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The Role of Craniofacial Abnormalities and Orthodontic Interventions in Residual Obstructive Sleep Apnea after Adenotonsillectomy in Children: A Scoping Review

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Abstract

Background: Obstructive sleep apnea (OSA) in children is often treated with adenotonsillectomy, yet residual or persistent OSA occurs in 20–75% of cases, particularly in children with craniofacial abnormalities. These structural features contribute to ongoing airway obstruction and highlight the need for phenotype-specific management. The objective of this scoping review was to map the evidence on craniofacial and dentofacial contributions to residual OSA and assess the potential role of orthodontic interventions, particularly rapid maxillary expansion (RME), within a multidisciplinary framework.

Methods: This scoping review followed PRISMA-ScR guidelines and Joanna Briggs Institute methodology. A systematic search was conducted in PubMed, Web of Science, and Scopus from January 2010 to December 2025 using combinations of terms related to residual OSA, adenotonsillectomy, craniofacial abnormalities, and orthodontic interventions. Studies including children <18 years with residual/persistent OSA post-adenotonsillectomy were considered. Screening, selection, and data extraction were performed independently by two reviewers, with discrepancies resolved by discussion or a third reviewer. Data extracted included study design, sample size, craniofacial features, orthodontic interventions, outcomes (AHI, snoring, quality of life), and multidisciplinary management.

Results: Six studies met the inclusion criteria. Craniofacial features such as high/narrow palate, maxillary constriction, retrognathia, and Class II tendencies were consistently associated with residual OSA, with prevalence up to 93%. Orthodontic interventions, particularly RME, reduced AHI by up to 70%, decreased snoring, and improved quality of life in children with transverse maxillary deficiency. Multidisciplinary approaches involving ENT, sleep specialists, and orthodontists were emphasized for optimal assessment and management.

Conclusion: Craniofacial abnormalities are important but under-recognized contributors to persistent pediatric OSA post-adenotonsillectomy. Orthodontic treatments, especially RME, offer a valuable non-surgical adjunct in multidisciplinary care. Current evidence is limited by small sample sizes and few long-term trials. Future research should focus on high-quality, phenotype-driven studies to guide evidence-based management of residual OSA in children.

Keywords: Obstructive Sleep Apnea, Children, Adenotonsillectomy, Residual OSA, Craniofacial Abnormalities, Rapid Maxillary Expansion

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↑What is "already known" in this topic:
Adenotonsillectomy is the first-line treatment for pediatric OSA, but residual OSA commonly persists in many children, particularly in high-risk groups such as those with craniofacial abnormalities. Craniofacial features play a significant role in ongoing airway obstruction, and RME has shown promising improvements in AHI and symptoms as an adjunctive treatment in selected cases, although the evidence is largely from small or observational studies.

→What this article adds:
This scoping review maps the evidence on craniofacial and dentofacial abnormalities as key contributors to residual OSA after adenotonsillectomy in children, an area previously covered only fragmentarily. It emphasizes the emerging supportive role of orthodontic interventions (especially rapid maxillary expansion) in multidisciplinary management and identifies major gaps, including the need for high-quality RCTs and long-term outcome studies in non-syndromic populations.

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Introduction

Obstructive sleep apnea in children is a prevalent sleep-disordered breathing disorder, affecting 1–5% of the general pediatric population, with higher rates in high-risk groups such as those with obesity, craniofacial anomalies, or syndromic conditions (1-3). Characterized by recurrent upper airway collapse during sleep, pediatric OSA leads to fragmented sleep, intermittent hypoxemia, and hypercapnia, resulting in significant neurocognitive deficits, behavioral issues, cardiovascular strain, and impaired growth (4-6). Unlike adults, where obesity predominates as the primary risk factor, childhood OSA is frequently driven by adenotonsillar hypertrophy, though craniofacial and dentofacial abnormalities—such as maxillary constriction, retrognathia, high-arched palate, and class II malocclusion—play a substantial role in airway vulnerability (7-9).

Adenotonsillectomy remains the first-line treatment for most children with OSA associated with lymphoid hypertrophy, yielding substantial improvements in many cases (10, 11). However, residual or persistent OSA post-surgery is common, occurring in approximately 20–40% of children overall, with rates varying widely due to differences in follow-up duration, definition of residual OSA (e.g., AHI cutoff), and patient characteristics. In high-risk groups, such as those with comorbidities like craniofacial abnormalities, obesity, or severe baseline disease, persistence can reach up to 50–75% or higher (12-14). These structural factors contribute to ongoing airway obstruction by reducing nasopharyngeal volume, promoting posterior tongue displacement, and limiting nasal airflow, often rendering adenotonsillectomy insufficient alone (15, 16).

Orthodontic interventions, particularly rapid maxillary expansion, have gained attention as non-surgical adjuncts to address underlying skeletal discrepancies in children with transverse maxillary deficiency (17, 18). Systematic reviews and meta-analyses suggest RME can reduce the AHI by approximately 50–80% (with some studies reporting reductions up to 70–80%) alleviate snoring, and improve quality of life in selected cases, likely through increased nasal cavity dimensions and enhanced tongue posture (19-21) .Despite promising preliminary evidence, the literature remains heterogeneous due to variations in study design, patient selection (e.g., presence of residual adenotonsillar tissue or large tonsils), follow-up duration, and the lack of large high-quality randomized trials, particularly in non-syndromic children with residual OSA (22, 23).

Although previous studies have investigated OSA treatment outcomes and the effects of orthodontic interventions, there is a clear gap in systematically mapping the existing evidence regarding the contribution of craniofacial abnormalities to residual OSA after adenotonsillectomy in children. Furthermore, the role of orthodontic interventions within a multidisciplinary management framework remains underexplored, particularly for phenotype-specific approaches.

This scoping review aims to systematically map the evidence on the contribution of craniofacial abnormalities to residual OSA after adenotonsillectomy in children, and to explore the role of orthodontic interventions in its multidisciplinary management. The review seeks to identify key concepts, highlight knowledge gaps, and suggest directions for future research, in line with current clinical guidelines.

Methods

Design

The present scoping review was designed and conducted according to the methodological recommendations of the Joanna Briggs Institute (JBI). A structured approach was employed to examine and synthesize the current evidence on craniofacial abnormalities and orthodontic treatment strategies related to residual obstructive sleep apnea after adenotonsillectomy in children, while also highlighting major concepts, research trends, and knowledge gaps in the literature. The study was reported according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses extension for Scoping Reviews (PRISMA-ScR) checklist (Appendix) (23).

Eligibility criteria

The eligibility criteria for study selection were established according to the Population, Concept, and Context (PCC) framework proposed by the JBI, which guided the development of the review question and inclusion criteria.

Population

Participants aged <18 years with residual or persistent OSA or sleep-disordered breathing after adenotonsillectomy, presenting with craniofacial or dentofacial abnormalities.

Concept

Studies addressing at least one aspect of the role of craniofacial or dentofacial abnormalities as contributing factors to residual OSA, and/or evaluating orthodontic or orthopedic interventions (such as rapid maxillary expansion or other orthodontic appliances). Eligible studies were required to include an assessment of clinical outcomes (e.g., apnea–hypopnea index [AHI], snoring severity, or quality of life), or at least demonstrate a measurable trend in outcomes, and to provide level A or B evidence (randomized controlled trials, systematic reviews and meta-analyses, well-conducted comparative studies, or cohort studies).

Context

Residual or persistent OSA or sleep-disordered breathing as the primary pathology following adenotonsillectomy. Studies in which OSA was primarily driven by severe obesity without craniofacial involvement, as well as those focusing on complex neuromuscular, syndromic, or genetic conditions, were excluded.

Inclusion criteria

- Pediatric population (<18 years)
- Residual or persistent OSA/sleep-disordered breathing after adenotonsillectomy

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- Presence of craniofacial or dentofacial abnormalities
- Evaluation of craniofacial factors and/or orthodontic interventions
- Reporting of relevant clinical outcomes (AHI, snoring, or quality of life)
- Evidence level A or B
- Articles published in English between 1 January 2010 and 1 December 2025

Exclusion criteria

- Studies including only adult participants
- Case reports, narrative reviews, expert opinions, or conference abstracts
- OSA is primarily attributable to severe obesity without craniofacial components
- Neuromuscular, syndromic, or genetic disorders
- Studies lacking relevant outcome measures

Identification of studies

This review involved a comprehensive search strategy using both Medical Subject Headings (MeSH) and free-text terms. Free-text terms were identified through an iterative process that included screening of key articles, extraction of frequently used keywords from titles and abstracts, and expansion of MeSH terms using synonyms and entry terms available in PubMed**.** Pilot searches were conducted to refine the strategy and maximize sensitivity.

The search was restricted to articles written in English and published between 1 January 2010 and 1 December 2025, using combinations of terms such as “residual obstructive sleep apnea,” “persistent OSA,” “post-adenotonsillectomy,” “craniofacial abnormalities,” “dentofacial morphology,” “malocclusion,” “rapid maxillary expansion,” “orthodontic treatment,” “child,” and “pediatric”.

Three electronic databases were searched: PubMed, Web of Science, and Scopus, with Title/Abstract filters applied where appropriate to reduce irrelevant records.

The complete electronic search strategy for PubMed was as follows:

((“Obstructive Sleep Apnea”[Mesh] OR "residual obstructive sleep apnea" OR "persistent OSA") AND ("Adenotonsillectomy" OR "adenotonsillectomy"[Mesh])
AND ("Craniofacial Abnormalities"[Mesh] OR craniofacial OR dentofacial OR malocclusion)
AND ("Orthodontic Treatment" OR "Rapid Maxillary Expansion" OR orthodontic)
AND (child OR pediatric*))**

Screening, study selection, and data extraction

All retrieved records from the electronic database searches were imported into a reference management software, and duplicate records were removed prior to screening. The screening and study selection process was conducted in two sequential stages by two independent reviewers.

In the first stage, titles and abstracts were screened independently against the predefined inclusion and exclusion criteria. Studies that were clearly irrelevant were excluded at this stage. In the subsequent screening stage, full-text versions of potentially eligible articles were independently reviewed by the same investigators to determine their final inclusion in the review. Discrepancies between reviewers at any stage were addressed through mutual discussion, with involvement of a third reviewer when required to reach an agreement.

The study selection process was documented and reported using a PRISMA-ScR flow diagram, detailing the number of records identified, screened, excluded (with reasons), and included in the final review.

Data extraction was performed independently by two reviewers using a predefined and pilot-tested data extraction form developed specifically for this scoping review. Extracted data included: author(s), year of publication, country, study design, study population characteristics, type of craniofacial or dentofacial abnormality, details of orthodontic or orthopedic interventions (if applicable), outcome measures (e.g., apnea–hypopnea index, snoring severity, quality of life), and key findings relevant to residual obstructive sleep apnea following adenotonsillectomy. Any disagreements in data extraction were resolved through discussion and consensus to ensure accuracy and consistency.

Results

The study selection process is presented in Figure 1. In total, about 579 studies were identified through the electronic database search. After duplicates were removed (n≈570 unique records), titles and abstracts were screened. Forty full-text articles were assessed for eligibility. Eleven articles met the inclusion criteria based on relevance to residual/persistent OSA post-adenotonsillectomy and craniofacial/orthodontic elements. However, only six articles were accessible in full text and were therefore included in the final scoping review. The key characteristics of these six studies are summarized in Table 1.

These articles included one retrospective cohort (24), one narrative review (25), one prospective comparative study (26), one retrospective review (27), one prospective interventional study (28), and one preliminary cephalometric study (29). The orthodontic intervention (primarily rapid maxillary expansion) was examined in 2 articles(25, 28) , while the remaining focused on identifying craniofacial contributions to residual OSA without direct intervention (24, 26, 27, 29). Among the included studies, sample sizes varied considerably, ranging from 13 (29) to 400 participants (27).

The findings of this review were analyzed with a focus on the role of craniofacial abnormalities and the effectiveness of orthodontic interventions in residual obstructive sleep apnea following adenotonsillectomy. The main criterion for evaluating outcomes was a reduction in the AHI or improvements in snoring/quality of life. Among the studies examining craniofacial contributions, high/narrow palate, retrognathia/small mandible, maxillary constriction, and class II tendencies were consistently identified as key factors in persistent OSA, with prevalence up to 93.3% (27).

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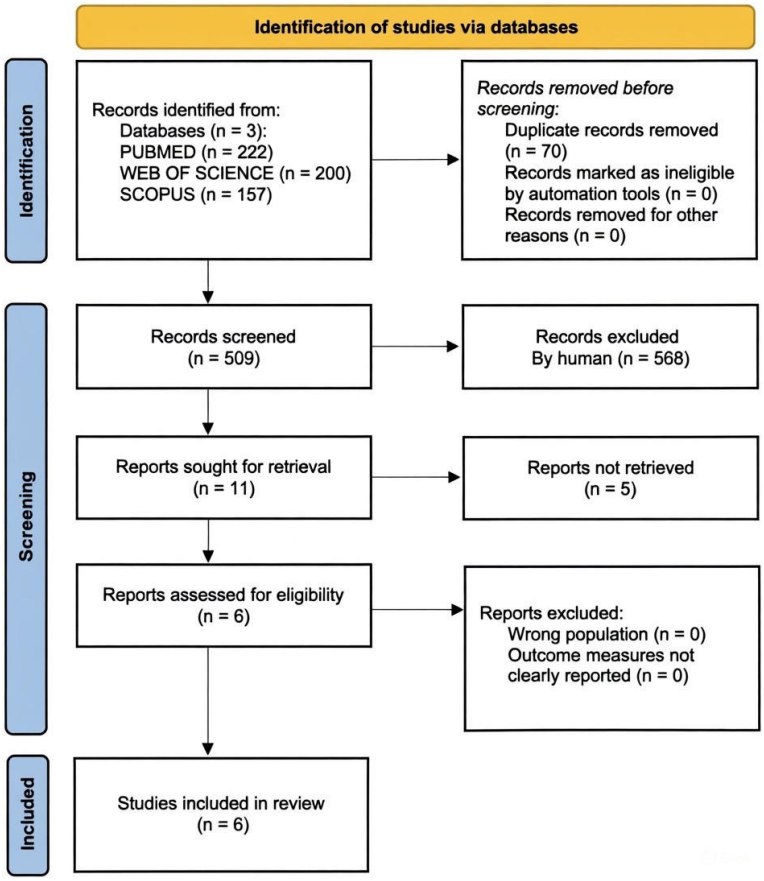

Figure 1. Flow diagram

For example, Kim & Guilleminault reported residual AHI in 44.2% of 400 children post-adenotonsillectomy, attributing incomplete resolution to a narrow nasomaxillary complex and retroplaced mandible (27). Similarly, Yap et al. found higher obstructive AHI (1.26 vs 0.16 in controls) in children with narrower maxillary arch and posterior crossbite, suggesting routine orthodontic records can detect risks for persistent snoring (26). Kortge et al. observed residual OSA requiring PAP in 23% of 150 children with craniofacial abnormalities or skeletal dysplasia (24).

Regarding orthodontic interventions, RME showed promising results in cases with transverse maxillary deficiency. Bariani et al. demonstrated significant reductions in snoring, OSA-18 scores, PSQ, ESS, and CAS (P<0.001) in 24 children post-RME, indicating improved quality of life (28). Leung et al., in a narrative review, reported up to 70% AHI reduction with RME in selected cases and emphasized its role in multidisciplinary management (25).

Multidisciplinary approaches (involving ENT, orthodontics, and sleep specialists) were highlighted in several studies as essential for addressing residual cases(24, 25, 28). Overall, craniofacial abnormalities appear to significantly contribute to incomplete resolution after adenotonsillectomy, while orthodontic interventions like RME offer potential benefits for symptom relief in appropriately selected children. Knowledge gaps include limited long-term follow-up and RCTs specifically on orthodontic efficacy in residual OSA.

Discussion

The objective of this scoping review was to identify and map the current evidence on craniofacial and dentofacial factors associated with residual or persistent OSA after adenotonsillectomy in children, as well as to evaluate the potential role of orthodontic interventions in its management (24-29).

Regarding the selection criteria, no restrictions were applied based on the quantitative or qualitative characteristics of the study samples, provided that the population consisted of children under 18 years with residual or persistent OSA following adenotonsillectomy. However, patient age ranges and inclusion criteria varied across studies, complicating generalisation of findings. The challenge of recruiting sufficient patients, combined with underdiagnosis of residual OSA in craniofacial cases, often resulted in small to moderate sample sizes, limiting large-scale extrapolation (26, 27).

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Table 1. Characteristics and Key Findings of Included Studies

Study ID	Authors (Year)	Study Design	Sample Size	Type of Craniofacial/ Dentofacial Abnormality	Orthodontic Intervention	Key Outcomes (e.g., Change in AHI/Snoring/QoL)	Multidisciplinary Management	Key Conclusions
1	Kortge et al. (2025)	Retrospective cohort	150	Craniofacial abnormalities (69%), skeletal dysplasia (25%)	None	23% residual OSA requiring PAP; snoring primary symptom (61%)	Yes (Respiratory/Sleep Medicine, ENT, Plastic Surgery)	Anatomic malformations are key contributors to residual OSA; surgery is effective in 77%.
2	Leung et al. (2021)	Narrative review	N/A	Mandibular hypoplasia, narrow/high palate, class II malocclusion	RME (up to 70% AHI reduction reported)	Residual OSA rates 20-54% post-AT; improvements in symptoms with orthodontics	Yes (pulmonologist, ENT, orthodontist)	Orthodontics promising for selected residual cases; multidisciplinary approach essential.
3	Yap et al. (2019)	Prospective comparative	19	Increased lower face height, narrower maxillary arch, class II tendencies, posterior crossbite	Suggested (e.g., maxillary expansion)	Higher OAHI in the SDB group (1.26 vs 0.16); increased risk of persistent snoring post-AT	Implied (ENT + orthodontics for detection)	Routine orthodontic records are useful for identifying risks of persistent SDB.
4	Kim & Guilleminault (2011)	Retrospective review	400	High/narrow hard palate, small/retroplaced mandible, narrow nasomaxillary complex (93.3%)	None (references to RME in literature)	Residual AHI in 44.2% post-AT; mean pre-AT AHI 14.6	Implied (sleep medicine + ENT)	Craniofacial features predict incomplete response to AT; the Mallampati score is predictive.
5	Bariani et al. (2023)	Prospective interventional	24	Transverse maxillary deficiency/constriction	(RME)	Significant reductions in snoring, OSA-18, PSQ, ESS, CAS scores ($p<0.001$); improved QoL	Yes (otorhinolaryngology + orthodontics)	RME is effective for persistent snoring/OSA in children with maxillary constriction post-AT.
6	Maeda et al. (2014)	Preliminary cephalometric study	13	Smaller mandible relative to Japanese norms	None (suggests future orthodontic appliances)	AHI reduced from 12.3 to 3.0 post-AT ($p=0.001$); residual OSA in 84.6%	Implied (somnology + otolaryngology + cephalometry)	A smaller mandible contributes to residual OSA; evaluate maxillomandibular morphology in planning.

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Moreover, some studies focused on specific subgroups (e.g., syndromic or non-obese children), while treatment responses may differ depending on the underlying phenotype, making it difficult to reach consensus on the efficacy of orthodontic approaches in broader populations (3, 24, 25).

In terms of diagnosis, preoperative and postoperative polysomnography (PSG), considered the gold standard, was reported in most studies but not uniformly applied. The apnea-hypopnea index (AHI) served as the primary objective outcome, yet cut-off points for defining "residual" OSA or treatment success varied (e.g., AHI <1 or <5), and there remains no universal consensus on pathological thresholds in children (25, 27, 30). Alternative tools, such as routine orthodontic records (lateral cephalometrics) or clinical scores (OSA-18, PSQ), were highlighted for detecting craniofacial risks early, offering practical screening advantages in dental settings (15, 26).

Regarding the role of craniofacial abnormalities, the included studies consistently demonstrated that features such as high/narrow hard palate, maxillary constriction, retrognathia/small mandible, and class II malocclusion are major contributors to incomplete resolution after adenotonsillectomy, with a high prevalence of such craniofacial features in children with residual or persistent OSA, particularly in selected or high-risk groups (e.g., up to 93.3% in some studies reporting specific facial characteristics as risk factors) (8, 27). These structural factors likely maintain upper airway obstruction through reduced nasal volume, posterior tongue displacement, and impaired airflow, explaining residual rates of 20–40% (or higher in high-risk groups) in affected children (2, 24, 25, 27, 31). This underscores that adenotonsillectomy, while effective for adenotonsillar hypertrophy, often fails to address underlying skeletal discrepancies, leading to persistent symptoms such as snoring and elevated AHI (26, 29, 32).

Orthodontic interventions, particularly RME, emerged as a promising non-invasive option for cases with transverse maxillary deficiency. Evidence showed significant improvements in snoring, quality-of-life scores (OSA-18), and daytime symptoms post-RME, with systematic reviews and meta-analyses reporting AHI reductions of 50–70% in selected patients (18, 25, 28, 33). These benefits probably arise from increased nasal cavity dimensions and better tongue posture, directly targeting the dentofacial mismatch implicated in residual OSA (17, 34).

Although the evidence is encouraging, it remains preliminary—largely from observational or small interventional studies—without robust long-term data or direct comparisons to alternatives like continuous positive airway pressure (CPAP) or revision surgery (21, 25, 28). RME and similar appliances require patient cooperation and good oral hygiene, but are less invasive than surgical revisions, positioning orthodontics as a valuable adjunct rather than a standalone therapy (19).

Multidisciplinary management was emphasised across studies as essential for optimal care, involving otolaryngologists (ENT), sleep specialists, orthodontists, and pulmonologists for comprehensive phenotyping and tailored interventions (5, 24, 25, 28). Routine integration of orthodontic assessment (e.g., cephalometrics) could facilitate early identification of at-risk children, enabling phenotype-driven strategies that combine adenotonsillectomy with orthodontic correction to prevent or treat residual disease (7, 26).

A few studies also explored emerging diagnostic tools, such as drug-induced sleep endoscopy (DISE) or cine-MRI, which may better localize obstruction sites and guide the selection of orthodontic versus surgical revisions (24, 35). Additionally, while not the primary focus, supportive therapies like myofunctional re-education were noted in reviews as potential complements to orthodontic treatment for sustaining airway improvements (25, 36).

Although a comprehensive search strategy was applied covering the period from 2010 to 2025 with broad eligibility criteria, only a limited number of studies were identified. This reflects the emerging nature of the topic, scarcity of high-level evidence (few RCTs), and access constraints (full texts available for only 6 of 11 eligible studies).

Scoping reviews are limited by the inclusion of heterogeneous methodologies—such as retrospective cohort studies, review articles, and interventional trials—which may affect the overall validity and strength of the conclusions drawn.

However, despite these limitations, this scoping review effectively maps the field, highlights craniofacial abnormalities as an under-recognised driver of residual OSA, and positions orthodontic interventions—particularly RME—as a key complementary role in multidisciplinary care (2, 3, 10).

Future investigations should focus on long-term outcomes of orthodontic appliance therapy in residual OSA, with an emphasis on randomized controlled trials in non-syndromic children presenting with defined craniofacial characteristics post-adenotonsillectomy.

Prospective trials incorporating advanced imaging and standardised multidisciplinary protocols would strengthen evidence and guide clinical recommendations. Greater collaboration between ENT specialists and orthodontists could ultimately improve outcomes, reducing reliance on long-term CPAP or repeated surgeries in this vulnerable population.

Conclusion

Residual OSA following adenotonsillectomy in pediatric patients poses a major therapeutic challenge due to its significant impact on quality of life, growth development, and long-term prognosis, including potential progression to adult OSA and cardiopulmonary morbidity. The variability in clinical presentation, coupled with diverse risk factors—particularly craniofacial and dentofacial abnormalities—complicates effective management. Early detection of these structural contributors would facilitate timely intervention in severe cases, minimising secondary effects such as restricted craniofacial growth and neurocognitive impairment.

The results of this scoping review offer a comprehensive overview for clinicians managing residual OSA in children. By highlighting the prominent role of craniofacial abnormalities and the emerging evidence for orthodontic interventions (particularly rapid maxillary expansion), this

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study underscores the necessity of personalised, phenotype-driven assessment. Proper multidisciplinary evaluation, involving otolaryngologists, sleep specialists, and orthodontists, is crucial to identify suitable treatment pathways.

This review highlights orthodontic interventions as minimally invasive alternatives or adjuncts to revision surgery and long-term continuous positive airway pressure (CPAP), with the potential to achieve more stable long-term outcomes, reduce symptom recurrence, and improve overall quality of life in pediatric patients. Accordingly, it emphasizes the importance of a multidisciplinary and individualized approach to the management of residual obstructive sleep apnea in children. The findings also underscore the need for further high-quality research focusing on orthodontic treatment modalities to establish robust evidence-based recommendations and strengthen future clinical guidelines.

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Conflict of Interests

The authors declare that they have no competing interests.

Authors' Contributions

All authors contributed to the conception and design of the study. Literature search, data extraction, manuscript drafting, and critical revision were performed collaboratively by the authors. All authors read and approved the final manuscript.

Ethical Considerations

Because this study is a scoping review based on previously published literature, ethical approval and informed consent were not required.

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Data Availability

All bibliographic data supporting this review are available within the reference list, including DOIs where applicable.

AI Use Statement

The authors declare that artificial intelligence tools were used solely to assist with language editing and grammatical refinement during the preparation of this manuscript. No artificial intelligence tools were used for data collection, study selection, data analysis, interpretation of findings, or drawing scientific conclusions.

All intellectual content, including study design, data synthesis, and manuscript development, was performed exclusively by the authors. The authors take full responsibility for the integrity and accuracy of the work.

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Appendix. Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for Scoping Reviews (PRISMA-ScR) Checklist

SECTION	ITEM	PRISMA-ScR CHECKLIST ITEM	REPORTED ON PAGE #
TITLE			
Title	1	Identify the report as a scoping review.	1
ABSTRACT			
Structured summary	2	Provide a structured summary that includes (as applicable): background, objectives, eligibility criteria, sources of evidence, charting methods, results, and conclusions that relate to the review questions and objectives.	1
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of what is already known. Explain why the review questions/objectives lend themselves to a scoping review approach.	2
Objectives	4	Provide an explicit statement of the questions and objectives being addressed with reference to their key elements (e.g., population or participants, concepts, and context) or other relevant key elements used to conceptualize the review questions and/or objectives.	2
METHODS			
Protocol and registration	5	Indicate whether a review protocol exists; state if and where it can be accessed (e.g., a Web address); and if available, provide registration information, including the registration number.	2
Eligibility criteria	6	Specify characteristics of the sources of evidence used as eligibility criteria (e.g., years considered, language, and publication status), and provide a rationale.	2
Information sources*	7	Describe all information sources in the search (e.g., databases with dates of coverage and contact with authors to identify additional sources), as well as the date the most recent search was executed.	3
Search	8	Present the full electronic search strategy for at least 1 database, including any limits used, such that it could be repeated.	3
Selection of sources of evidence†	9	State the process for selecting sources of evidence (i.e., screening and eligibility) included in the scoping review.	3
Data charting process‡	10	Describe the methods of charting data from the included sources of evidence (e.g., calibrated forms or forms that have been tested by the team before their use, and whether data charting was done independently or in duplicate) and any processes for obtaining and confirming data from investigators.	4
Data items	11	List and define all variables for which data were sought and any assumptions and simplifications made.	3
Critical appraisal of individual sources of evidence§	12	If done, provide a rationale for conducting a critical appraisal of included sources of evidence; describe the methods used and how this information was used in any data synthesis (if appropriate).	3
Synthesis of results	13	Describe the methods of handling and summarizing the data that were charted.	3
RESULTS			
Selection of sources of evidence	14	Give numbers of sources of evidence screened, assessed for eligibility, and included in the review, with reasons for exclusions at each stage, ideally using a flow diagram.	4
Characteristics of sources of evidence	15	For each source of evidence, present characteristics for which data were charted and provide the citations.	4
Critical appraisal within sources of evidence	16	If done, present data on critical appraisal of included sources of evidence (see item 12).	4
Results of individual sources of evidence	17	For each included source of evidence, present the relevant data that were charted that relate to the review questions and objectives.	5
Synthesis of results	18	Summarize and/or present the charting results as they relate to the review questions and objectives.	5
DISCUSSION			
Summary of evidence	19	Summarize the main results (including an overview of concepts, themes, and types of evidence available), link to the review questions and objectives, and consider the relevance to key groups.	4,6
Limitations	20	Discuss the limitations of the scoping review process.	6
Conclusions	21	Provide a general interpretation of the results with respect to the review questions and objectives, as well as potential implications and/or next steps.	6,7
FUNDING			
Funding	22	Describe sources of funding for the included sources of evidence, as well as sources of funding for the scoping review. Describe the role of the funders of the scoping review.	7

JBI = Joanna Briggs Institute; PRISMA-ScR = Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for Scoping Reviews.
* Where sources of evidence (see second footnote) are compiled from, such as bibliographic databases, social media platforms, and Web sites.
† A more inclusive/heterogeneous term used to account for the different types of evidence or data sources (e.g., quantitative and/or qualitative research, expert opinion, and policy documents) that may be eligible in a scoping review as opposed to only studies. This is not to be confused with information sources (see first footnote).
‡ The frameworks by Arksey and O'Malley (6) and Levac and colleagues (7) and the JBI guidance (4, 5) refer to the process of data extraction in a scoping review as data charting.
§ The process of systematically examining research evidence to assess its validity, results, and relevance before using it to inform a decision. This term is used for items 12 and 19 instead of "risk of bias" (which is more applicable to systematic reviews of interventions) to include and acknowledge the various sources of evidence that may be used in a scoping review (e.g., quantitative and/or qualitative research, expert opinion, and policy document).

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