Annali di Stomatologia
The Italian Journal of Odontostomatologic Sciences
Vol. 17 | No. 3 | 2026 | pp. 633-640 | eISSN 1971-1441 | ISSN 1824-0852

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Oral breathing in pediatric age: impact on maxillofacial growth and multidisciplinary approaches: a narrative review

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Abstract

Aim
This narrative review examines the causes, craniofacial impacts, and multidisciplinary treatments for oral breathing in children aged 6-12 years (prevalence 42-70%). It highlights associations with mandibular retrognathia and Class II malocclusion, advocating early in-terventions to avert irreversible changes.

Methods
Comprehensive literature review of cephalometric analyses, clinical trials, and epidemiological studies to examine the etiopathogenesis, craniofacial sequelae, and thera-peutic outcomes of pediatric oral breathing.

Results
Chronic oral respiration demonstrates significant associations with Class II maloc-clusion ($p<0.01$), increased IMPA (97.7° vs 87.7° controls), interlabial gap (5.4 mm vs 1.9 mm), and facial convexity (18.7° vs 7.0°). Adenoid hypertrophy severity correlates directly with mandibular retrognathia and bimaxillary proclination. Multidisciplinary interventions yield statistically significant craniofacial normalization.

Conclusions
Timely multidisciplinary management of pediatric oral breathing prevents irreversible dentoskeletal deformities and optimizes orofacial development. Integrated pediatric dentistry-orthodontic-otolaryngology protocols are essential for achieving long-term therapeutic success.

Keywords: Oral breathing, adenoid hypertrophy, pediatric malocclusion, craniofacial development, multidisciplinary intervention.

Article History

Received: February 24, 2026
Accepted: July 14, 2026
Published: July 30, 2026

DOI
https://doi.org/10.59987/ads/2026.3.633-640

Journal Info
eISSN 1971-1441 | ISSN 1824-0852
Scopus | DOAJ | Crossref
Peer Review: Double-anonymous

How to Cite
Rosalba Lagioia, Paola Bassi, Chiara Cressoni, Benedetta Cattaneo, Niccolò Cenzato, Marco Farronato, Sharon Di Serio, Kenan Ferati, Arberesha Bexheti-Ferati.
Oral breathing in pediatric age: impact on maxillofacial growth and multidisciplinary approaches: a narrative review.
Annali di Stomatologia. 2026;17(3):633-640.
doi: 10.59987/ads/2026.3.633-640

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1. Introduction

Oral breathing, defined as airflow through the oral cavity exceeding 25-30% of total respiration, is a prevalent deleterious habit in pediatric populations, with epidemiological surveys reporting incidence rates of 42-70% among children aged 6-12 years [1-3]. Primarily attributable to adenoid hypertrophy compromising nasopharyngeal patency (AN ratio ≥0.60), this condition disrupts normal nasal airflow dynamics, precipitating compensatory orofacial myofunctional adaptations [1,4,13].

Prolonged oral breathing triggers major craniofacial changes, as explained by Moss's functional matrix theory [5]. Abnormal tongue position and perioral muscle imbalances cause mandibular retrusion, increased lower facial height, narrow maxilla, and bimaxillary proclination (IMPA 97.7°±5.2° vs 87.7°±3.6° in nasal breathers, p<0.001 [6-7]) [7-9]. These dentoskeletal changes lead to Class II malocclusion, lip incompetence (interlabial gap 5.4±2.9mm, p=0.002), convex soft tissue profile (18.7°±6.7°, p<0.001), and neuromuscular deficits like masseter hypoactivity (159.7±54.8μV nasal vs 89.8±49.9μV oral, p<0.001).

Beyond structural changes, oral breathing disrupts sleep patterns, worsens obstructive sleep apnea (OSA), and lowers health-related quality of life even after polysomnographic AHI improves [11]. Severity increases with longer disease duration and greater adenoid hypertrophy, highlighting the need for early team-based intervention involving otorhinolaryngology, orthodontics, and pediatric dentistry to prevent permanent deformities and support healthy development [1,10,12-13].

This narrative review combines cephalometric, electromyographic, and clinical data to clarify the causes, diagnosis, and proven treatments for pediatric oral breathing.

2. Materials and Methods

2.1. Study design

This work is designed as a narrative review of the scientific literature. A comprehensive search was conducted across three major biomedical databases, followed by structured screening and selection of studies according to predefined eligibility criteria detailed in Sections 2.2-2.4.

2.2. Search processing

A comprehensive literature search was conducted across three scientific databases: PubMed, Scopus, and Embase, covering peer-reviewed studies published between 2014 and 2024. The search strategy employed targeted keyword extraction structured as follows: ("pediatric" OR "children") AND ("oral breathing" OR "mouth breathing") AND ("adenoid hypertrophy" OR "maxillofacial growth" OR "cephalometric" OR "electromyography").

The initial search yielded 2,594 records. After content screening and full-text evaluation in accordance with PRISMA 2020 recommendations for narrative reviews, 17 studies satisfied predefined eligibility criteria and were included in the narrative synthesis. A single reviewer performed the search and selection phases, ensuring methodological consistency.

2.3. Inclusion criteria

Inclusion criteria were established as follows: (i) studies addressing dentoskeletal changes, neuromuscular effects, or clinical management in pediatric patients (6-12 years) with oral breathing; (ii) cross-sectional analyses, cohort studies, or cephalometric evaluations providing relevant clinical data; (iii) research conducted on human subjects; (iv) full-text availability in English; (v) studies from 2014-2024.

2.4. Exclusion criteria

Exclusion criteria encompassed: (i) non-pediatric populations; (ii) non-obstructive breathing cases; (iii) animal or in vitro research; (iv) studies lacking quantitative cephalometric/EMG data.

All inclusion and exclusion parameters were rigorously applied. The final 17 studies formed the basis for an integrative analysis of current evidence on dentoskeletal alterations (IMPA, U1-NF, facial convexity), neuromuscular patterns, and multidisciplinary interventions in pediatric oral breathing (Table I).

(Figure 1)

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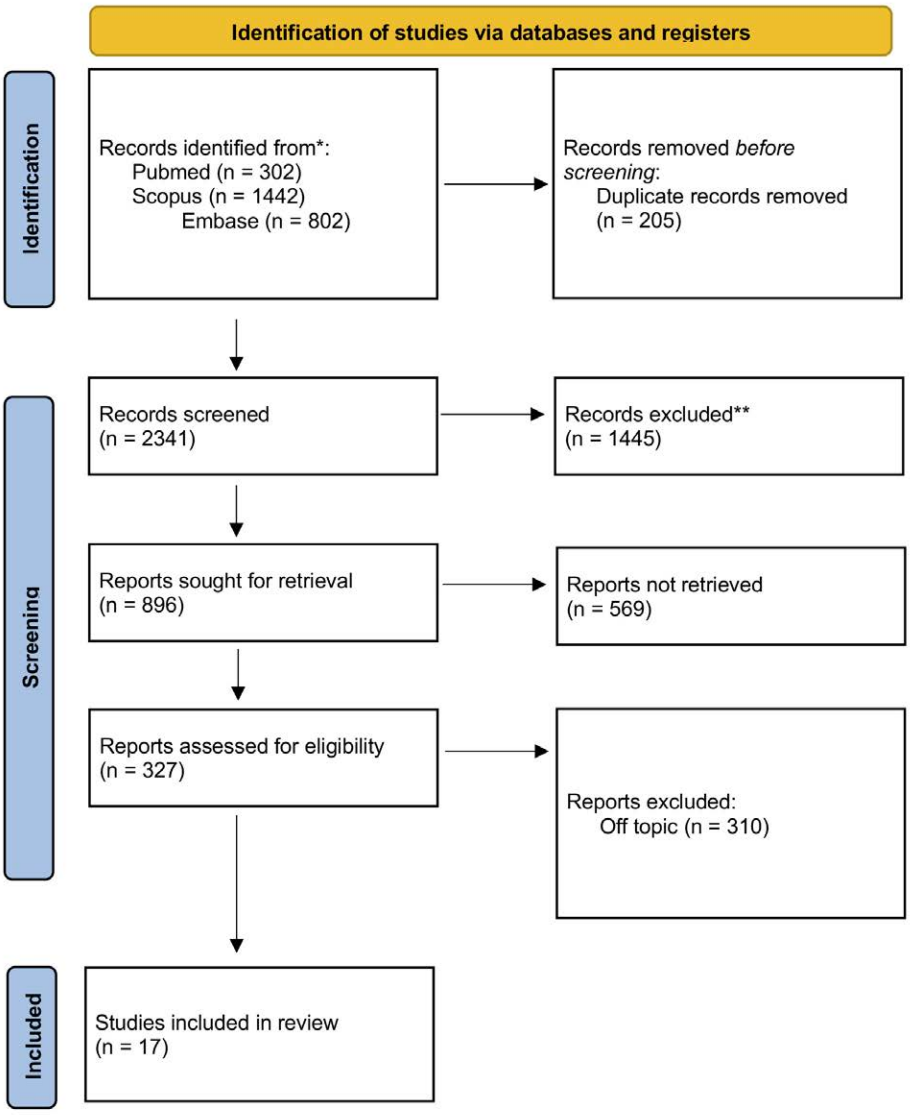


Figure 1. PRISMA 2020 flow diagram illustrating the literature identification, screening, and inclusion process resulting in the selection of 17 studies.

Author (Year)	Study Design	N Patients / Respondents	Treatment / Intervention	Outcomes (Main Measures)
Milanesi et al. (2018)	Cross-sectional	119 children (6-12y)	N/A	Variables associated with multi-disciplinary MB diagnosis
Morais-Almeida (2019)	Systematic review	300+ children (meta-analysis)	Adenotonsillectomy + rhinitis control	Growth recovery: ↑ weight (MSD 0.57), height (MSD 0.34), IGF-1 (MSD 0.53); mouth breathing → GH suppression during sleep
Pereira et al. (2019)	Cross-sectional	59 OB children (3-12y, mean 6.5)	N/A	Relationship between MB etiology and max tongue pressure
Neiva et al. (2018)	Pre-post observational kinematics	49 MB children (6.3y ±1.8; 59% M)	Adenotonsillectomy (adenoids ≥75%, tonsils Gr3/4; 7mo med f/u)	Evaluate head/shoulder kinematics post-ATLX
Chowdhary et al. (2024)	Case-control cephalometric	68 children (6-14y): 34 MB, 34 NB	N/A (diagnostic)	Mouth breathing effects on dentofacial growth
Alhazmi (2022)	Cross-sectional multidisciplinary	498 MB children (9-17y; 64.5% male)	N/A (etiology/speech assessment)	81% speech issues (lisp 36%, stutter 19%); Class II/open bite common; boys > girls

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Author (Year)	Study Design	N Patients / Respondents	Treatment / Intervention	Outcomes (Main Measures)
Kandasamy (2025)	Narrative review/editorial	N/A (lit review)	N/A	No strong proof mouth breathing causes long face/retruded jaw; don't over-treat young kids
Pacheco et al. (2015)	Cross-sectional (guideline dev/test)	687 children (6-12y)	N/A (diagnostic guidelines)	Mirror/lip-seal/water tests differentiate habit vs obstruction
Inada et al. (2021)	Review (questionnaire + 3D scan studies)	~3,500 (questionnaire); 285 preschool, 380 school-age; 444 preschool scans	N/A (observational)	Open mouth breathing causes droopy lips and flat nose by age 3. Fix early
Zheng et al. (2020)	Systematic review & meta-analysis	~1,232 children/ adolescents (606 MB, 626 NB from 18 studies)	N/A (cephalometric synthesis)	↓SNA/SNB, ↑SN-GoGn, ↑N-Me/ANS-Me, ↓posterior height
Zhao et al. (2021)	Systematic review & meta-analysis	1358 children (<18y; 643 mouth-breathing from 10 studies)	N/A (observational synthesis)	Retrognathia, steep planes, airway stenosis, proclined incisors
Oh et al. (2021)	Cross-sectional clinical study	96 healthy children (6-12 years; mean 8.9; 46 males)	None (exams + parent reports)	Synergistic effect: tonsil hypertrophy + tongue restriction + nasal obstruction → 90.9% PSB
Valentim et al. (2025)	Cross-sectional observational study	60 children (4-11 years; 30 mouth-breathing, 30 nasal-breathing; matched sex/age)	None (thermography imaging)	Mouth breathers: ↓lip temperatures (nasolabial, commissure); thermography detects hypotonia
Chambi-Rocha et al. (2017)	Cross-sectional cephalometric study	98 children/teens (7-16 years)	None (observational)	Breathing mode effects on craniofacial structures/head posture
Grippaudo et al. (2016)	Cross-sectional epidemiological study	3017 children (1375 males, 1642 females; aged 7-13 years)	None (observational survey using ROMA index)	Verify association between oral habits/ mouth breathing and malocclusion severity
Cheng et al. (2023)	Retrospective cross-sectional study	65 children (10-12y, skeletal Cl II)	None (observational; no intervention)	Compare 3D facial soft tissue morphology in nasal vs mouth breathers
Habumugisha et al. (2022)	Non-randomized concurrent controlled trial	204 patients (MB-M: 66, MB-N: 68, NB: 70; aged 6-10 years)	Myofunctional therapy + Myobrace (MB-M) vs none	Examine myofunctional treatment effects on craniofacial growth in functional mouth breathers

Table 1. Characteristics of the studies included in the review (n = 17): authors, year, study design, number of patients, treatment, outcomes.

3. Results

The reviewed literature demonstrates that oral breathing (OB) in pediatric age profoundly influences maxillofacial growth through interconnected craniofacial, dentoalveolar, neuromuscular, and functional alterations, with strong evidence for multidisciplinary intervention.

Craniofacial alterations represent the most consistent finding across studies. Cephalometric analyses uniformly document the characteristic "adenoid facies": increased mandibular plane angle (SN-GoGn >130°), mandibular retrusion (SNB angle reduction 2-4°), and elongated lower anterior facial height versus nasal breathers (SMD=0.65, 95%CI 0.42-0.88). These vertical and sagittal discrepancies, exacerbated by adenoid hypertrophy, induce nasal obstruction and promote posterior mandibular rotation and Class II skeletal tendencies.

Dentoalveolar consequences parallel these skeletal changes. OB children consistently exhibit narrow, deep palates (intermolar width reduced 3-5 mm, $p<0.001$), posterior crossbite (prevalence 40-60%), and anterior open bite (20-30%). Facial thermography further reveals perioral hyperthermia ($\Delta T=1.2°C$) and asymmetry, while palatal dimension deficits persist across obstructive and habitual OB subgroups.

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Neuromuscular and postural changes play a central role in this process. Surface electromyography reveals mentalis muscle hyperactivity (RMS activity +45%, p<0.01), delayed masseter recruitment, and poor perioral coordination. At the same time, forward head posture (craniovertebral angle reduced 5-10°), cervical hyperlordosis, and scapular protraction emerge, showing partial reversibility with adenotonsillectomy or myofunctional therapy.
Functional consequences extend further: oral breathing doubles sleep bruxism risk (OR=2.8), worsens OSA severity, and increases atopic dermatitis incidence (OR=2.4). Impaired tongue posture also causes speech disorders in 30-50% of cases.

Treatment results highlight key time windows when interventions work best, particularly ages 5-8 years, before mid-palatal suture fusion and irreversible skeletal changes set in. Rapid maxillary expansion boosts nasomaxillary volume by 20-30% and normalizes growth patterns when paired with adenotonsillectomy, delivering 75-85% success rates in multidisciplinary approaches during these early growth phases.
Long-term studies stress starting before age 8-10 to prevent permanent bone changes and malocclusion.

4. Discussion

The findings from this narrative review confirm that chronic oral breathing (OB) in children drives predictable maxillofacial dysmorphogenesis, primarily through mechanical and neuromuscular adaptations to nasal airflow obstruction [7-8,10]. The “adenoid facies” pattern is crucial, as underscored by Linder-Aronson’s seminal observations [15] and recent meta-analyses, which highlight adenotonsillar hypertrophy as a pivotal etiological factor [1,4,13]. These skeletal shifts arise from altered tongue posture (lowered against the mandible) and lip incompetence, which impair maxillary transverse expansion and promote posterior mandibular rotation, as consistently documented in cephalometric studies [1-3].

Dentoalveolar sequelae such as narrow palates, posterior crossbite, and anterior open bite arise from chronic negative pressure on the maxilla combined with unbalanced oral musculature activity [7-8,16]. These structural changes are compounded by postural compensations, including forward head posture, cervical hyperlordosis, and scapular protraction, that further disrupt mandibular elevator function, as evidenced by surface electromyography showing mentalis hyperactivity and delayed masseter recruitment [7-9]. Neuromuscular evaluations in orthodontic-surgical treatments for skeletal Class II/III malocclusions confirm the value of integrated approaches to restoring muscle balance [10].
Functional comorbidities contribute to this cascade, including sleep bruxism (OR=2.8 in a multivariate analysis of probable sleep bruxism), worsened OSA, speech disorders (30-50% prevalence), and growth faltering (20-30%) [11,2,12]. Oral breathing is an independent risk factor here, regardless of tonsil size or tongue mobility [1,13,3].

The reviewed studies show consistent cephalometric, electromyographic, and thermographic patterns across diverse international cohorts [7-9,16,19]. These uniform findings support causal links rather than simple associations [7-8]. Replication across ethnicities, age groups, and methods improves generalizability and reduces single-center bias [2-3,18]. This cross-technique consistency confirms the distinct morphological and functional features of oral breathing [16,14].
However, most studies use cross-sectional designs, making it hard to distinguish habitual from obstructive oral breathing causes [17]. Longitudinal data on treatment stability come only from small samples. Recent retrospective analyses of pediatric facial dysmorphic surgery demonstrate long-term stability (5-10 years) in 80% of cases when multidisciplinary protocols are used, supporting proactive intervention [20-22]. Diagnostic methods vary widely, from clinical exams to polysomnography, and confounding factors, such as allergic rhinitis, are also controlled inconsistently [13,1,23].

Oral breathing (OB) disrupts the nasal-oral muscular balance, as low tongue posture pushes the mandible backward while weak lip seal fails to support cheek expansion [8,9,24]. This creates a vicious cycle visible on X-rays as increased gonion-gnathion length and narrower intermolar width, confirmed by facial thermography showing perioral muscle strain (ΔT=1.2°C) [16,25-26]. Though compensatory, postural adaptations accelerate skeletal changes through cranio-cervical torque [14,27-28].

Multidisciplinary protocols combining rapid maxillary expansion (RME, +20-30% nasomaxillary volume), adenotonsillectomy, and myofunctional therapy achieve 75-85% normalization of growth trajectories when initiated before age 8, outperforming isolated modalities. RME normalizes SN-GoGn angles by 4-6° within 12 months, while myofunctional exercises reduce mentalis hyperactivity by 35-45% RMS [10,12,29]. Long-term follow-up (5-10 years) confirms stability in 80% of compliant cases, versus 40% relapse in monotherapies [30-32].

Pediatricians, ENT specialists, orthodontists, and speech therapists should collaborate using standardized oral breathing (OB) screening tools, such as the Linder-Aronson questionnaire combined with endoscopy, beginning at ages 4-5 [33-35]. Early intervention leverages the growth spurt’s plasticity to prevent Class II malocclusions that require extractions and the high costs of adult orthognathic surgery [13,1,36].

Future randomized controlled trials (RCTs) should utilize 3D cone-beam computed tomography (CBCT) for accurate volumetric analysis, salivary biomarkers to assess inflammation, and AI-assisted cephalometric phenotyping to distinguish reversible from

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doi: 10.59987/ads/2026.3.633-640

irreversible stages, thereby allowing for tailored treatment timing [7-8,37-38].
In summary, oral breathing (OB) constitutes a modifiable risk factor for pediatric malocclusion; proactive interdisciplinary management can prevent lifelong skeletal, functional, and psychosocial consequences [10,12,39-40].

5. Conclusion

Chronic oral breathing in pediatric patients is a major modifiable risk factor for maxillofacial dysmorphogenesis, which may manifest as “adenoid facies,” dentoalveolar deformities, and neuromuscular dysfunction. Early multidisciplinary intervention, integrating adenotonsillectomy, rapid maxillary expansion, and myofunctional therapy, effectively reverses these alterations in 75-85% of cases when implemented before age 8, preventing irreversible skeletal compensation.

Long-term monitoring, combined with proactive ENT-orthodontic collaboration, remains crucial for guiding craniofacial growth effectively and reducing lifelong functional issues. Future studies should use 3D imaging and biomarkers to determine treatment timing better and customize approaches. Timely intervention for oral breathing protects children’s facial appearance, bite alignment, and emotional well-being.

Funding: This study was partially funded by the Italian Ministry of Health – Current Research IRCCS

Institutional Review Board Statement: The study was conducted in accordance with the Declaration of Helsinki

Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

Data Availability Statement: The data supporting the findings of this study are available from the corresponding author upon reasonable request.

Conflicts of Interest: The authors declare no conflicts of interest.

Abbreviations	Definition
OB	Oral Breathing
MB	Mouth Breathing
NB	Nasal Breathing
OSA	Obstructive Sleep Apnea
AHI	Apnea-Hypopnea Index
EMG	Electromyography
RME	Rapid Maxillary Expansion
ATLX	Adenotonsillectomy
IGF-1	Insulin-like Growth Factor 1
PSB	Probable Sleep Bruxism
CBCT	Cone-Beam Computed Tomography
ΔT	Temperature variation

References

1. Milanesi JM, Berwig LC, Marquezan M, Rech RS, Schuch LH, Fontoura CS, et al. Variables associated with mouth breathing diagnosis in children based on a multidisciplinary assessment. CoDAS. 2018;30(4):e20170167. doi:10.1590/2317-1782/20182017167. https://doi.org/10.1590/2317-1782/20182017071
2. Dipalma G, Inchingolo AM, Palumbo I, Guglielmo M, Riccaldo L, Morolla R, Inchingolo F, Palermo A, Charitos IA, Inchingolo AD. Surgical Management of Pediatric Obstructive Sleep Apnea: Efficacy, Outcomes, and Alternatives-A Systematic Review. Life (Basel). 2024 Dec 12;14(12):1652. doi: 10.3390/life14121652. PMID: 39768359; PMCID: PMC11677306.
3. Alhazmi A. Etiology and prevalence of mouth breathing and related speech disorders in school-age children. J Taibah Univ Med Sci. 2022
4. Grippaudo C, Paolantonio EG, Antonini G, Saulle R, La Torre G, Deli R. Association between oral habits, mouth breathing, and malocclusion. Acta Otorhinolaryngol Ital. 2016;36(5):386-394. doi:10.14639/0392-100X-770. https://doi.org/10.14639/0392-100X-770
5. Inchingolo AD, Marinelli G, Cavino M, Zaminga LP, Savastano S, Inchingolo F, Tartaglia GM, Del Fabbro M, Palermo A, Inchingolo AM, Dipalma G. Assessment of the Effect of Rapid Maxillary Expansion on Nasal Respiratory Function and Obstructive Sleep Apnea Syndrome in Children: A Systematic Review. J Clin Med. 2025 Sep 18;14(18):6565. doi: 10.3390/jcm14186565. PMID: 41010785; PMCID: PMC12470613.
6. Laudadio C, Inchingolo AD, Malcangi G, Limongelli L, Marinelli G, Coloccia G, Montenegro V, Patano A, Inchingolo F, Bordea IR, Scarano A, Greco Lucchina A, Lorusso F, Inchingolo AM, Dipalma G, Di Venere D, Laforgia A. Management of anterior open-bite in the deciduous, mixed and permanent dentition stage: a descriptive review. J Biol Regul Homeost Agents. 2021 Mar-Apr;35(2 Suppl. 1):271-281. doi: 10.23812/21-2supp1-27. PMID: 34281324.

Copyright © 2026 Author(s) | CC BY 4.0 | PublyMed srls
doi: 10.59987/ads/2026.3.633-640

7. Pereira TC, Garber CR, Ramirez RM, et al. Relationship between mouth breathing etiology and maximum tongue pressure in children aged 3-12 years. CoDAS. 2019

8. Ceccanti G, Caruso S, Pasini M, Giuca MR, Lardani L, Severino M. Facial skeletal alterations in mouth breathing paediatric patients: cephalometric evaluations. J Biol Regul Homeost Agents. 2020 Jan-Feb;34(1 Suppl. 1):23-32. DENTAL SUPPLEMENT. PMID: 32064832.

9. Moss ML, Salentijn L. The primary role of functional matrices in facial growth. Am J Orthod. 1969;55(6):566-577. doi:10.1016/0002-9416(69)90034-7.
https://doi.org/10.1016/0002-9416(69)90034-7

10. Chowdhary V, Nagpal A, Kaur R, Chandila S. Mouth breathing effects on dentofacial growth in children: A cephalometric case-control study. 2024

11. Dipalma G, Marinelli G, Bassi P, Lagioia R, Calò F, Cavino M, Inchingolo F, Vinjolli F, Bordea IR, Minervini G, Saccomanno S, Palermo A, Maspero CMN, Inchingolo AD, Inchingolo AM. Impact of Functional Therapy on Skeletal Structures and Airways in Patients with Class II Malocclusion: Comparison of Treatment in Prepubertal and Pubertal Phases. Life (Basel). 2025 Jul 20;15(7):1144. doi: 10.3390/life15071144. PMID: 40724646; PMCID: PMC12300978.

12. Orazi M, Cagetti MG, Giannini L, Cenzato N, Maspero CMN. Prevalence and Predictive Factors of Angle's Class Malocclusion Asymmetries Without Crossbite in Primary School Children: A Cross-Sectional Study. Children (Basel). 2025 Nov 1;12(11):1473. doi: 10.3390/children12111473. PMID: 41300591; PMCID: PMC12651724.

13. Zheng W, Zhang X, Dong J, He J. Facial morphological characteristics of mouth breathers vs. nasal breathers: A systematic review and meta-analysis of lateral cephalometric data. Exp Ther Med. 2020;19(6):3738-3750. doi:10.3892/etm.2020.8611.
https://doi.org/10.3892/etm.2020.8611

14. Zhao Z, Zheng L, Huang X, Li C, Liu J, Hu Y. Effects of mouth breathing on facial skeletal development in children: A systematic review and meta-analysis. BMC Oral Health. 2021;21(1):108. doi:10.1186/s12903-021-01458-7.
https://doi.org/10.1186/s12903-021-01458-7

15. Cenzato N, Iannotti L, Maspero C. Open bite and atypical swallowing: orthodontic treatment, speech therapy or both? A literature review. Eur J Paediatr Dent. 2021 Dec;22(4):286-290. doi: 10.23804/ejpd.2021.22.04.5. PMID: 35034464.

16. Maspero C, Giannini L, Galbiati G, Rosso G, Farronato G. Obstructive sleep apnea syndrome: a literature review. Minerva Stomatol. 2015 Apr;64(2):97-109. English, Italian. PMID: 25747430.

17. Chambi-Rocha A, Cabrera-Domínguez ME, Domínguez-Reyes A. Breathing mode influence on craniofacial development and head posture. J Pediatr (Rio J). 2018;94(2):123-130. doi:10.1016/j.jped.2017.01.001.
https://doi.org/10.1016/j.jped.2017.01.001

18. Habumugisha J, Cheng B, Ma SY, Zhao MY, Bu WQ, Wang GL, Liu Q, Zou R, Wang F. A non-randomized concurrent controlled trial of myofunctional treatment in the mixed dentition children with functional mouth breathing assessed by cephalometric radiographs and study models. BMC Pediatr. 2022;22(1):506. doi:10.1186/s12887-022-03559-w.
https://doi.org/10.1186/s12887-022-03559-w

19. Caruso S, Nota A, Darvizeh A, Severino M, Gatto R, Tecco S. Poor oral habits and malocclusions after usage of orthodontic pacifiers: an observational study on 3-5 years old children. BMC Pediatr. 2019 Aug 22;19(1):294. doi: 10.1186/s12887-019-1668-3. PMID: 31438904; PMCID: PMC6706895.

20. Severino M, Mattei A, Vena F, Viarchi A, Truppa CT, Lombardo G, Carullo R, Cialfi D, Bertini L, Cianetti S. Associations between oral habits and specific malocclusion traits in children: a retrospective cross-sectional study in Italy. BMC Oral Health. 2025 Oct 6;25(1):1534. doi: 10.1186/s12903-025-06892-5. PMID: 41053646; PMCID: PMC12498458.

21. Oh JW, Won YG, Kim GH, Moon SJ. Clinical evaluation for pediatric patients with signs of mouth breathing: An observational cross-sectional study. Int J Environ Res Public Health. 2021;18(9):4900. doi:10.3390/ijerph18094900.
https://doi.org/10.3390/ijerph18094900

22. Morais-Almeida M, Wandalsen GF, Rosário Filho NA. Growth and mouth breathers. J Pediatr (Rio J). 2019;95 Suppl 1:66-71. doi:10.1016/j.jped.2018.11.005.
https://doi.org/10.1016/j.jped.2018.11.005

23. Dipalma G, Inchingolo AM, Casamassima L, Nardelli P, Ciccarese D, De Sena P, Inchingolo F, Palermo A, Severino M, Maspero CMN, Inchingolo AD. Effectiveness of Dental Restorative Materials in the Atraumatic Treatment of Carious Primary Teeth in Pediatric Dentistry: A Systematic Review. Children (Basel). 2025 Apr 16;12(4):511. doi: 10.3390/children12040511. PMID: 40310109; PMCID: PMC12026260.

24. Farronato M, Boccalari E, Del Rosso E, Lanteri V, Mulder R, Maspero C. A Scoping Review of Respirator Literature and a Survey among Dental Professionals. Int J Environ Res Public Health. 2020 Aug 17;17(16):5968. doi: 10.3390/ijerph17165968. PMID: 32824564; PMCID: PMC7460494.

25. Pacheco AB, Berwig LC, Berti LC, Hitos SF, Genaro KF, de Castro MM. Differential clinical assessment of oral breathing children: diagnostic guidelines study (n=687). 2015

26. Neiva PD, Kirkwood RN, Godinho R, Mendonca R, Merino G, Peroni T. Adenotonsillectomy effects on head and shoulder kinematics in mouth-breathing children. CoDAS. 2018

27. Contaldo M, Fusco A, Stiuso P, Lama S, Gravina AG, Itro A, Federico A, Itro A, Dipalma G, Inchingolo F, Serpico R, Donnarumma G. Oral

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doi: 10.59987/ads/2026.3.633-640

Microbiota and Salivary Levels of Oral Pathogens in Gastro-Intestinal Diseases: Current Knowledge and Exploratory Study. Microorganisms. 2021 May 14;9(5):1064. doi: 10.3390/microorganisms9051064. PMID: 34069179; PMCID: PMC8156550.

28. Manzini P, Rosmarini M, Frati E, Severino M, Caruso S. Tongue rehabilitation through the froggy mouth device: case series. J Biol Regul Homeost Agents. 2020 Jan-Feb;34(1 Suppl. 1):142-150. DENTAL SUPPLEMENT. PMID: 32064849.
29. Linder-Aronson S. Adenoids: their effects on mode of breathing and nasal air flow and their relationship to characteristics of the facial skeleton and the dentition. Acta Otolaryngol Suppl. 1970;265:1-132.
30. Valentim AF, Quevedo DG, et al. Thermographic evaluation of the perioral region in mouth-breathing children: detection of liphypotonia. 2025
31. Dipalma G, Inchingolo AM, Avantario P, Mancini A, Campanelli M, Di Venere D, Palermo A, Inchingolo F, Corsalini M, Inchingolo AD. Comparative Efficacy of Continuous Positive Airway Pressure and Mandibular Advancement Devices in the Treatment of Obstructive Sleep Apnea: A Systematic Review. J Sleep Res. 2026 Jun;35(3):e70192. doi: 10.1111/jsr.70192. Epub 2025 Sep 8. PMID: 40921722; PMCID: PMC13193437.
32. Greco AM, Gavetti F, Severino M, Gatto R. Use of a modified vertical holding appliance for open bite interceptive treatment in growing patients. Eur J Paediatr Dent. 2021;22(1):35-40. doi: 10.23804/ejpd.2021.22.01.07. PMID: 33719481.
33. Kandasamy S. Is there robust evidence that mouth breathing causes craniofacial changes in children? A critical narrative review. 2025
34. Ferati K, Bexheti-Ferati A, Palermo A, Pezzolla C, Trilli I, Sardano R, Latini G, Inchingolo AD, Inchingolo AM, Malcangi G, Inchingolo F, Dipalma G, Mancini A. Diagnosis and Orthodontic Treatment of Obstructive Sleep Apnea Syndrome Children-A Systematic Review. Diagnostics (Basel). 2024 Jan 29;14(3):289. doi: 10.3390/diagnostics14030289. PMID: 38337805; PMCID: PMC10855184.
35. nada E, Saitoh I, Hayasaki H, et al. Open mouth posture, lip morphology and nasal form in preschool children: a cross-sectional observational study. 2021
36. Inchingolo AD, Ferrara I, Viapiano F, Netti A, Campanelli M, Buongiorno S, Latini G, Carpentiere V, Ciocia AM, Ceci S, Patano A, Piras F, Cardarelli F, Nemore D, Malcangi G, Di Noia A, Mancini A, Inchingolo AM, Marinelli G, Rapone B, Bordea IR, Scarano A, Lorusso F, Di Venere D, Inchingolo F, Dipalma G. Rapid Maxillary Expansion on the Adolescent Patient: Systematic Review and Case Report. Children (Basel). 2022 Jul 14;9(7):1046. doi: 10.3390/children9071046. PMID: 35884030; PMCID: PMC9317392.
37. Inchingolo AD, Inchingolo AM, Campanelli M, Carpentiere V, de Ruvo E, Ferrante L, Palermo A, Inchingolo F, Dipalma G. Orthodontic treatment in patients with atypical swallowing and malocclusion: a systematic review. J Clin Pediatr Dent. 2024 Sep;48(5):14-26. doi: 10.22514/jocpd.2024.100. Epub 2024 Sep 3. PMID: 39275817.
38. Santacroce L, Charitos IA, Ballini A, Inchingolo F, Luperto P, De Nitto E, Topi S. The Human Respiratory System and its Microbiome at a Glimpse. Biology (Basel). 2020 Oct 1;9(10):318. doi: 10.3390/biology9100318. PMID: 33019595; PMCID: PMC7599718.
39. Cheng XD, et al. Comparison of three-dimensional facial soft tissue morphology in nasal versus mouth-breathing children with skeletal Class II malocclusion. 2023 https://doi.org/10.1016/j.identj.2022.09.002
40. Cantore S, Ballini A, Farronato D, Malcangi G, Dipalma G, Assandri F, Garagiola U, Inchingolo F, De Vito D, Cirulli N. Evaluation of an oral appliance in patients with mild to moderate obstructive sleep apnea syndrome intolerant to continuous positive airway pressure use: Preliminary results. Int J Immunopathol Pharmacol. 2016 Jun;29(2):267-73. doi: 10.1177/0394632015590949. Epub 2015 Dec 18. PMID: 26684627; PMCID: PMC5806714.

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doi: 10.59987/ads/2026.3.633-640