced Tongue strength and swallowing difficulty

Namasivayam, A. M. et. al., *Clin Nutr* 2016;35(5):1078-83. DOI: [10.1016/j.clnu.2015.08.001](https://doi.org/10.1016/j.clnu.2015.08.001)



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Clinical Nutrition

journal homepage: <http://www.elsevier.com/locate/clnu>



Original article

The effect of tongue strength on meal consumption in long term care

Ashwini M. Namasivayam^{a, b, c, *}, Catriona M. Steele^{a, b, c, d, e}, Heather Keller^f

^a Toronto Rehabilitation Institute, University Health Network, 550 University Avenue, Toronto, ON M5G2A2, Canada

^b Speech-Language Pathology, University of Toronto, 500 University Avenue, Toronto, ON M5G1V7, Canada

^c Rehabilitation Sciences Institute, University of Toronto, 500 University Avenue, Toronto, ON M5G1V7, Canada

^d Institute for Biomaterials and Biomedical Engineering, University of Toronto, Canada

^e Bloorview Research Institute, Canada

^f Schlegel Research Chair, Nutrition & Aging, Schlegel-University of Waterloo Research Institute for Aging, University of Waterloo, Canada

ABSTRACT

Purpose: As many as 74% of residents in long-term care (LTC) are anticipated to have swallowing difficulties (dysphagia). Low food intake is commonly reported in persons with swallowing problems, but food intake may also be affected by fatigue in the swallowing muscles. As fatigue sets in during mealtimes, the strength of the tongue may decline. Tongue strength is also known to decline with age but it is unclear how this functional change may influence food intake. In this pilot study, we explored the relationship between tongue strength and meal consumption in persons not previously diagnosed with dysphagia.

Methods: The Iowa Oral Performance Instrument was used to collect maximum anterior isometric tongue-palate pressures from 12 LTC residents (5 male; mean age: 85, range 65e99). Residents were also screened for dysphagia with applesauce and a water swallow test. Each resident was observed at three different meals to record the length of time taken to eat the meal, amount of food consumed, and any indication of overt signs of swallowing difficulty (e.g. coughing).

Results: Residents who displayed observable swallowing difficulties at mealtimes had significantly lower tongue strength than those without swallowing difficulties ($p < 0.01$). Those with lower tongue strength took significantly longer to complete meals ($p < 0.05$) and consumed less food. Tongue strength was not predictive of performance on the water screen and the water swallow test was not a good predictor of which participants were observed to display mealtime difficulties.

Conclusion: Among seniors in long term care, reduced tongue strength is associated with longer meal times, reduced food consumption, and the presence of observable signs of swallowing difficulty. Further exploration of these relationships is warranted.

B. The use of oropharyngeal exercises for rehabilitation of tongue, throat and oral muscles.

1. Myofunctional Therapy for treatment of tongue thrust

Shah, S. S., et. al, *Int J Clin Pediatr Dent.* 2021;14(2):298-303. DOI: [10.5005/jp-journals-10005-1926](https://doi.org/10.5005/jp-journals-10005-1926)

REVIEW ARTICLE

Orofacial Myofunctional Therapy in Tongue Thrust Habit: A Narrative Review

Sejal S Shah¹, Meenakshi Y Nankar², Vikas D Bendgude³, Bhagyashree R Shetty⁴

ABSTRACT

Aim and objective: The respective review article is to provide an overview of the various exercises in orofacial myofunctional therapy (OMT) as a treatment modality for tongue thrust habit. Tongue thrust is the persistence of an infantile swallow pattern during late childhood. This leads to breathing and speech difficulties, open bite, and protruded teeth. During formative years, most children successfully transition from an infantile to a mature swallowing pattern. However, a few develop a retained infantile swallow and tongue thrust habit which could be due to abnormal habit like thumb sucking or an underlying cause like enlarged adenoids.

Adverse effects of these habits can be avoided by early detection and intervention in a growing child. Tongue thrust can be treated in different ways with early diagnosis, removal of underlying causes, correcting tongue posture, and breaking of habit with the use of orthodontic appliances. This review article is focused on the various OMT techniques employed for the correction of tongue thrust. There are several exercises in OMT which can help a child with tongue thrust. These can be performed at home under the supervision of the child's parents. Orofacial myofunctional therapy has provided a dramatic and positive influence on patients treated for tongue thrust. The joy of eating, speaking, and correct breathing can be regained along with confidence, self-esteem, and improved quality of life. Clinically, OMT plays a positive role by not only improving swallow but also the posture of tongue, improper muscle function, and reduces relapse of previous orthodontic treatments.

2. Myofunctional therapy for mouth breathing

Sacomanno, S., et. al., *Eur J Paediatr Dent.* 2018;19(3):243-246.
DOI: [10.23804/ejpd.2018.19.03.14](https://doi.org/10.23804/ejpd.2018.19.03.14)

A specific protocol of myo-functional therapy in children with Down syndrome. A pilot study



S. Sacomanno*, C. Martini**, L. D'Alatri***,
S. Farina****, C. Grippaudo*

Fondazione Policlinico Universitario A. Gemelli IRCCS, Rome
Università Cattolica del Sacro Cuore

* Dental Institute, Head and Neck Department, Università
Cattolica del Sacro Cuore

** Dental Institute, Università Cattolica del Sacro Cuore

*** ENT, Head and Neck Department - Università Cattolica del
Sacro Cuore

**** ENT, Head and Neck Department

email: sabinasacomanno@hotmail.it

DOI: [10.23804/ejpd.2018.19.03.14](https://doi.org/10.23804/ejpd.2018.19.03.14)

ABSTRACT

In this article the authors propose a specific myofunctional therapy protocol for children with Down syndrome. For these patients, who usually present with atypical swallowing problems, mouth breathing and lip incompetence, the use of a myofunctional therapy protocol with specific exercises has been shown to improve orofacial and nasal functions. In addition to the functional results, such as the correction of the atypical swallowing, restoration of lip competence, breathing improvement and reduction of nasal rhinorrhea, there were also aesthetic results. This protocol can be useful to improve the quality of life of these patients.

3. Oropharyngeal exercises for treatment of snoring and sleep apnea

i. *Guimaraes, K. C., et. al., Am J Respir Crit Care Med, 2009 (179), 962-966.*

DOI: [10.1164/rccm.200806-981OC](https://doi.org/10.1164/rccm.200806-981OC)

Effects of Oropharyngeal Exercises on Patients with Moderate Obstructive Sleep Apnea Syndrome

Kátia C. Guimarães¹, Luciano F. Drager¹, Pedro R. Genta¹, Bianca F. Marcondes¹, and Geraldo Lorenzi-Filho¹

¹Sleep Laboratory, Pulmonary Division, Heart Institute (InCor), University of São Paulo Medical School, São Paulo, Brazil

ABSTRACT

Rationale: Upper airway muscle function plays a major role in maintenance of the upper airway patency and contributes to the genesis of obstructive sleep apnea syndrome (OSAS). Preliminary results suggested that oropharyngeal exercises derived from speech therapy may be an effective treatment option for patients with moderate OSAS.

Objectives: To determine the impact of oropharyngeal exercises in patients with moderate OSAS.

Methods: Thirty-one patients with moderate OSAS were randomized to 3 months of daily (~30min) sham therapy (n = 15, control) or a set of oropharyngeal exercises (n = 16), consisting of exercises involving the tongue, soft palate, and lateral pharyngeal wall.

Measurements and Main Results: Anthropometric measurements, snoring frequency (range 0–4), intensity (1–3), Epworth daytime sleepiness (0–24) and Pittsburgh sleep quality (0–21) questionnaires, and full polysomnography were performed at baseline and at study conclusion. Body mass index and abdominal circumference of the entire group were 30.3 ± 3.4 kg/m² and 101.4 ± 9.0 cm, respectively, and did not change significantly over the study period. No significant change occurred in the control group in all variables. In contrast, patients randomized to oropharyngeal exercises had a significant decrease ($P < 0.05$) in neck circumference (39.6 ± 3.6 vs. 38.5 ± 4.0 cm), snoring frequency (4 [4–4] vs. 3 [1.5–3.5]), snoring intensity (3 [3–4] vs. 1 [1–2]), daytime sleepiness (14 ± 5 vs. 8 ± 6), sleep quality score (10.2 ± 3.7 vs. 6.9 ± 2.5), and OSAS severity (apnea-hypopnea index, 22.4 ± 4.8 vs. 13.7 ± 8.5 events/h). Changes in neck circumference correlated inversely with changes in apnea-hypopnea index ($r = 0.59$; $P < 0.001$).

Conclusions: Oropharyngeal exercises significantly reduce OSAS severity and symptoms and represent a promising treatment for moderate OSAS.

3. Oropharyngeal exercises for treatment of snoring and sleep apnea

ii. Engelke, W., et. al., *Eur J Orthod* 2010, 32(5):490-5. DOI: [10.1093/ejo/cjp135](https://doi.org/10.1093/ejo/cjp135)

European Journal of Orthodontics 32 (2010) 490–495
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Functional treatment of snoring based on the tongue-repositioning manoeuvre

Wilfried Engelke*, Wolfgang Engelhardt*, Milagros Mendoza-Gärtner*,
Oscar Deccó**, Jenifer Barrirero** and Michael Knösel***

Departments of *Maxillofacial Surgery and ***Orthodontics, University of Göttingen, Germany, **Laboratorio Bioimplantes, Universidad Nacional de Entre Ríos, Paraná, Argentina

Correspondence to: Professor Wilfried Engelke, Department of Maxillofacial Surgery, Georg August University Göttingen, Robert Koch Street 40, D-37075 Göttingen, Germany. E-mail: wengelke@med.uni-goettingen.de

ABSTRACT

Orofacial biofunction comprises muscular and physical effects, which may contribute to stabilization of the oropharyngeal airway. The tongue-repositioning manoeuvre (TRM) provides physical stabilization of the tongue and the soft palate together with, as a prerequisite, a nasal breathing mode. The aim of the present study was to evaluate the influence of a TRM treatment concept on primary snoring.

The TRM was used to achieve a closed biofunctional rest position of the orofacial system and to re-educate the nasal breathing pattern. Pressure indicating oral shields were used for home exercises as a biofeedback instrument and to support nocturnal mouth closure. Treatment was undertaken on 125 consecutive primary snorers [101 males, mean age 52.4 years, range 34–75, mean body mass index (BMI) 28.1, range 18.9–38.5, and 24 females, mean age 55.2 years, range 36–70, mean BMI 26.8, range 22.7–31.9]. Bed partner ranking was performed, and snoring was judged using a 10-cm visual analogue scale (VAS).

The VAS score was 8.4 (range 6–10) before treatment and decreased to 4.1 (range 0–10) after treatment [mean observation time 4.6 months (1–10)]. Analysis of variance showed a significant influence of treatment in subjects with a normal body weight (BMI 18.5–25).

The data provide evidence that dynamic stabilization of the orofacial system with the TRM in conjunction with nocturnal wear of an oral shield is beneficial for reducing the symptoms in primary snorers with a normal BMI.

3. Oropharyngeal exercises for treatment of snoring and sleep apnea

iii. *Leto, V. et. al., CHEST 2015; 148 (3): 683 – 691, DOI: [10.1378/chest.14-2953](https://doi.org/10.1378/chest.14-2953)*

[Original Research **Sleep Disorders**]



Effects of Oropharyngeal Exercises on Snoring A Randomized Trial

Vanessa Ieto, PhD; Fabiane Kayamori, SLP; Maria I. Montes, MD; Raquel P. Hirata, MS; Marcelo G. Gregório, MD, PhD; Adriano M. Alencar, PhD; Luciano F. Drager, MD, PhD; Pedro R. Genta, MD, PhD; and Geraldo Lorenzi-Filho, MD, PhD

ABSTRACT

BACKGROUND: Snoring is extremely common in the general population and may indicate OSA. However, snoring is not objectively measured during polysomnography, and no standard treatment is available for primary snoring or when snoring is associated with mild forms of OSA. This study determined the effects of oropharyngeal exercises on snoring in minimally symptomatic patients with a primary complaint of snoring and diagnosis of primary snoring or mild to moderate OSA.

METHODS: Patients were randomized for 3 months of treatment with nasal dilator strips plus respiratory exercises (control) or daily oropharyngeal exercises (therapy). Patients were evaluated at study entry and end by sleep questionnaires (Epworth Sleepiness Scale, Pittsburgh Sleep Quality Index) and full polysomnography with objective measurements of snoring.

RESULTS: We studied 39 patients (age, 46 ± 13 years; BMI, 28.2 ± 3.1 kg/m²; apnea-hypopnea index (AHI), 15.3 ± 9.3 events/h; Epworth Sleepiness Scale, 9.2 ± 4.9 ; Pittsburgh Sleep Quality Index, 6.4 ± 3.3). Control (n = 20) and therapy (n = 19) groups were similar at study entry. One patient from each group dropped out. Intention-to-treat analysis was used. No significant changes occurred in the control group. In contrast, patients randomized to therapy experienced a significant decrease in the snore index (snores > 36 dB/h), 99.5 (49.6-221.3) vs 48.2 (25.5-219.2); P = .017 and total snore index (total power of snore/h), 60.4 (21.8-220.6) vs 31.0 (10.1-146.5); P = .033.

CONCLUSIONS: Oropharyngeal exercises are effective in reducing objectively measured snoring and are a possible treatment of a large population suffering from snoring.

3. Oropharyngeal exercises for treatment of snoring and sleep apnea

iv. Camacho, M., et. al., *Eur Arch Otorhinolaryngol.* 2018;275(4):849-855. DOI: [10.1007/s00405-017-4848-5](https://doi.org/10.1007/s00405-017-4848-5)

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REVIEW ARTICLE



Oropharyngeal and tongue exercises (myofunctional therapy) for snoring: a systematic review and meta-analysis

Macario Camacho¹  · Christian Guilleminault² · Justin M. Wei¹ · Sungjin A. Song¹ · Michael W. Noller³ · Lauren K. Reckley¹ · Camilo Fernandez-Salvador¹ · Soroush Zaghi⁴

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ABSTRACT

Purpose: Oropharyngeal and tongue exercises (myofunctional therapy) have been shown to improve obstructive sleep apnea. However, to our knowledge, a systematic review has not been performed for snoring. The study objective is to perform a systematic review, with a meta-analysis, dedicated to snoring outcomes after myofunctional therapy.

Methods: PubMed/MEDLINE and three other databases were searched through November 25, 2017. Two authors independently searched the literature. Eligibility (1) patients: children or adults with snoring, (2) intervention: oropharyngeal and/or tongue exercises, (3) comparison: pre and post-treatment data for snoring, (4) outcomes: snoring frequency and snoring intensity, (5) study design: publications of all study designs.

Results: A total of 483 articles were screened, 56 were downloaded in their full text form, and nine studies reported outcomes related to snoring. There were a total of 211 patients (all adults) in these studies. The snoring intensity was reduced by 51% in 80 patients from pre-therapy to post-therapy visual analog scale values of 8.2 ± 2.1 (95% CI 7.7, 8.7) to 4.0 ± 3.7 (95% CI 3.2, 4.8). Berlin questionnaire snoring intensity reduced by 36% in 34 patients from 2.5 ± 1.0 (95% CI 2.2, 2.8) to 1.6 ± 0.8 (95% CI 1.3, 1.9). Finally, time spent snoring during sleep was reduced by 31% in 60 patients from $26.3 \pm 18.7\%$ (95% CI 21.6, 31.0) to $18.1 \pm 20.5\%$ (95% CI 12.9, 23.3) of total sleep time.

Conclusions This systematic review demonstrated that myofunctional therapy has reduced snoring in adults based on both subjective questionnaires and objective sleep studies.

3. Oropharyngeal exercises for treatment of snoring and sleep apnea

v. *Maria de Felicio, C., et. al., Nat Sci Sleep. 2018, 6;10:271-286. DOI: [10.2147/NSS.S141132](https://doi.org/10.2147/NSS.S141132)*

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REVIEW

Obstructive sleep apnea: focus on myofunctional therapy

ABSTRACT

Purpose: Orofacial myofunctional therapy (OMT) is a modality of treatment for children and adults with obstructive sleep apnea (OSA) to promote changes in the musculature of the upper airways. This review summarizes and discusses the effects of OMT on OSA, the therapeutic programs employed, and their possible mechanisms of action.

Methods: We conducted an online literature search using the databases MEDLINE/PubMed, EMBASE, and Web of Science. Search terms were “obstructive sleep apnea” in combination with “myofunctional therapy” OR “oropharyngeal exercises” OR “speech therapy”. We considered original articles in English and Portuguese containing a diagnosis of OSA based on polysomnography (PSG). The primary outcomes of interest for this review were objective measurement derived from PSG and subjective sleep symptoms. The secondary outcome was the evaluation of orofacial myofunctional status.

Results: Eleven studies were included in this review. The studies reviewed reveal that several benefits of OMT were demonstrated in adults, which include significant decrease of apnea–hypopnea index (AHI), reduced arousal index, improvement in subjective symptoms of daytime sleepiness, sleep quality, and life quality. In children with residual apnea, OMT promoted a decrease of AHI, increase in oxygen saturation, and improvement of orofacial myofunctional status. Few of the studies reviewed reported the effects of OMT on the musculature.

Conclusion: The present review showed that OMT is effective for the treatment of adults in reducing the severity of OSA and snoring, and improving the quality of life. OMT is also successful for the treatment of children with residual apnea. In addition, OMT favors the adherence to continuous positive airway pressure. However, randomized and high-quality studies are still rare, and the effects of treatment should also be analyzed on a long-term basis, including measures showing if changes occurred in the musculature.

4. Tongue Strengthening Exercises in Dysphagia Rehabilitation

i. Kraaijenga, S. A. C., et. al., *Dysphagia*, 2015, 30:392–403, DOI: [10.1007/s00455-015-9611-8](https://doi.org/10.1007/s00455-015-9611-8)

Dysphagia (2015) 30:392–403
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ORIGINAL ARTICLE

Effects of Strengthening Exercises on Swallowing Musculature and Function in Senior Healthy Subjects: a Prospective Effectiveness and Feasibility Study

S. A. C. Kraaijenga¹ · L. van der Molen¹ · M. M. Stuijver^{2,3} · H. J. Teertstra⁴ · F. J. M. Hilgers^{1,5,6} · M. W. M. van den Brekel^{1,5,6}

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ABSTRACT

Head and neck cancer (HNC) patients may develop dysphagia due to muscle atrophy and fibrosis following chemoradiotherapy. Strengthening of the swallowing muscles through therapeutic exercise is potentially effective for improving swallowing function. We hypothesize that a customized Swallow Exercise Aid (SEA), developed for isometric and isokinetic strengthening exercises (against resistance), can help to functionally strengthen the suprahyoid musculature, which in turn can improve swallowing function. An effectiveness/feasibility study was carried out with ten senior healthy volunteers, who performed exercises 3 times per day for 6 weeks. Exercises included chin tuck against resistance (CTAR), jaw opening against resistance (JOAR), and effortful swallow exercises with the SEA. Multidimensional assessment consisted of measurements of maximum chin tuck and jaw opening strength, maximum tongue strength/endurance, suprahyoid muscle volume, hyoid bone displacement, swallowing transport times, occurrence of laryngeal penetration/aspiration and/or contrast residue, maximum mouth opening, feasibility/compliance (questionnaires), and subjective swallowing complaints (SWALQOL). After 6-weeks exercise, mean chin tuck strength, jaw opening strength, anterior tongue strength, suprahyoid muscle volume, and maximum mouth opening significantly increased ($p < .05$). Feasibility and compliance (median 86 %, range 48–100 %) of the SEA exercises were good. This prospective effectiveness/feasibility study on the effects of CTAR/JOAR isometric and isokinetic strengthening exercises on swallowing musculature and function shows that senior healthy subjects are able to significantly increase swallowing muscle strength and volume after a 6-week training period. These positive results warrant further investigation of effectiveness and feasibility of these SEA exercises in HNC patients with dysphagia.

4. Tongue Strengthening Exercises in Dysphagia Rehabilitation

ii. Sakai, K., et al., *Dysphagia*, 2017, 32:241–249, DOI: [10.1007/s00455-016-9751-5](https://doi.org/10.1007/s00455-016-9751-5)

Dysphagia (2017) 32:241–249
DOI 10.1007/s00455-016-9751-5



ORIGINAL ARTICLE

Tongue Strength is Associated with Grip Strength and Nutritional Status in Older Adult Inpatients of a Rehabilitation Hospital

Kotomi Sakai^{1,2} · Enri Nakayama² · Haruka Tohara³ · Tomomi Maeda⁴ ·
Motonobu Sugimoto⁴ · Takahiro Takehisa⁵ · Yozo Takehisa⁶ · Koichiro Ueda²

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ABSTRACT

The aim of this cross-sectional study was to investigate whether tongue strength observed in older adult inpatients of a rehabilitation hospital is associated with muscle function, nutritional status, and dysphagia. A total of 174 older adult inpatients aged 65 years and older in rehabilitation (64 men, 110 women; median age, 84 years; interquartile range, 80–89 years) who were suspected of having reduced tongue strength due to sarcopenia were included in this study. Isometric tongue strength was measured using a device fitted with a disposable oral balloon probe. We evaluated age, muscle function as assessed by the Barthel index and grip strength, nutritional status as measured by the Mini Nutritional Assessment-short form (MNA-SF), body mass index, serum albumin, controlling nutritional status, and calf circumference and arm muscle area to assess muscle mass. In addition, the functional oral intake scale (FOIS) was used as an index of dysphagia. Multivariate linear regression analysis revealed that isometric tongue strength was independently associated with grip strength (coefficient = 0.33, 95 % confidence interval (CI) 0.12–0.54, $p = 0.002$), MNA-SF (coefficient = 0.74, 95 % CI 0.12–1.35, $p = 0.019$), and FOIS (coefficient = 0.02, 95 % CI 0.00–0.15, $p = 0.047$). To maintain and improve tongue strength in association with sarcopenic dysphagia, exercise therapy and nutritional therapy interventions, as well as direct interventions to address tongue strength, may be effective in dysphagia rehabilitation in older adult inpatients.

5. Effect of tongue position on postural stability

Alghadir, A. H., et. al., *Somatosens Mot Res.*, 2015, 32(3), 183-6.

DOI: [10.3109/08990220.2015.1043120](https://doi.org/10.3109/08990220.2015.1043120)

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ORIGINAL ARTICLE

Effect of tongue position on postural stability during quiet standing in healthy young males

Ahmad H. Alghadir¹, Hamayun Zafar^{1,2}, & Zaheen A. Iqbal¹

¹Department of Rehabilitation Sciences, College of Applied Medical Sciences, King Saud University, Riyadh, Saudi Arabia and ²Department of Odontology, Clinical Oral Physiology, Umea University, Umea, Sweden

ABSTRACT

Background and aims: Role of the neck and jaw sensory motor system in control of body balance has been established. Tongue is an integral part of jaw sensory motor system and helps in execution of purposeful and precise motor tasks like eating, drinking and speaking. The purpose of this study was to evaluate the possible effects of tongue position on the postural control system.

Materials and method: We compared the mean center of gravity (COG) velocity during quiet standing on an unstable surface with eyes closed during two test conditions: (i) with habitual jaw resting position and (ii) with instructed tongue positioned against the upper incisors. One hundred and sixteen normal healthy male subjects (average age 31.56 ± 8.51 years and height 170.86 ± 7.26 cm) participated in the study. Their COG velocity (deg/s) was measured using the NeuroCom_Balance Master version 8.5.0 (Clackamas, OR, USA).

Results and conclusions: The results show that COG velocity decreased significantly while tongue was positioned against upper incisors in comparison to the habitual jaw resting position. Our findings suggest that the tongue positioning can modulate postural control mechanisms. Tongue positioning against the upper incisors can enhance the postural stability during upright standing on an unstable surface and in the absence of vision in healthy young adults. Our findings can be of value for evaluation and rehabilitation protocols for postural control dysfunction.