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Exploring the Impact of Twin-Block Appliances on Sleep-Disordered Breathing and Sleep Quality in Children: A Scoping Review

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ABSTRACT

Sleep-disordered breathing (SDB), including conditions such as obstructive sleep apnea (OSA), poses a serious concern in children due to its negative effects on cognition, behavior, and overall well-being. One of the underlying causes of SDB is mandibular skeletal deficiency, which is frequently observed in Class II malocclusion. The Twin-Block appliance, a functional orthodontic device, has been explored for its ability to advance the mandible and potentially improve airway patency and sleep-related physiological parameters. This scoping review aimed to explore and summarize the breadth of existing evidence concerning the influence of Twin-Block treatment on pediatric SDB and sleep quality. A comprehensive search, guided by the participants, interventions, comparisons, outcomes, and study design (PICOS) framework, was conducted across PubMed, Scopus, and ScienceDirect for studies published between 2015 and 2025. Abstracts, eligible full texts, and reference lists were screened, and all reported primary and non-primary outcomes, as well as methods of measurement, were recorded. Eligible studies included clinical and observational research assessing outcomes such as the apnea-hypopnea index (AHI), blood oxygen saturation, airway morphology, and aspects of sleep architecture. The review process followed Joanna Briggs Institute (JBI) methodological guidance for scoping reviews. Thirteen studies met the inclusion criteria, most of which demonstrated positive changes following Twin-Block intervention, including reduced AHI, improved oxygen saturation, enlarged upper airway dimensions, and enhanced sleep quality. However, discrepancies in research designs, intervention protocols, and measurement tools contributed to substantial variability across studies. Twin-Block therapy may provide a beneficial complementary approach to managing SDB in children, especially those with mandibular deficiencies. Nonetheless, more rigorous and standardized studies are necessary to confirm its effectiveness and support its broader application in clinical practice.

Keywords: Twin-Block Functional appliance, Mandibular advancement therapy, Sleep-disordered breathing, Obstructive sleep apnea, Sleep quality.

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INTRODUCTION

Sleep-disordered breathing (SDB) in children is a spectrum of conditions that includes snoring, partial obstruction of the airway, and obstructive sleep apnea (OSA). SDB can affect children's growth and development, including behavior, academic performance, and overall quality of life (Fernandes et al., 2024; Lyra et al., 2020). Epidemiological data reveal that the prevalence of obstructive sleep disorder (SDB) in children ranges from 7% to 16.9%, with a significant association with craniofacial abnormalities and malocclusion, emphasizing the importance of early detection and intervention. If left untreated, SDB in children can cause negative impacts, such as decreased academic performance, cardiovascular problems, and behavioral disorders, which underscores the need to implement effective therapeutic strategies (Piełunowicz et al., 2025). Traditional treatment has relied more on non-orthodontic interventions, especially adeno-tonsillectomy. However, recent research highlights the important role of orthodontic approaches in addressing anatomical factors that contribute to airway obstruction (Özköylü et al., 2024).

Among various contemporary orthodontic modalities, the Twin-Block appliance has gained considerable attention due to its potential to enlarge upper airway dimensions, reposition the mandible, and reduce OSA symptoms in children during the growth period

(Duan et al., 2022; Khan et al., 2022; Zreaqat et al., 2025). Recent meta-analyses and controlled clinical trials show that Twin-Block therapy can significantly lower the apnea-hypopnea index (AHI), increase minimum oxygen saturation, and improve various health-related aspects of quality of life in children with mandibular retrognathia and OSA. Compared to other functional appliances, the Twin-Block design offers greater mandibular advancement and better patient adherence, both of which are important factors in the successful treatment of SDB related to craniofacial morphology (Jeha & Haddad, 2024; Radwan et al., 2024; Saifeldin & Negm, 2024). However, the diversity of reported results, variations in study designs, and differences in patient selection have led to an incomplete understanding of the true effectiveness and optimal clinical applications of this appliance.

It should be noted that the mechanism by which the Twin-Block appliance reduces upper airway collapsibility and improves sleep architecture remains the subject of ongoing research (Bariani et al., 2022; Batra & Shetty, 2022). Several studies using advanced imaging and polysomnography have provided evidence that Twin-Block therapy results in favorable structural changes in the oropharyngeal airway, reduces the prevalence and severity of apneic events, and moderately improves sleep efficiency metrics (Entrenas et al., 2019). Although these results are promising, there are still differences in findings regarding the magnitude of improvement, the sustainability of post-treatment outcomes, and the subpopulation groups most likely to benefit, especially given the diversity of dental arch relationships and accompanying comorbidities. This complexity underscores the need for systematic mapping of current scientific evidence through a scoping review to identify knowledge gaps, support clinical guidelines, and formulate future research agendas (Anagnostopoulos et al., 2025). Taking into account methodological variations and the rapid development of sleep medicine, a comprehensive scoping review is needed to synthesize existing data, clarify indications, and assess the scope and limitations of the literature related to the impact of Twin-Block appliance use on sleep quality and sleep-disordered breathing (SDB) in children. This review will compile findings related to patient characteristics, device use protocols, duration of therapy, and both subjective and objective sleep outcomes, enabling clinicians and policymakers to identify patterns and prioritize high-value research directions. Furthermore, this effort aligns with current best-practice approaches that emphasize individualized and interdisciplinary management of sleep disorders in children and require strong evidence to support therapeutic decision-making (Entrenas et al., 2019; Genc et al., 2022; Ramar et al., 2015). Therefore, this scoping review aims to systematically explore and elucidate the effects of Twin-Block appliance use on sleep-disordered breathing (SDB) and sleep quality in children. Specifically, the research question is as follows: in children diagnosed with sleep-disordered breathing (participants), how does treatment using Twin-Block orthodontic appliances (interventions), compared to no treatment or alternative therapeutic modalities (comparators), affect respiratory sleep outcomes, polysomnography parameters, and patient-reported quality of life (outcomes), as documented in observational studies, randomized and non-randomized trials, as well as systematic reviews conducted in the past decade (study design)? This review aims to map and critically evaluate the available literature, highlight gaps in scientific evidence, and propose priorities for further research in the orthodontic management of SDB in pediatric populations.

RESEARCH METHODS

The type of research conducted is a scoping review. This study uses the PRISMA-ScR (Preferred Reporting Items for Systematic Reviews and Meta-Analyses extension for Scoping Reviews) guidelines. A comprehensive literature search was conducted with reference to the PICOS (Participants, Interventions, Comparisons, Outcomes, and Study design) framework through the PubMed, Scopus, and ScienceDirect databases for research articles in the form of randomized clinical trials (RCTs), quasi-experimental, cohort, and case reports published between 2015 and 2025. Exclusion criteria include review articles, animal studies, non-English publications, and non-open access articles. The PICOS framework is also applied in the following inclusion criteria:

P (Participants): Children diagnosed with sleep-disordered breathing (SDB), including conditions such as obstructive sleep apnea (OSA).

I (Intervention): Therapy using twin-block orthodontic devices aimed at advancing the mandible and improving the airway dimensions.

C (Comparison): No treatment or compared with alternative therapy modalities (e.g. adeno-tonsillectomy, other orthodontic devices, or placebo).

(Outcomes): Respiratory sleep outcomes (such as apnea-hypopnea index), polysomnographic parameters (oxygen saturation, sleep architecture), as well as patient-reported quality of life or sleep quality.

S (Study design): Randomized control trial (RCT), quasi-experimental, cohort, and case report studies conducted in the last ten years.

The search was conducted using keywords: (("Twin-Block" OR "Functional appliance" OR "Mandibular advancement therapy") AND ("Sleep- disordered breathing" OR "Obstructive sleep apnea" OR "Sleep quality")). This scoping review aims to explore and summarize the scope of existing scientific evidence on the effect of twin-block therapy on SDB and sleep quality in children. Abstracts of all studies found were evaluated by one reviewer (I.W) who had experience in reviewing patient-reported outcomes and clinical trial design. Articles in full-text form are obtained for studies that meet the inclusion criteria or when the information in the title and abstract is insufficient to make a decision. The second reviewer (M.G) helped resolve the uncertainty related to the final inclusion until consensus was reached. The JBI Critical Assessment Tool checklist is used to assess the quality of studies.

RESULTS AND DISCUSSION

A total of 158 articles were collected in the initial stage, consisting of 19 articles from the Scopus database, 20 articles from PubMed, and 119 articles from ScienceDirect. After the process of removing duplicate articles, 36 articles were eliminated, leaving 122 articles. The next screening was conducted based on titles and abstracts, which resulted in 39 articles and eliminated another 83 articles. The subsequent screening process, based on full-text review, resulted in 19 articles that met the inclusion criteria and excluded an additional 20 articles. The final stage, involving screening based on reasons for full-text exclusion, resulted in 13 articles being included in the qualitative synthesis, while the remaining 6 articles were excluded for the following reasons: 1 article could not be translated, 1 article was only available as a poster, 2 articles were not openly accessible (non-open access), and 2 articles had not presented research

results. The article selection procedure is visually depicted in the PRISMA-ScR flowchart (Diagram 1). This scoping review synthesized findings from thirteen studies examining the effects of the use of Twin-Block appliances and other mandibular advancement devices in the management of obstructive sleep apnea (OSA) in children with Class II malocclusion.

The decrease in the Apnea-Hypopnea Index (AHI) is a prominent and consistent finding. Zreaqat et al. (2025) and Zreaqat et al. (2023) reported a reduction in AHI of approximately 74–75% after Twin-Block therapy. Mastud et al. (2024) and Duan et al. (2025) also documented a significant decrease in AHI, accompanied by an increase in airway volume and changes in hyoid bone position. Similarly, Bignotti et al. (2019) demonstrated the benefits of a combined surgical and orthodontic approach, where the AHI decreased from 25.5 to 3.4 after tonsillectomy and further to 0.7 following Twin-Block therapy. Idris et al. (2018), through randomized crossover clinical trials, reported a 37% reduction in AHI, along with improvements in quality of life and a reduction in snoring duration (Bignotti et al., 2019; Duan et al., 2025; Mastud et al., 2024).

An increase in upper airway dimensions has been confirmed in several studies. Duan et al. (2024) found significant improvements in the width, volume, and area of the palatal region following the use of a modified Twin-Block appliance. Zreaqat et al. (2023) and Pavoni et al. (2017) also reported an increase in oropharyngeal airway volume, along with anterior displacement of the hyoid bone, further supporting the structural effectiveness of mandibular advancement. Batra and Shetty (2022) observed an increase in the SNB angle and mandibular advancement, which correlated with improvements in sleep parameters (Idris et al., 2018; Pavoni et al., 2017). Improvements in sleep outcomes, both subjective and objective, have been consistently reported across various studies. Zreaqat et al. (2025) reported significant improvements in four out of five domains of quality of life based on the OSA-18 questionnaire. Similarly, improved sleep quality, decreased snoring frequency, and behavioral improvements were reported in studies by Idris et al. (2018) and Batra and Shetty (2022).

Biochemical evidence related to the reduction of systemic inflammation is also evident in several studies. Bhosale et al. (2023) reported a decrease in salivary C-reactive protein (CRP) levels post-treatment, while Bhosale and Shetty (2023) found significant reductions in tumor necrosis factor-alpha (TNF-α) and malondialdehyde (MDA), indicating decreased oxidative stress. In contrast, Zreaqat et al. (2023) reported improvements in sleep and airway function without significant changes in systemic biomarkers such as urinary leukotriene E4 and serum CRP (Bhosale et al., 2023; Bhosale & Shetty, 2023; Zreaqat et al., 2023).

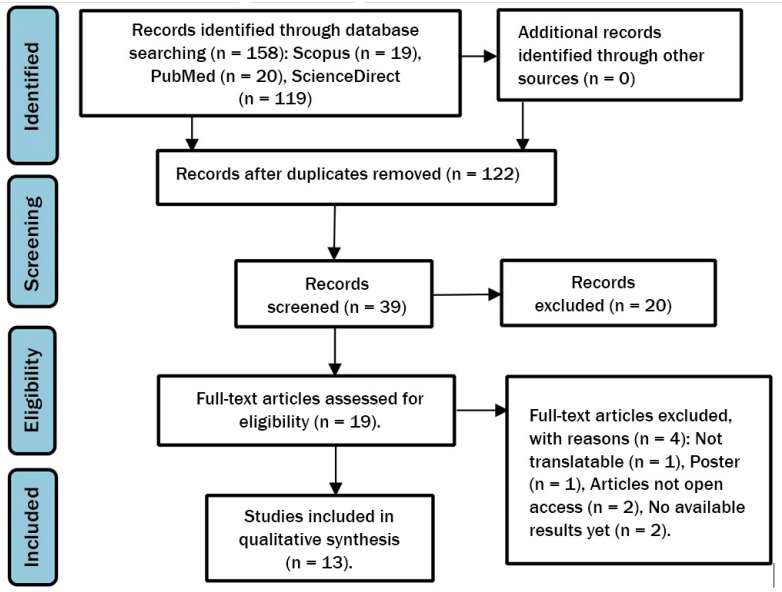

Diagram 1. Diagram alur PRISMA ScR

Table 1. Risk assessment of bias

No	Study	1	2	3	4	5	6	7	8	9	10	11	12	13	Assessment
Quasi-Experimental															
1	Idris Et Al., 2018	YES	YES	YES	YES	NO	YES	YES	YES	YES	YES	YES	YES	YES	LOW RISK OF BIAS
2	Mustfa Et Al., 2024	UNCLEAR	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	HIGH QUALITY
3	Duan Et Al., 2024	YES	YES	NO	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	MODERATE QUALITY
4	Kumar Et Al.,	UNCLEAR	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	HIGH QU

	2022														ALITY
5	Bhaskar & Shetty, 2023	UNCLEAR	YES	NO	YES	YES	YES	UNCLEAR	YES	YES	YES	YES	YES	YES	MODERATE QUALITY
6	Baran & Shetty, 2022	UNCLEAR	YES	NO	YES	YES	YES	UNCLEAR	YES	YES	YES	YES	YES	YES	LOW QUALITY
7	Parthi Et Al., 2017	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	HIGH QUALITY
Cohort															
1	Zhang Et Al., 2023	NO	N/A	YES	PARTIALLY	YES	YES	YES	PARTIALLY	NO	YES	YES	YES	YES	POOR QUALITY
2	Trequet Et Al., 2023	YES	YES	YES	PARTIALLY	YES	YES	YES	YES	NO	YES	YES	YES	YES	GOOD QUALITY
3	Bhaskar Et Al., 2023	NO	N/A	YES	PARTIAL	NO	YES	YES	PARTIALLY	NO	YES	YES	YES	YES	POOR QUALITY

					LY										
4	Risk Et Al., 2020	YES	YES	YES	PARTIALLY	YES	YES	YES	YES	/ A	YES	YES	YES	YES	GOOD QUALITY
Case Report															
1	Bighetti Et Al., 2019	YES	YES	YES	YES	YES	YES	PARTIALLY	YES	YES	YES	YES	YES	YES	HIGH QUALITY

Table 2. Presentation of data analysis

No	Identitas Artikel (Penulis, Tahun, Judul)	Asal Negara	Tujuan	Desain Penelitian	Populasi Sasaran / Ukuran Sampel	Kerangka Konseptual / Teoretis	Kerangka yang Digunakan	Keterbatasan	Poin-Poin Kesimpulan
1	Zhang et al., 2021 – *Effects of twin-block appliance on quality of life in OSA children*	Malaysia, Saudi Arabia	Mengetahui dampak alat twin-block terhadap kualitas hidup anak dengan OSA	Cohort	47 anak usia 10–12 tahun	Perubahan twin-block meningkatkan ruang napas	Twin-block meningkatkan volume saluran napas	Tidak ada kelompok kontrol	Twin-block meningkatkan kualitas hidup
2	Duan et al., 2021 – *Airway morphology and*	China	Menilai efek twin-block terhadap morfologi	Quasi-experimental	35 anak dengan OSA	Pemajuan mandibula memperbaiki	Penurunan signifikan pada AHI	Tidak ada kelompok kontrol	MTBA meningkatkan jalan napas

	position after twin-block therapy		jalan napas			jalan napas			
3	Maheshwari et al., 2022 – *Evaluation of Treatment Outcomes of Twin-block Therapy*	India	Mengevaluasi hasil perawatan menggunakan twin-block	Quasi-experimental	22 anak perempuan usia 9–12 tahun	Ekspansi maksila dan pemajuan mandibula	Perbaikan signifikan secara statistik	Sampel kecil	Alat ortodontik fungsional efektif
4	Tian et al., 2022 – *Pharyngeal Airway Treatment of Children with OSA*	China	Menilai perubahan pada saluran napas setelah penggunaan twin-block	Quasi-experimental	26 anak dengan OSA	Pemajuan mandibula meningkatkan ruang napas	MTBA meningkatkan lebar palatal	Tidak ada data jangka panjang	MTBA meningkatkan perkembangan saluran napas
5	Zhang et al., 2023 – *Effects of functional appliances on sleep parameters in OSA children*	Malaysia, Saudi Arabia	Menilai efek alat fungsional terhadap parameter tidur	Cohort	48 anak usia 9–12 tahun	Pemajuan mandibula memperbaiki fungsi napas	Volume mandibula meningkat	Keterbatasan CBCT	Twin-block meningkatkan kualitas tidur
6	Bhaskar et al., 2023 – *Salivary biomarker changes before*	India	Menilai kadar CRP saliva sebelum dan sesudah terapi	Cohort	18 anak usia 8–12 tahun	Gangguan napas saat tidur berkaitan inflamasi	Kadar CRP menurun	Sampel kecil	Twin-block mengurangi peradangan

	and after twin-block therapy								
7	Zeng et al., 2023 – *Effect of Twin-block Appliance Therapy on Airway Volume*	China	Menilai efek twin-block pada volume jalan napas	Quasi-experimental	40 pasien maloklusi	Respons pernapasan meningkat	Twin-block meningkatkan volume saluran napas	Tidak ada kontrol	Twin-block memperbaiki respirasi
8	Bhaskar & Shetty, 2022 – *Salivary Biomarker Levels Before and After Twin-block Therapy*	India	Menilai perubahan TNF-α dan MDA	Quasi-experimental	18 anak usia 8–13 tahun	TNF-α sebagai indikator inflamasi	TNF-α dan MDA menurun	Sampel kecil	Terapi twin-block menurunkan inflamasi
9	Baran & Shetty, 2022 – *Pharyngeal Airway Volume Changes*	India	Menganalisis perubahan volume airway	Quasi-experimental	20 anak usia 9–13 tahun	Pemajuan mandibula memperbaiki airway	Peningkatan volume airway	Tanpa kontrol	Alat twin-block efektif
10	Mandibular advancement appliances for sleep-disordered breathing	New Zealand	Menguji efektivitas MA dalam OSA	RCT	36 pasien OSA	MA memajukan mandibula	MA menurunkan AHI	Durasi pendek	MA efektif mengurangi OSA
11	Preventi et al., 2017	Italy	Mengukur perubahan	Quasi-experi	51 anak	Alat fungsi	Kelompok yang	Studi terbatas	Terapi fungsio

	– *Orthopedic treatment effects of twin-block therapy*		pada jalan napas	mental		onal memperbesar airway	dirawat menunjukkan peningkatan		nal meningkatkan airway
12	Case et al., 2019 – *Changes in the oropharyngeal airway in OSA*	USA	Menge valuasi efek MAA	Cohort	20 anak	Pemajuan volume airway	Peningkatan volume airway	Retrospektif	MAA berman faat
13	Bighetti et al., 2019 – *Multidisciplinary approach in OSA case report*	Italy	Mendeskripsikan manajemen OSA	Case report	1 pasien	Perubahan mandibula	Perbaikan AHI	Kasus tunggal	Kombinasi terapi efektif

This scoping review presents a comprehensive synthesis of 13 clinical studies evaluating the therapeutic impact of functional appliances, specifically Twin-Block devices, on obstructive sleep apnea (OSA) in children with Class II malocclusion. The body of evidence consistently demonstrates clinical benefits in respiratory, anatomical, and biochemical aspects. Although methodological variations exist, the similarity of results across different settings reinforces the overall certainty of the evidence. Studies conducted by Zreaqat et al. (2025), Duan et al. (2025), Mastud et al. (2024), and Idris et al. (2018) reported significant improvements in AHI scores and airway structures, demonstrating strong internal consistency in outcomes across different populations and study designs (Duan et al., 2024).

The reduction in OSA severity, primarily reflected by a significant decrease in AHI scores, is the most consistent finding across studies. For example, Zreaqat et al. (2025) and Duan et al. (2025) reported reductions in AHI of up to 74%, supported by imaging evidence showing increased upper airway volume (Zreaqat et al., 2023). Studies by Mastud et al. (2024) and Bignotti et al. (2019) also demonstrated similar reductions through combined skeletal and soft tissue expansion techniques. These findings are particularly relevant for healthcare professionals seeking non-invasive and growth-compatible alternatives to CPAP or surgical interventions. Rizk et al. (2016) and Pavoni et al. (2017) further corroborated these findings through cephalometric and CBCT analyses, confirming that mandibular advancement can improve airway patency (Idris et al., 2016; Rizk et al., 2016).

Subjective improvements in quality of life related to sleep and behavioral health were also consistently reported. Zreaqat et al. (2025) observed improvements in four of the five OSA-18 domains. Similarly, Idris et al. (2018) and Batra and Shetty (2022) reported reductions in snoring, behavioral disturbances, and improvements in parent-reported sleep quality. These findings highlight meaningful benefits not only for children but also for parents and educators concerned with daytime functioning, attention, and emotional regulation in children with OSA.

In addition to anatomical and functional improvements, several studies examined systemic biomarkers related to inflammation and oxidative stress. Bhosale et al. (2023) and Bhosale and Shetty (2023) reported decreased levels of CRP, TNF-α, and MDA, suggesting broader physiological effects of mandibular advancement on systemic health[21,22]. Meanwhile, Zreaqat et al. (2023) found no significant changes in urinary leukotriene E4 or serum CRP; however, the study still demonstrated improvements in airway volume and sleep parameters, indicating that systemic responses may not always be directly or consistently reflected in biomarkers (Zreaqat et al., 2023).

Compared with previous literature, these results are consistent with earlier findings that functional appliances can modify airway structure and improve OSA symptoms in pediatric populations. However, unlike earlier studies that largely relied on cephalometric or skeletal changes, this review incorporates recent evidence on inflammatory biomarkers and sleep quality assessments, thereby providing a more holistic perspective on therapeutic outcomes (Zreaqat et al., 2023; Duan et al., 2024; Pavoni et al., 2017).

Nevertheless, several limitations should be acknowledged. Many included studies had small sample sizes, lacked long-term follow-up, and employed quasi-experimental designs without randomization. Only a few studies, such as Idris et al. (2018), applied a randomized crossover model (Guo et al., 2023). In addition, inconsistencies were observed in outcome measurements, appliance design, and control groups. Demographic factors such as sex, pubertal stage, and socioeconomic status were also not consistently reported or analyzed, thereby limiting the generalizability of the findings.

Future research should emphasize multicenter randomized clinical trials with standardized protocols, longer treatment durations, and stratified analyses based on age, sex, and skeletal maturity. The inclusion of patient-centered outcomes and health economic evaluations is also essential to support policy decision-making. Furthermore, research on appliance customization based on three-dimensional imaging and craniofacial morphology may enhance the precision and effectiveness of therapy (Duan et al., 2024; Mastud et al., 2024)

CONCLUSION

In conclusion, consistent findings from the 13 studies analyzed suggest that functional tools, particularly twin-blocks, offer promising therapeutic modalities for managing pediatric OSA associated with Class II malocclusion. These results are relevant not only for orthodontists and sleep disorder specialists, but also for families and healthcare systems that aim to reduce the long-term burden of sleep breathing disorders in children. Ongoing interdisciplinary research and clinical innovation will be key in optimizing therapeutic outcomes and ensuring wider accessibility across healthcare systems.

REFERENSI

Anagnostopoulos, I., et al. (2025). *Assessment of upper airway and temporomandibular joint changes in growing patients with Class II Division 1 malocclusion, treated with the Twin Block appliance: A retrospective cone-beam computed tomography study*. Arch Craniofac Surg, 26(3), 92–101. https://doi.org/10.7181/acfs.2024.0093

Bariani, R. C. B., et al. (2022). *Effectiveness of functional orthodontic appliances in obstructive sleep apnea treatment in children: Literature review*. Braz J Otorhinolaryngol, 88(2), 263–278. https://doi.org/10.1016/j.bjorl.2021.02.010

Batra, A., & Shetty, V. (2022). *Effect of Twin-block Appliance on Pharyngeal Airway, Sleep Patterns, and Lung Volume in Children with Class II Malocclusion*. J Contemp Dent Pract, 23(1), 66–73. https://doi.org/10.5005/jp-journals-10024-3289

Bhosale, T. B., et al. (2023). *Salivary biomarker C-reactive protein levels in children with sleep problems and Class II malocclusion before and after twin-block therapy*. J Indian Soc Pedod Prev Dent, 41(3), 190–196. https://doi.org/10.4103/jisppd.jisppd_338_23

Bhosale, T. B., & Shetty, V. (2023). *Salivary biomarker levels in children with sleep problems before and after twin block therapy*. Indian J Dent Res, 34(4), 391–395. https://doi.org/10.4103/ijdr.ijdr_88_23

Bignotti, et al. (2019). *Multidisciplinary approach in a 12-year-old patient affected by severe obstructive sleep apnea: A case-report*. Sleep Med Res, 10(2), 103–107. https://doi.org/10.17241/smr.2019.00465

Duan, J., et al. (2022). *The efficacy of Twin-Block appliances for the treatment of obstructive sleep apnea in children: A systematic review and meta-analysis*. BioMed Res Int, 2022, 3594162. https://doi.org/10.1155/2022/3594162

Duan, J., et al. (2024). *Palatal morphology after treatment of children with obstructive sleep apnoea using the modified twin-block appliance*. Int Dent J, 74(2), 1120–1128. https://doi.org/10.1016/j.identj.2024.03.007

Duan, J., et al. (2025). *Airway morphology, hyoid position, and serum inflammatory markers of obstructive sleep apnea in children treated with modified twin-block appliances*. BMC Oral Health, 25, 162. https://doi.org/10.1186/s12903-025-05528-y

Entrenas, I., et al. (2019). *Evaluation of changes in the upper airway after Twin Block treatment in patients with Class II malocclusion*. Clin Exp Dent Res, 5(3), 259–268. https://doi.org/10.1002/cre2.180

Fernandes, S., et al. (2024). *Prevalence of obstructive sleep apnea in 6–9-year-old children of Visnagar: A cross-sectional study*. Sleep Med Res, 15(1), 29–34. https://doi.org/10.17241/smr.2023.02054

Genc, E., et al. (2022). *Evaluation of dentoskeletal and pharyngeal airway changes after treatment with Twin Block and Monoblock appliance in growing patients*. J Dent Indones, 29(3), 211–222. https://doi.org/10.14693/jdi.v29i3.1411

Guo, L., et al. (2023). *Effect of removable twin-block appliance on upper airway dimensions in growing children with Class II Division 1 malocclusion: A retrospective study*. Clin Oral Investig, 27, 3305–3314. https://doi.org/10.1007/s00784-023-05090-0

Idris, G., et al. (2016). *Efficacy of a mandibular advancement appliance on sleep disordered breathing in children: A study protocol of a crossover randomized controlled trial*. Front Physiol, 7, 353. https://doi.org/10.3389/fphys.2016.00353

Idris, G., et al. (2018). *Mandibular advancement appliances for sleep-disordered breathing in children: A randomized crossover clinical trial*. J Dent, 72, 25–31. https://doi.org/10.1016/j.jdent.2018.01.006

Jeha, B. A., & Haddad, R. (2024). *Skeletal and dental effects of Forsus Fatigue Resistance Device versus Twin Block appliance for Class II malocclusion treatment in growing*

patients: A systematic review. Clin Exp Dent Res, 10, e70054. https://doi.org/10.1002/cre2.70054

Khan, M. I., et al. (2022). *Dentoskeletal effects of Twin Block appliance in patients with Class II malocclusion*. Medicine and Pharmacy Reports, 95(2), 191–196.

Lyra, A., et al. (2020). *Prevalence of sleep-disordered breathing and associations with malocclusion in children*. J Clin Sleep Med, 16(7), 1007–1012. https://doi.org/10.5664/jcsm.8370

Mastud, C. S., et al. (2024). *Evaluation of treatment outcomes of customized fixed intra-oral appliance with maxillary expansion and twin block in pediatric obstructive sleep apnea patients: A prospective study*. Sleep Med Res, 15(2), 113–123. https://doi.org/10.17241/smr.2024.02124

Özköylü, G., et al. (2024). *Comparison of monoblock and twinblock mandibular advancement devices in patients with obstructive sleep apnea and temporomandibular disorder: Effects on airway volume, polysomnography parameters, and sleepiness scale scores*. BMC Oral Health, 24, 1026. https://doi.org/10.1186/s12903-024-04653-4

Pavoni, C., et al. (2017). *Orthopaedic treatment effects of functional therapy on the sagittal pharyngeal dimensions in subjects with sleep-disordered breathing and Class II malocclusion*. Acta Otorhinolaryngol Ital, 37(6), 479–485. https://doi.org/10.14639/0392-100X-1420

Piełunowicz, M., et al. (2025). *Effects of rapid maxillary expansion and functional orthodontic treatment in children with sleep disordered breathing: A systematic review*. BMC Oral Health, 25(1), 1059. https://doi.org/10.1186/s12903-025-06348-w

Radwan, E. S., et al. (2024). *Effect of functional appliances on sleep-disordered breathing in Class II division 1 malocclusion children: Randomized controlled trial*. Orthod Craniofac Res, 27(1), 126–138. https://doi.org/10.1111/ocr.12696

Ramar, K., et al. (2015). *Clinical practice guideline for the treatment of obstructive sleep apnea and snoring with oral appliance therapy: An update for 2015*. J Clin Sleep Med, 11(7), 773–827. https://doi.org/10.5664/jcsm.4858

Rizk, S., et al. (2016). *Changes in the oropharyngeal airway of Class II patients treated with the mandibular anterior repositioning appliance*. Angle Orthod, 86(6), 955–961. https://doi.org/10.2319/042915-295.1

Saifeldin, H., & Negm, I. M. (2024). *Assessing the immediate impact of Twin-block appliance insertion on adolescents' sleep using a wearable device*. Orthod Craniofac Res, 27(4), 598–605. https://doi.org/10.1111/ocr.12773

Zreaqat, M., et al. (2023). *Effects of twin-block appliance on upper airway parameters in OSA children with class II malocclusion and mandibular retrognathia: A CBCT study*. Eur J Pediatr, 182, 5501–5510. https://doi.org/10.1007/s00431-023-05226-3

Zreaqat, M., et al. (2025). *Effects of twin-block therapy on urinary leukotriene E4 and serum C-reactive protein levels in OSA children with Class II malocclusion and mandibular retrognathia*. Sleep Breath, 27(3), 1057–1064. https://doi.org/10.1007/s11325-022-02755-7

Zreaqat, M., et al. (2025). *Effects of twin-block appliance on quality of life in OSA children with class 2 malocclusion and mandibular retrognathia*. J Oral Biol Craniofac Res, 15(6), 864–868. https://doi.org/10.1016/j.jobcr.2025.06.003