Iran J Orthod. 2025 December; 20(2):e1255. doi:10.22034/ijo.2025.2061652.1255.
Published online 2025 December 1 Research Article
Review Article **Open Access**

Interactions Between Orthodontic Treatment and Temporomandibular Joint Disorders: An Umbrella Review of Current Evidence

Abolfazl Azimi [1], Soheil Shahbazi [2], Mohammad Behnaz [3]*

[1] Student of Dentistry, Tehran Medical Sciences, Islamic Azad University, Tehran, Iran
[2] Student of Dentistry, University of California, Los Angeles, United States
[3] Associate Professor, Department of Orthodontics, School of Dentistry, Shahid Beheshti University of Medical Sciences, Tehran, Iran

***Corresponding author:** Mohammad Behnaz

Address: Department of Orthodontics, School of Dentistry, Shahid Beheshti University of Medical Sciences, Daneshjou Boulevard, Tajrish, Tehran, Iran

E-mail: Behnaz1357@yahoo.com

Received: 2025 May 25; **Revised:** 2025 September 20; **Accepted:** 2025 October 26

Abstract

Aim: This umbrella review examined the impact of orthodontic treatment on temporomandibular joint disorders (TMDs), highlighting key themes, research gaps, and evidence trends.
Methods: A comprehensive electronic search was conducted in PubMed, Scopus, Web of Science, and Cochrane databases. Eligible studies included systematic reviews, network meta-analyses, and consensus-based recommendations evaluating orthodontic interventions and TMD. Data extraction included demographics, treatment types, TMD diagnostic methods, and study findings. Quality assessment was performed using the AMSTAR 2 tool.
Results: The initial search yielded 6,928 studies, reduced to 4,611 after duplicate removal. Title/abstract screening resulted in 82 articles, with 25 studies ultimately included. Orthodontic treatments, including clear aligners, functional therapy, and orthognathic surgery, showed inconsistent effects on TMD onset or progression. Non-orthodontic interventions, including cognitive behavioral therapy (CBT) with biofeedback, splints, and cervical mobilization, consistently alleviated symptoms. Systemic conditions, such as juvenile idiopathic arthritis, were associated with higher TMD prevalence. Heterogeneity in study design, diagnostic criteria, and follow-up duration limited definitive conclusions.
Conclusion: Orthodontic treatment does not consistently influence TMD. Management should prioritize multidisciplinary and non-orthodontic approaches. Standardized, long-term studies are needed to clarify orthodontic-TMD relationships, particularly for contemporary treatments like clear aligners and orthognathic surgery.
Keywords: Dental Occlusion, Malocclusion, Orthodontics, Temporomandibular Joint Disorders

Background

Temporomandibular joint disorder (TMD) encompasses a range of disorders affecting the temporomandibular joint (TMJ), the muscles involved in mastication, and associated structures (1). Traditional symptoms include pain, restricted jaw movement, and joint sounds, which can significantly diminish the quality of life (2,3). The etiology of TMD is multifactorial, involving genetic, anatomical, psychological, and environmental factors (4). Orthodontic treatments aim to correct malocclusions and enhance dental function (5,6). Orthodontic treatments, including braces, aligners, and other appliances, alter occlusal relationships and jaw dynamics, potentially affecting the TMJ (7). Some researchers posit that orthodontic treatment

Copyright © 2025, Author(s). This is an open-access article distributed under the terms of the Creative Commons Attribution-NonCommercial 4.0 International License (http://creativecommons.org/licenses/by-nc/4.0/) which permits copy and redistribute the material just in noncommercial usages, provided the original work is properly cited.

can alleviate TMD symptoms by improving occlusion and jaw function (3), while others argue it may exacerbate or have no effect on TMD (6).

The existing literature reflects a significant debate regarding the relationship between orthodontic treatment and TMD. Some studies suggest that TMD may be triggered by orthodontic interventions. In contrast, others propose that TMD is a precursor to the need for such treatments, making it challenging to draw a definitive conclusion (9,10). This review aimed to provide a comprehensive overview and lay the groundwork for future research. Emerging evidence, including that reported by Almalki et al. (8) on clear aligners and Ronsivalle et al. (11) on juvenile idiopathic arthritis (JIA), highlights the role of contemporary treatments and systemic factors, reinforcing the need for a broader evaluation beyond orthodontic interventions alone. Reviews like that by Lekaviciute and Kriauciunas (12) on occlusal factors further support this complexity, aligning with the aim to synthesize diverse perspectives and guide future research directions. An umbrella review was undertaken to synthesize existing systematic reviews and meta-analyses, providing a comprehensive overview of the evidence on the orthodontics-TMD relationship that a standard systematic review could not achieve, given the volume and diversity of prior syntheses.

Methods

Overview of Methodology

This umbrella review followed the PRISMA-ScR guidelines and was registered in PROSPERO (Registration No. CRD420251019993; https://www.crd.york.ac.uk/PROSPERO/view/CRD420251019993). The review explored the range of evidence on the relationship between orthodontic treatment and TMD. It involved the analysis of secondary data from published studies and did not directly involve human participants, human material, or human data collection. As such, ethics approval was not required. However, all the included studies were assessed for ethical compliance as part of the quality assessment using the AMSTAR 2 tool (13).

Search Strategy

A comprehensive electronic search was conducted across four major databases: PubMed, Scopus, Web of Science, and the Cochrane Database of Systematic Reviews, spanning from database inception to April 11, 2025. The search was limited to English-language studies to ensure the feasibility of review, though this may introduce language bias, which is acknowledged as a limitation in the “Discussion” section. The search strategy employed orthodontic treatment and TMD-related keywords, as well as related medical subject headings (MeSH) terms (Table 1). The search was designed to capture a broad range of study designs and methodologies, enabling a comprehensive mapping of the available literature.

Table 1: Search Terms

Database	Search Terms
PubMed	("Orthodontics"[Mesh] OR "Orthodontic Appliances"[Mesh] OR "orthodontic treatment" OR "orthodontic therapy" OR "orthodontic intervention" OR "braces" OR "aligners" OR "dental braces" OR "clear aligners") AND ("Temporomandibular Joint Disorders"[Mesh] OR "Temporomandibular Joint Dysfunction Syndrome"[Mesh] OR "Temporomandibular Joint"[Mesh] OR "temporomandibular joint disorders" OR "TMD" OR "TMJ" OR "temporomandibular dysfunction" OR "temporomandibular disorder" OR "TMJ dysfunction" OR "TMJ disorder")
Scopus	TITLE-ABS-KEY("Orthodontics" OR "Orthodontic Appliances" OR "orthodontic treatment" OR "orthodontic therapy" OR "orthodontic intervention" OR "braces" OR "aligners" OR "dental braces" OR "clear aligners") AND TITLE-ABS-KEY("Temporomandibular Joint Disorders" OR "Temporomandibular Joint Dysfunction Syndrome" OR "Temporomandibular Joint" OR "temporomandibular joint disorders" OR "TMD" OR "TMJ" OR "temporomandibular dysfunction" OR "temporomandibular disorder" OR "TMJ dysfunction" OR "TMJ disorder")
Web of Science	TS= ("Orthodontics" OR "Orthodontic Appliances" OR "orthodontic treatment" OR "orthodontic therapy" OR "orthodontic intervention" OR "braces" OR "aligners" OR "dental braces" OR "clear aligners") AND TS= ("Temporomandibular Joint Disorders" OR "Temporomandibular Joint Dysfunction Syndrome" OR "Temporomandibular Joint" OR "temporomandibular joint disorders" OR "TMD" OR "TMJ" OR "temporomandibular dysfunction" OR "temporomandibular disorder" OR "TMJ dysfunction" OR "TMJ disorder")
Cochrane Database of Systematic Reviews	("Orthodontics" OR "Orthodontic Appliances" OR "orthodontic treatment" OR "orthodontic therapy" OR "orthodontic intervention" OR "braces" OR "aligners" OR "dental braces" OR "clear aligners") AND ("Temporomandibular Joint Disorders" OR "Temporomandibular Joint Dysfunction Syndrome" OR "Temporomandibular Joint" OR "temporomandibular joint disorders" OR "TMD" OR "TMJ" OR "temporomandibular dysfunction" OR "temporomandibular disorder" OR "TMJ dysfunction" OR "TMJ disorder")

Eligibility Criteria

This umbrella review included systematic reviews, network meta-analyses, and consensus-based recommendations that examined the relationship between orthodontic treatment and TMD. Studies were selected regardless of their methodological quality to ensure the inclusion of a wide range of evidence. Studies not directly assessing orthodontic treatment but providing essential context on TMD etiology, such as occlusal factors (e.g., Manfredini et al., (9); Lekaviciute et al., (12)) or systemic conditions (e.g., Ronsivalle et al., (11)), were included to ensure a comprehensive understanding of the relationship between orthodontics and TMD, enhancing the review's scope. While the primary focus was on systematic reviews, network meta-analyses, and consensus-based recommendations, select narrative reviews (e.g., Karkazi et al. (1)) were included if they provided high-quality evidence or historical context on the orthodontics-TMD relationship. Studies were excluded if they met any of the following criteria:

- Irrelevance to the relationship between orthodontic treatment and TMD
- Insufficient data
- Focused solely on non-orthodontic interventions, such as surgical or pharmacological treatments, without reference to orthodontic approaches
- Published in languages other than English

Screening Process

Two independent reviewers conducted title/abstract and full-text screening. The selection process involved removing duplicates, screening titles and abstracts to exclude irrelevant studies, and performing full-text reviews to identify studies that met the inclusion criteria for the umbrella review. Inter-rater agreement was assessed, with discrepancies resolved by discussion.

Data Extraction

Two reviewers independently extracted data from the included studies. Study design, sample size, demographic characteristics, type of orthodontic treatment, TMD assessment tools, and key findings were extracted from each study. Disagreements between reviewers were resolved through discussion to ensure consensus.

Quality Assessment

Of the 25 included studies, 20 were systematic reviews or meta-analyses, which were assessed using the AMSTAR 2 tool, as shown in Figure 1. The remaining five studies, including narrative reviews and consensus-based recommendations, were not suitable for AMSTAR 2 assessment due to their design but were included for their contextual relevance to the orthodontics-TMD relationship. The quality of included systematic reviews, network meta-analyses, and consensus-based recommendations was assessed using the AMSTAR 2 tool to evaluate potential biases in selection, performance, detection, and reporting (13). AMSTAR 2, a validated tool for assessing systematic reviews, rates studies by assessing 16 methodological items as 'Yes,' 'Partial Yes,' or 'No,' focusing on critical domains like protocol registration and risk of bias, and assigns an overall confidence level (high, moderate, low, or critically low) based on the presence of critical and non-critical flaws, as illustrated in Figure 1 (13).

Data Synthesis

The findings were synthesized descriptively to identify key themes, trends, and gaps in the literature. No meta-analysis was conducted due to the heterogeneity in study designs, orthodontic interventions, and outcomes. The primary aim was to chart the most recurrent topics and highlight areas where further research is needed.

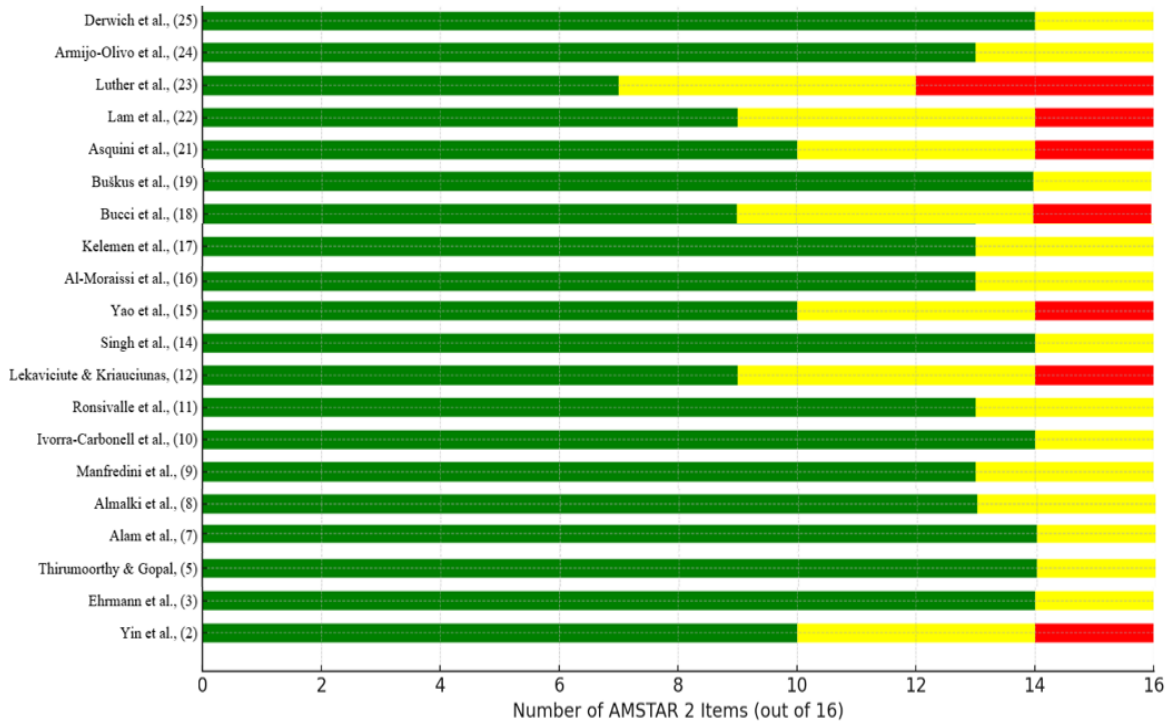


Figure 1. Quality assessment of included systematic reviews using AMSTAR 2 criteria
Green: criteria fully met ('Yes'), Yellow: criteria partially met ('Partial Yes'), Red: criteria not met ('No').

Ethics

This umbrella review involved the analysis of secondary data from published systematic reviews, network meta-analyses, and consensus-based recommendations, and did not directly involve human participants or experimental animals. As such, ethics approval was not required. However, all included studies were assessed for ethical compliance using the AMSTAR 2 tool, ensuring adherence to the Declaration of Helsinki and institutional guidelines where applicable.

Results

Search Results

The initial search yielded 6,928 results, which were narrowed down to 4,611 after removing duplicates. A total of 82 articles remained following title/abstract screening. Finally, 25 studies were included for data extraction (Figure 2 illustrates the study selection process using the PRISMA flow diagram).

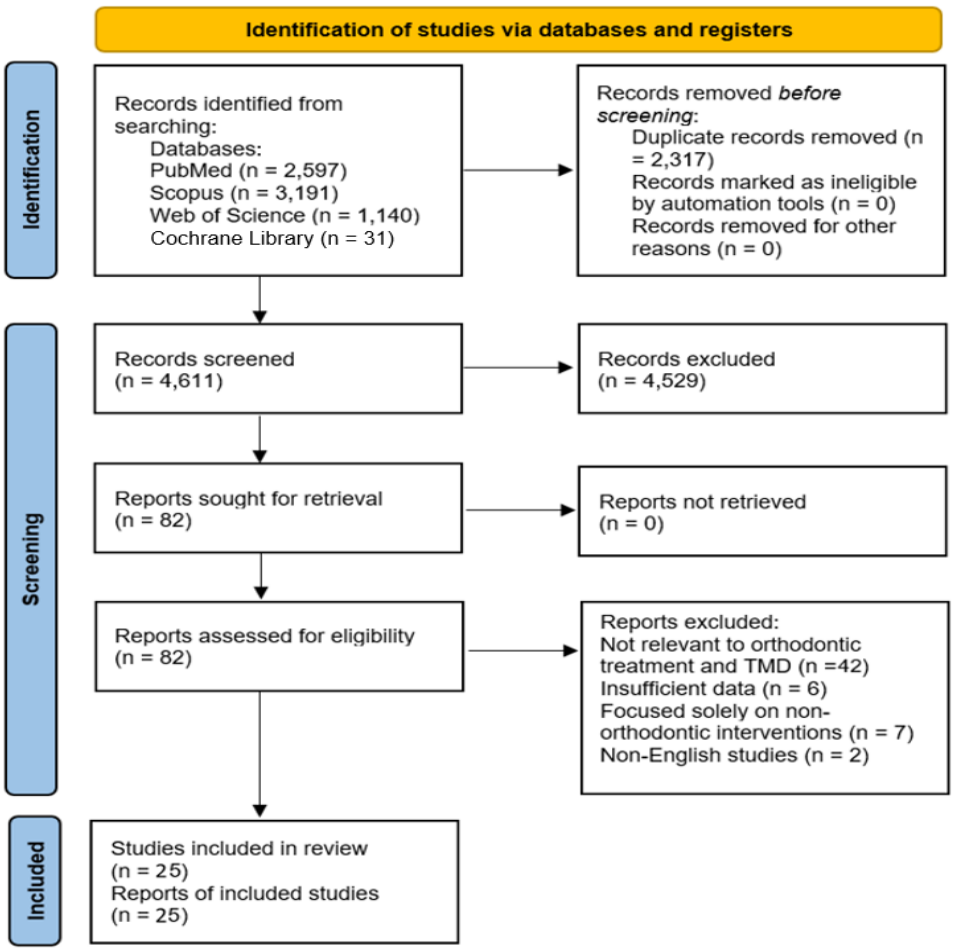


Figure 2. PRISMA Flow Diagram of Study Selection

Study Characteristics

The included studies encompassed a diverse range of research designs, including systematic reviews, network meta-analyses, and consensus-based recommendations. The studied populations ranged from children to adults, with some studies specifically focusing on unique subgroups such as children with obstructive sleep apnea (OSA) or JIA.

Women comprised 46% of the total pooled sample size of 10,593 participants. The total pooled sample size of 10,593 participants and gender distribution (46% women) were calculated based on studies that reported these demographics, acknowledging that some studies did not provide this information (marked as 'NR' in Table 2).

Table 2: Data Extraction Table

Study	Design	Population	Sample Size	Gender	Country	Year	Type of Orthodontic Treatment	Control/Comparator	TMD Diagnosis Method
Karkazi et al. [1]	Systematic Review	Adolescents/Adults	NR	NR	Turkey	2020	Various orthodontic treatments	Untreated cases	Clinical exam, imaging
Yin et al. [2]	Systematic Review	Adults	NR	NR	China	2020	None	N/A	MRI
Ehrmann et al. [3]	Systematic Review	Adolescents/Adults	NR	NR	France	2024	Orthodontic-surgical treatments	Untreated TMD cases	Clinical exam
Matheson et al. [4]	Rapid Evidence Review	Not Specified	NR	NR	USA	2023	None	N/A	Clinical assessment
Thirumoorthy et al. [5]	Systematic Review	Adolescents/Adults	NR	NR	India	2023	Various orthodontic treatments	Untreated cases	NR
How CK [6]	Evidence-Based Commentary	Not Specified	NR	NR	NR	2004	Various orthodontic treatments	Untreated cases	NR
Alam et al. [7]	Systematic Review/Meta-Analysis	Adolescents/Adults	1,234	NR	Saudi Arabia	2023	Various orthodontic treatments	Untreated TMD cases	Clinical exam, imaging
Almalki et al. [8]	Systematic Review	Adults	NR	NR	Saudi Arabia	2024	Clear aligner therapy	NR	NR
Manfredini et al. [9]	Systematic Review	Adults	245	133 F, 112 M	Italy	2017	Occlusal adjustments	Natural occlusion	Clinical exam, MRI
Ivorra-Carbonell et al. [10]	Systematic Review	Adolescents/Adults	210	108 F, 102 M	Spain	2016	Functional mandibular advancement	No appliances	CBCT, MRI
Ronsivalle et al. [11]	Systematic Review/Meta-Analysis	Adolescents/Children (JIA)	NR	NR	Italy	2024	None	Healthy controls	DC/TMD
Lekaviciute et al. [12]	Systematic Review	Adults	NR	NR	Lithuania	2024	None	NR	NR
Shea et al. [13]	Methodology Paper	Not Applicable	N/A	N/A	Canada	2017	None	N/A	N/A
Singh et al. [14]	Systematic Review	Adults	NR	NR	India	2017	Occlusal interventions	NR	NR
Yao et al. [15]	Systematic Review/Meta-Analysis	Adults	8,713	4,213 F, 4,500 M	China	2023	None	Placebo treatments	Clinical exam, questionnaire
Al-Moraissi et al. [16]	Network Meta-Analysis	Adults	NR	NR	Italy	2024	None	Various treatments	NR
Kelemen et al. [17]	Systematic Review/Meta-Analysis	Adults	NR	NR	Hungary	2024	None	Conservative treatments	NR
Bucci et al. [18]	Systematic Review/Meta-Analysis	Children (OSA)	110	50 F, 60 M	USA	2023	Rapid maxillary expansion	No expansion	Polysomnography, clinical
Buškus et al. [19]	Systematic Review	Adults	NR	NR	Lithuania	2023	Orthognathic surgery	Pre-surgery	NR
Jung et al. [20]	Narrative Review	Adults	NR	NR	South Korea	2015	Orthognathic surgery	Pre-surgery	NR
Asquini et al. [21]	Systematic Review	Adults	180	NR	Italy	2022	None	No manual therapy	Clinical exam, palpation
Lam et al. [22]	Systematic Review/Meta-Analysis	Adults	NR	NR	Canada	2023	None	No mobilization	NR
Luther et al. [23]	Systematic Review	Adolescents/Adults	NR	NR	UK	2016	Various orthodontic treatments	No treatment	Clinical exam
Armijo-Olivo et al. [24]	Systematic Review/Meta-Analysis	Adults	250	NR	Canada	2016	None	No therapy/exercise	Clinical exam, questionnaire
Derwich et al. [25]	Systematic Review	Adults	NR	NR	Poland	2021	None	N/A	NR

CBT: Cognitive Behavioral Therapy, MT: Manual Therapy, OSA: Obstructive Sleep Apnea, TMD: Temporomandibular Joint Disorders, TMJ: Temporomandibular Joint, JIA: Juvenile Idiopathic Arthritis, CBCT: Cone Beam Computed Tomography, MRI: Magnetic Resonance Imaging

Geographically, the studies spanned various countries, reflecting diverse cultural and clinical practices. For instance, research from Sweden, Italy, Australia, and Spain primarily focused on systematic reviews assessing the impact of various orthodontic treatments on TMD. Additionally, studies from China and the USA have incorporated advanced interventions, such as cognitive behavioral therapy (CBT) combined with biofeedback and rapid maxillary expansion, to improve airway function. Additional studies from Turkey, Lithuania, and Saudi Arabia evaluated clear aligner therapy and occlusal factors, while reviews from Italy and Lithuania addressed systemic conditions like JIA and specific TMD subtypes. Denmark's consensus-based recommendations emphasized interdisciplinary approaches for children with JIA (Figure 3 illustrates the publication trend of these studies over the last 10 years. Figure 4 shows the publication trend of these studies over the past decade.

The orthodontic treatments evaluated included clear aligners, functional therapy, fixed braces, and rapid maxillary expansion. Orthognathic surgery, combined with orthodontic treatment and non-orthodontic interventions such as splint therapy and cervical mobilization, was also assessed, broadening the range of evaluated approaches. These treatments were compared against untreated malocclusions, natural occlusion, and placebo treatments. Diagnostic methods varied, including clinical examinations, magnetic resonance imaging (MRI), cone-beam computed tomography (CBCT), and questionnaires.

The heterogeneity in population demographics, treatment modalities, and diagnostic techniques highlights the complexity of assessing the relationship between orthodontic interventions and TMD. Despite the diversity in study designs and sample populations, methodological limitations such as small sample sizes and inconsistent follow-up periods were common across studies. The detailed characteristics of the included studies, such as population demographics, treatment modalities, and diagnostic techniques, are summarized in Table 2.

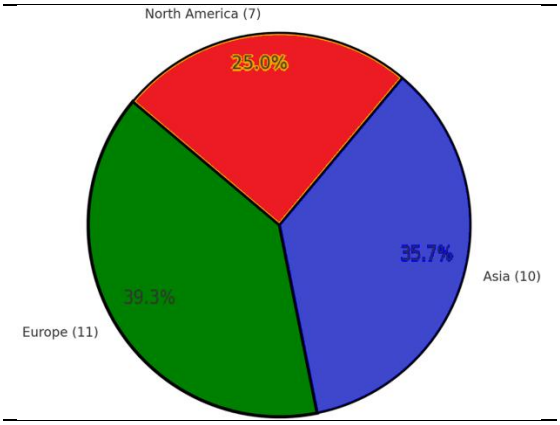


Figure 3. Geographic distribution of included studies by continent (n = number of studies).

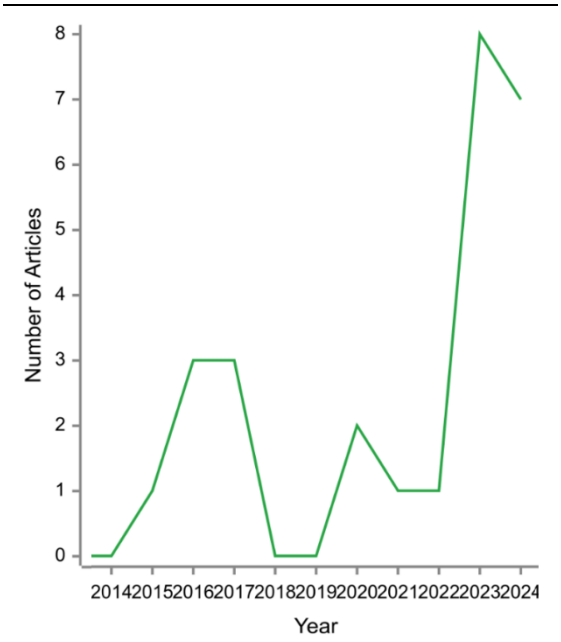


Figure 4. Publication trend of included studies within the last 10 years

Study Outcomes

The studies included in this review present a multifaceted view of temporomandibular joint disorders (TMD) in relation to orthodontic treatments, non-orthodontic interventions, systemic conditions, occlusal factors, and diagnostic approaches. The findings are organized into thematic subsections to synthesize the evidence clearly and concisely.

Orthodontic Interventions and TMD

Research on orthodontic treatments reveals no consistent evidence linking these interventions to the onset or exacerbation of TMD:

- Clear aligner therapy: Studies have reported a moderate prevalence of TMD (up to 40%) among patients but have found no significant worsening of symptoms or consistent evidence that orthodontic treatment exacerbates or initiates TMD, emphasizing the need for tailored approaches in predisposed patients (7,8). Transient muscle changes were noted, although without a clear onset of TMD (8).
- Orthognathic surgery: This intervention was associated with reduced TMJ pain and improved mandibular function in some cases (19); however, the evidence is limited by small sample sizes and variable follow-up durations. Effects on disc position and joint function varied, potentially due to differences in surgical techniques and pre-existing TMD status (20).
- Rapid maxillary expansion (RME): In children with obstructive sleep apnea (OSA), RME improved airway function, with potential indirect benefits for TMD symptoms suggested by improved craniofacial dynamics (18). However, direct evidence linking RME to TMD relief remains limited, and findings are constrained by small cohorts and a lack of long-term data.

These findings suggest that orthodontic interventions do not consistently trigger or exacerbate TMD, with outcomes varying depending on the treatment type and patient context.

Non-Orthodontic Interventions for TMD

Non-orthodontic treatments showed more consistent efficacy in managing TMD symptoms:

- Cognitive behavioral therapy (CBT) with biofeedback: Identified as the most effective intervention for reducing chronic TMD pain, outperforming placebo treatments in a large cohort (15).
- Splint therapy and arthrocentesis: Demonstrated moderate efficacy for TMD disc displacement with reduction (16), though splints were not superior to other conservative treatments for myogenic TMD (18).
- Manual therapy: Techniques targeting craniomandibular and upper cervical structures improved pain and maximum mouth opening, although evidence quality was low to moderate (21,22). Psychological factors emerge as a critical dimension in TMD management across multiple reviews. Derwich et al.'s systematic review (25) on TMD osteoarthritis treatments emphasized the multifactorial nature of TMD, suggesting that interventions must extend beyond mechanical corrections, particularly for osteoarthritis-related cases where psychological support may enhance outcomes alongside therapies like hyaluronic acid.

These results highlight the significant role of psychological and manual therapies in alleviating TMD symptoms, often surpassing mechanical approaches.

Systemic Conditions and TMD

Systemic conditions were associated with increased TMD prevalence or indirect treatment effects:

- Obstructive sleep apnea (OSA): RME in children improved airway function, with potential indirect benefits for TMD; however, direct causal relationships remain unclear (8).
- Juvenile idiopathic arthritis (JIA): Patients exhibited a higher TMD incidence (up to 50%) compared to healthy controls, suggesting a systemic influence (11).

These findings underscore the importance of considering systemic factors in TMD management, particularly in patients with comorbid conditions.

Occlusal Factors in TMD

Studies consistently found limited evidence linking occlusal features to TMD:

- Systematic reviews reported no clinically relevant associations between most

occlusal factors and TMD, except in specific cases, such as centric relation-maximum intercuspation slides and mediotrusive interferences (9,12).
- Occlusal interventions lacked sufficient evidence to support their superiority in TMD treatment (14).

This suggests that occlusal adjustments may not be a primary focus for TMD management, challenging traditional mechanical perspectives.

Diagnostic Methods

Diagnostic approaches varied across studies, contributing to methodological heterogeneity:

- Tools included clinical examinations (e.g., Manfredini et al., (9)), MRI (e.g., Yin et al., (2)), CBCT (e.g., Ivorra-Carbonell et al., (10)), and patient questionnaires (e.g., Yao et al., (15)).
- This variability may influence the consistency of reported outcomes, emphasizing the need for standardized diagnostic criteria in future TMD research.

Quality of Evidence

The quality of evidence across studies varied from very low to high, with several factors negatively affecting the reliability of the findings. Common issues included small sample sizes, lack of standardized diagnostic criteria, and methodological inconsistencies. For instance, low-quality evidence was often associated with inadequate blinding procedures and short follow-up periods, which hindered the ability to assess the long-term effects of orthodontic treatment on TMD. The quality of the 20 included systematic reviews and meta-analyses was evaluated using the AMSTAR 2 tool. The overall confidence levels for each study are presented in Table 3, with ratings ranging from critically low to high. Of the 20 systematic reviews and meta-analyses assessed with AMSTAR 2, 5 were rated high, 9 moderate, 4 low, and 1 critically low, indicating moderate overall reliability with some studies having significant limitations.

Figure 1 illustrates the detailed risk of bias assessment across each systematic review and meta-analysis, highlighting the variability in quality and potential sources of bias. Recent reviews, such as those by Almalki et al. (8) and Ronsivalle et al. (11), adhered to rigorous standards, including PRISMA and Cochrane guidelines; however, variability persisted across the expanded set of studies, as depicted in Figure 2. The AMSTAR 2 assessment revealed quality ranging from low to high, with most studies rated as moderate due to issues such as incomplete risk of bias reporting. This variability suggests caution in interpreting findings, particularly from lower-quality studies. These limitations highlight the need for larger, well-designed randomized clinical trials and higher methodological rigor to draw more conclusive findings.

Table 3: AMSTAR 2 overall confidence levels for included systematic reviews and meta-analyses

Reference	Study	Overall Confidence
2	Yin et al., 2020	High
3	Ehrmann et al., 2024	Moderate
5	Thirumoorthy & Gopal, 2023	Low
7	Alam et al., 2023	Critically Low
8	Almalki et al., 2024	Moderate
9	Manfredini et al., 2017	Moderate
10	Ivorra-Carbonell et al., 2016	Low
11	Ronsivalle et al., 2024	Moderate
12	Lekaviciute & Kriauciunas, 2024	high
14	Singh et al., 2017	low
15	Yao et al., 2023	High
16	Al-Moraissi et al., 2024	Moderate
17	Kelemen et al., 2024	Moderate
18	Bucci et al., 2023	High
19	Buškus et al., 2023	Low
21	Asquini et al., 2022	Moderate
22	Lam et al., 2023	Moderate
23	Luther et al., 2016	High
24	Armijo-Olivo et al., 2016	Moderate
25	Derwich et al., 2021	Low

Discussion

This umbrella review synthesizes findings from systematic reviews, network meta-analyses, and consensus-based recommendations to explore the complex relationship between orthodontic treatment and temporomandibular joint disorders (TMD). The evidence reveals significant heterogeneity and methodological variability across studies, complicating efforts to draw definitive conclusions. While orthodontic interventions, such as clear aligners and orthognathic surgery, show inconsistent effects on TMD, non-orthodontic approaches, particularly psychological interventions, demonstrate greater efficacy in symptom management (19,20). Below, we discuss the key findings, limitations, clinical implications, and future research directions.

The reviewed evidence indicates that orthodontic treatments do not consistently trigger or alleviate TMD. The lack of consistent evidence linking clear aligner therapy to TMD onset, despite moderate prevalence and transient changes (9), suggests that orthodontic factors may not be primary drivers, pointing to other influences. Similarly, Ivorra-Carbonell et al. (10) reported that functional mandibular advancement appliances advance condylar position without significant adverse effects in healthy patients. However, evidence is limited for those with pre-existing TMD. Similarly, Alam et al.'s meta-analysis (7) reinforces this, finding no consistent evidence that orthodontic treatment initiates or exacerbates TMD, yet highlighting the necessity for individualized strategies, particularly for patients with predisposing factors. For orthognathic surgery outcomes Buškus et al. (19) noted significant pain reduction and improved mandibular function in a systematic review, though limited by small sample sizes. These disparities reflect methodological differences across studies. Unlike orthodontic treatments, which showed inconsistent effects on TMD, psychological interventions such as cognitive behavioral therapy (CBT) with biofeedback (15) significantly reduced pain, suggesting greater efficacy for symptom management. investigation.

Limitations

Several limitations impact the reliability and generalizability of the current findings:

- **Methodological variability:** Differences in study designs, sample sizes, and follow-up durations contribute to heterogeneity in outcomes. For instance, Armijo-Olivo et al. (24) noted high variability in their meta-analysis of manual therapy, while Asquini et al. (21) cited small sample sizes and inconsistent methodologies as sources of very low-quality evidence.

- **Lack of standardized protocols:** Existing studies vary widely in design, diagnostic criteria, and outcome measures, limiting comparability and reducing the ability to synthesize findings conclusively.

- **Limited long-term data:** Most studies do not assess the long-term effects of orthodontic interventions on TMJ health, leaving uncertainties about sustained outcomes and potential delayed effects.

- **Quality of evidence:** AMSTAR 2 assessments indicate that most included reviews are of moderate quality, with some rated low or critically low due to incomplete risk of bias reporting or poor methodological rigor, necessitating caution in interpretation.

- **Insufficient consideration of sex and gender:** Many reviews fail to analyze sex- or gender-specific differences, despite the higher prevalence of TMD in women, restricting understanding of differential outcomes.

- **Narrow interdisciplinary integration:** Current research often focuses on mechanical or orthodontic factors without adequately considering psychological, systemic, and dental influences that contribute to TMD's multifactorial etiology.

- **Geographical gaps:** Regional variations in TMD management and cultural differences are underexplored, limiting the generalizability of findings across different populations.

- **Language bias:** Restricting studies to English-language research may exclude relevant non-English studies, potentially limiting global applicability.

- **Diagnostic inconsistency:** The use of varied diagnostic tools (e.g., clinical exams, MRI, questionnaires) across studies hinders outcome consistency.

Conclusion

This umbrella review revealed no consistent evidence linking orthodontic treatment to the onset or progression of TMD. Non-orthodontic interventions, such as cognitive behavioral therapy and manual therapy, effectively manage symptoms, while systemic conditions like juvenile idiopathic arthritis elevate TMD prevalence. The multifactorial nature of TMD necessitates a multidisciplinary approach, and future research should prioritize standardized, long-term studies to clarify this relationship.

Availability of Data and Materials

Data sharing does not apply to this article as no datasets were generated or analyzed during the current study. All data supporting the findings are derived from the published studies listed in the References section.

Competing Interests

The authors declare that they have no competing interests.

Funding

This study received no specific funding.

Acknowledgements

Not applicable.

References

1. Karkazi F, Özdemir F. Temporomandibular disorders: fundamental questions and answers. Turk J Orthod. 2020;33(4):246-52. doi: 10.5152/TurkJOrthod.2020.20031.
2. Yin Y, He S, Xu J, You W, Li Q, Long J, et al. The neuropathophysiology of Temporomandibular disorders-related pain: a systematic review of structural and functional MRI studies. J Headache Pain. 2020;21(1):78. doi: 10.1186/s10194-020-01131-4.
3. Ehrmann E, Bernabeu M, Tillier Y, Camia J, Ecalle C, Savoldelli C, et al. Impact of orthodontic-surgical treatments on the signs and symptoms of Temporomandibular disorders: a systematic review. Dent J. 2024;12(5):132. doi: 10.3390/dj12050132.
4. Matheson EM, Fermo JD, Blackwelder RS. Temporomandibular disorders: rapid evidence review. Am Fam Physician. 2023;107(1):52-8.
5. Thirumoorthy S, Gopal S. Association between orthodontic treatment and the occurrence of Temporomandibular disorders: smoke and mirrors in the form of a systematic review? Evid Based Dent. 2023;24(2):85-8. doi: 10.1038/s41432-023-00893-5.
6. How CK. Orthodontic treatment has little to do with Temporomandibular disorders. Evid Based Dent. 2004;5(3):75. doi: 10.1038/sj.ebd.6400269.
7. Alam MK, Abutayyem H, Alzabni KMD, Almuhyi NHS, Alsabilah KAS, Alkubaydan FST, et al. The impact of Temporomandibular disorders on orthodontic management: a systematic review and meta-analysis. Cureus. 2023;15(8):e44243. doi: 10.7759/cureus.44243.
8. Almalki SA, Al Jameel AH, Gowdar IM, Langaliya A, Vaddamanu SK, Di Blasio M, et al. Impact of clear aligner therapy on masticatory musculature and Stomatognathic system: a systematic review conducted according to PRISMA guidelines and the Cochrane handbook for systematic reviews of interventions. BMC Oral Health. 2024;24(1):350. doi: 10.1186/s12903-024-04029-8.
9. Manfredini D, Lombardo L, Siciliani G. Temporomandibular disorders and dental occlusion. a systematic review of association studies: end of an era? J Oral Rehabil. 2017;44(11):908-23. doi: 10.1111/joor.12531.
10. Ivorra-Carbonell L, Montiel-Company JM, Almerich-Silla JM, Paredes-Gallardo V, Bellot-Arcís C. Impact of functional Mandibular advancement appliances on the Temporomandibular joint - a systematic review. Med Oral Patol Oral Cir Bucal. 2016;21(5):e565-72. doi: 10.4317/medoral.21180.
11. Ronsivalle V, Marrapodi MM, Tirupathi S, Afnan L, Cicciù M, Minervini G. Prevalence of Temporomandibular disorders in juvenile idiopathic arthritis evaluated with diagnostic criteria for Temporomandibular disorders: a systematic review with meta-analysis. J Oral Rehabil. 2024;51(3):628-37. doi: 10.1111/joor.13625.
12. Lekaviciute R, Kriauciunas A. Relationship between occlusal factors and Temporomandibular disorders: a systematic literature review. Cureus. 2024;16(2):e54130. doi: 10.7759/cureus.54130.
13. Shea BJ, Reeves BC, Wells G, Thuku M, Hamel C, Moran J, et al. AMSTAR 2: a critical appraisal tool for systematic reviews that include randomised or non-randomised studies of healthcare interventions, or both. BMJ. 2017;358:j4008. doi: 10.1136/bmj.j4008.
14. Singh BP, Singh N, Jayaraman S, Kirubakaran R, Joseph S, Muthu MS, et al Occlusal interventions for managing Temporomandibular disorders. Cochrane Database Syst Rev. 2024;9(9):CD012850. doi: 10.1002/14651858.CD012850.pub2.
15. Yao L, Sadeghirad B, Li M, Li J, Wang Q, Crandon HN, et al. Management of chronic pain secondary to Temporomandibular disorders: a systematic review and network meta-analysis of randomised trials. BMJ. 2023;383:e076226. doi: 10.1136/bmj-2023-076226.
16. Al-Moraissi EA, Al-Otaibi K, Almaweri AA, Bastos RM, Haas Junior OL, Amran AG. Treatment of painful Temporomandibular joint disc displacement without reduction: network meta-analysis of randomized clinical trials. Int J Oral Maxillofac Surg.

2024;53(7):584-95. doi: 10.1016/j.ijom.2024.02.004.
17. Kelemen K, König J, Czumbel M, Szabó B, Hegyi P, Gerber G, et al. Additional splint therapy has no superiority in myogenic Temporomandibular disorders: a systematic review and meta-analysis of randomized controlled trials. J Prosthodont Res. 2024;68(1):12-9. doi: 10.2186/jpr.JPR_D_22_00264.
18. Bucci R, Rongo R, Zunino B, Michelotti A, Bucci P, Alessandri-Bonetti G, et al. Effect of orthopedic and functional orthodontic treatment in children with obstructive sleep apnea: A systematic review and meta-analysis. Sleep Med Rev. 2023;67:101730. doi: 10.1016/j.smrv.2022.101730.
19. Buškus A, Milvydaitė G, Rokicki JP. Effect of orthognathic surgery on Temporomandibular joint pain. a systematic review. Stomatologija. 2023;25(4):97-102.
20. Jung HD, Kim SY, Park HS, Jung YS. Orthognathic surgery and Temporomandibular joint symptoms. Maxillofac Plast Reconstr Surg. 2015;37(1):14. doi: 10.1186/s40902-015-0014-4.
21. Asquini G, Pitance L, Michelotti A, Falla D. Effectiveness of manual therapy applied to Craniomandibular structures in Temporomandibular disorders: a systematic review. J Oral Rehabil. 2022;49(4):442-55. doi: 10.1111/joor.13299.
22. Lam AC, Liddle LJ, MacLellan CL. The effect of upper cervical mobilization/manipulation on Temporomandibular joint pain, maximal mouth opening, and pressure pain thresholds: a systematic review and meta-analysis. Arch Rehabil Res Clin Transl. 2022;5(1):100242. doi: 10.1016/j.arrct.2022.100242.
23. Luther F, Layton S, McDonald F. Orthodontics for treating temporomandibular joint (TMJ) disorders. Cochrane Database Syst Rev. 2016 7;2016(1):CD006541. doi: 10.1002/14651858.CD006541.pub3.
24. Armijo-Olivo S, Pitance L, Singh V, Neto F, Thie N, Michelotti A. Effectiveness of manual therapy and therapeutic exercise for Temporomandibular disorders: systematic review and meta-analysis. Phys Ther. 2016;96(1):9-25. doi: 10.2522/ptj.20140548.
25. Derwich M, Mitus-Kenig M, Pawlowska E. Mechanisms of action and efficacy of Hyaluronic acid, corticosteroids and platelet-rich plasma in the treatment of Temporomandibular joint Osteoarthritis-a systematic review. Int J Mol Sci. 2021;22(14):7405. doi: 10.3390/ijms22147405.