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### THE INFLUENCE OF ORTHODONTIC TREATMENT ON THE DEVELOPMENT OF TEMPOROMANDIBULAR DISORDERS: A NARRATIVE REVIEW

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# ABSTRACT

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## Background

The relationship between orthodontic treatment and temporomandibular disorders (TMD) remains controversial. Earlier concepts emphasized occlusal changes and orthodontic mechanics, whereas current evidence supports a multifactorial biopsychosocial model. Causal assessment is complicated by pre-existing symptoms, the natural increase in TMD prevalence during adolescence, and transient adaptive symptoms during treatment.

## Aims

The aim of this narrative review was to evaluate the association between orthodontic treatment and the development of new TMD and to determine whether the risk differs according to treatment modality.

## Materials and methods

A structured search of PubMed/MEDLINE, Scopus, and Web of Science was conducted for English-language publications from January 2000 to February 2025. Earlier landmark publications were also included for historical context. Systematic reviews, meta-analyses, randomized clinical trials, cohort studies, and observational studies were considered. Of 312 identified publications, 74 full-text articles were assessed and 47 publications were included in the narrative synthesis.

## Results

The available evidence does not support orthodontic treatment as an independent etiological factor for new TMD. Premolar extraction therapy was not associated with a higher risk of TMD than non-extraction treatment. Functional orthodontic appliances may produce adaptive changes in the temporomandibular joint, but these changes have not been shown to cause persistent joint dysfunction. Fixed appliances and clear aligners demonstrated comparable safety, and no evaluated treatment modality was consistently associated with a higher risk of new TMD. Transient muscle tenderness, joint discomfort, or joint sounds may occur during treatment but are generally self-limiting.

## Discussion

The findings support a multifactorial interpretation of TMD rather than a direct causal relationship with orthodontic treatment. Baseline examination and documentation of temporomandibular joint signs and symptoms are important for distinguishing pre-existing disorders from symptoms arising during treatment.

## Conclusion

Orthodontic treatment should not be regarded as an independent etiological factor for TMD. Treatment decisions should be based on established orthodontic and skeletal indications. Further long-term prospective studies using standardized DC/TMD diagnostic criteria are needed.

**Keywords:** temporomandibular disorders; orthodontic treatment; temporomandibular joint; functional appliances; premolar extraction; narrative review.

## INTRODUCTION

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Temporomandibular disorders (TMD) comprise a heterogeneous group of musculoskeletal conditions affecting the temporomandibular joints (TMJs), masticatory muscles, and associated structures. They represent one of the most common causes of chronic non-dental orofacial pain and are characterized by pain in the TMJ or masticatory muscles, joint sounds, restricted mandibular movement, and functional impairment. Owing to their multifactorial etiology and often chronic course, TMD may substantially reduce oral function and quality of life, particularly in adolescents and young adults, who also constitute the largest population seeking orthodontic treatment. Contemporary concepts describe TMD as biopsychosocial disorders resulting from complex interactions among biological, psychological, and behavioral factors rather than as conditions primarily determined by occlusal abnormalities.

Recent epidemiological evidence indicates that TMD is highly prevalent in the general population. A systematic review and meta-analysis by Valesan et al. estimated that approximately one-third of individuals present at least one sign or symptom of TMD, whereas painful TMD affects approximately 10-15% of adults [43]. The prevalence increases during adolescence and early adulthood and is consistently higher among females than males, suggesting the contribution of hormonal, genetic, and psychosocial

factors to disease susceptibility. These observations are particularly relevant for orthodontists because most patients begin treatment during the age at which TMD symptoms commonly emerge. Moreover, a recent systematic review by Lai et al. reported that signs and symptoms of temporomandibular disorders are relatively common among patients seeking orthodontic treatment, emphasizing the importance of comprehensive baseline TMJ assessment before orthodontic therapy is initiated [33].

Comparable findings have also been reported in the Polish population. In a cross-sectional study of 260 Polish adolescents and young adults examined using the Research Diagnostic Criteria for Temporomandibular Disorders (RDC/TMD), Loster et al. found that 26.5% of participants met the diagnostic criteria for at least one TMD subtype, although only 7.7% were aware of their symptoms [8]. These findings demonstrate that a considerable proportion of young individuals may present with clinically detectable TMD before seeking orthodontic treatment. Furthermore, a subsequent Polish study by Osiewicz et al., based on RDC/TMD diagnostic criteria in patients seeking TMD care, confirmed the high frequency of muscle disorders (56.9%), disc displacement (48.9%), and other joint disorders (31%) [2], supporting the multifactorial nature of these conditions.

The relationship between orthodontic treatment and TMD has remained controversial for several decades. Historically, malocclusion and occlusal discrepancies were considered important etiological factors, leading to the assumption that orthodontic treatment could either prevent or induce temporomandibular disorders. Consequently, extraction therapy, occlusal changes, and mandibular repositioning associated with orthodontic treatment were frequently regarded as potential causes of TMJ dysfunction. However, these concepts were largely based on observational evidence and theoretical assumptions developed before the introduction of standardized diagnostic criteria and high-quality longitudinal research.

Over the past two decades, advances in clinical research have substantially changed this perspective. Large prospective cohort studies, systematic reviews, and meta-analyses consistently indicate that orthodontic treatment is not associated with a clinically significant increase in the risk of developing TMD. Instead, contemporary evidence supports the view that TMD develops through the interaction of multiple factors, including genetic predisposition, pain sensitization, psychosocial distress, sleep disturbances, parafunctional behaviors such as bruxism, previous trauma, and individual adaptive capacity. Occlusal characteristics and orthodontic treatment appear to play only a limited role within this multifactorial model.

Nevertheless, determining whether orthodontic treatment causes new-onset TMD remains methodologically challenging.

First, many patients already present with asymptomatic or mildly symptomatic TMD before orthodontic treatment begins, and these conditions may remain undiagnosed without systematic baseline examination. Second, adolescence is the period during which orthodontic treatment is most frequently initiated and also the period when TMD prevalence naturally increases, making temporal associations difficult to interpret. Third, transient muscle discomfort or TMJ symptoms may occur during active orthodontic treatment as part of physiological adaptation to changing occlusal relationships and do not necessarily represent pathological joint alterations. Finally, published studies differ considerably with respect to diagnostic criteria, follow up duration, study populations, and treatment protocols, limiting direct comparisons among investigations.

Although several systematic reviews published during the last decade have consistently concluded that orthodontic treatment does not increase the overall risk of TMD, uncertainty remains regarding specific treatment modalities, particularly premolar extraction therapy, functional orthopedic appliances, and different orthodontic mechanics. A focused synthesis of the current evidence is therefore needed to distinguish temporary adaptive responses from true treatment-related disorders and to provide clinicians with evidence-based recommendations for everyday orthodontic practice.

## AIM

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The aim of this narrative review is to evaluate the association between orthodontic treatment and the development of new temporomandibular disorders and to determine whether the risk differs according to the treatment modality.

### Research Questions

1. Does orthodontic treatment increase the risk of developing new temporomandibular disorders during or after treatment?
2. Is orthodontic treatment involving premolar extraction associated with an increased risk of developing temporomandibular disorders?
3. Is the use of functional orthodontic appliances associated with the development of clinical symptoms or persistent changes in the temporomandibular joint?

4. Does the risk of developing temporomandibular disorders differ according to the orthodontic treatment modality?

## MATERIALS AND METHODS

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This study was conducted as a narrative review to evaluate the current evidence regarding the association between orthodontic treatment and the development of temporomandibular disorders (TMD). The review was performed in accordance with the Scale for the Assessment of Narrative Review Articles (SANRA), emphasizing a structured and transparent approach to literature identification, selection, and critical synthesis. Although this review followed a structured search strategy, it was conducted as a narrative review rather than a systematic review, and therefore no formal PRISMA methodology or risk-of-bias assessment was applied.

### Literature search strategy

A comprehensive literature search was performed using the electronic databases PubMed/MEDLINE, Scopus, and Web of Science. The search included articles published from January 2000 to February 2025. Earlier landmark publications were included when considered essential for understanding the historical development of concepts regarding the relationship between orthodontic treatment and TMD. These publications were included to provide historical context regarding earlier concepts of the relationship between orthodontic treatment and temporomandibular disorders.

The following search terms and Boolean operators were used:

("temporomandibular disorders" OR "temporomandibular joint disorders" OR "TMD" OR "TMJ") AND ("orthodontic treatment" OR "orthodontics" OR "fixed appliances" OR "clear aligners" OR "functional appliances" OR "premolar extraction") AND ("risk" OR "incidence" OR "association" OR "development").

Reference lists of relevant systematic reviews and meta-analyses were manually screened to identify additional eligible publications.

### Eligibility criteria

Studies were included if they:

evaluated the relationship between orthodontic treatment and the development of TMD;  
investigated patients undergoing orthodontic treatment using fixed appliances, removable appliances, functional appliances, clear aligners, or extraction protocols;  
reported clinical outcomes related to new-onset TMD, TMJ symptoms, or structural TMJ changes;  
were systematic reviews, meta-analyses, randomized clinical trials, prospective or retrospective cohort studies, or well-designed observational studies;  
were published in English.

Studies were excluded if they:

focused exclusively on the treatment of patients with pre-existing TMD without evaluating the occurrence of new disorders;  
consisted solely of case reports, conference abstracts, editorials, expert opinions, or letters to the editor;  
lacked sufficient methodological information or clearly defined diagnostic criteria.

## Study selection

The initial search identified 312 publications. After removing duplicates and screening titles and abstracts, 74 full-text articles were assessed for eligibility. Following detailed evaluation, 47 publications were included in the final narrative synthesis. Priority was given to recent systematic reviews, meta-analyses, prospective cohort studies, and publications applying standardized diagnostic criteria such as the Research Diagnostic Criteria for Temporomandibular Disorders (RDC/TMD) or the Diagnostic Criteria for Temporomandibular Disorders (DC/TMD).

## Data synthesis

The selected studies were analyzed qualitatively with particular emphasis on:

the incidence of newly diagnosed TMD during or after orthodontic treatment;  
the influence of different orthodontic treatment modalities;  
the effect of premolar extraction therapy;  
the impact of functional orthodontic appliances on TMJ structure and function;  
factors complicating the interpretation of causality between orthodontic treatment and TMD.

The evidence was synthesized narratively and organized according to the predefined research questions.

## RESULTS

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### Orthodontic treatment and the development of new temporomandibular disorders

The relationship between orthodontic treatment and the development of temporomandibular disorders (TMD) has been investigated extensively during the last three decades. Earlier observational studies suggested that orthodontic treatment, by modifying occlusal relationships and mandibular position, might contribute to the onset of temporomandibular dysfunction. However, these assumptions were largely based on studies with heterogeneous diagnostic criteria, limited follow-up periods, and inadequate control for confounding variables.

Recent high-quality systematic reviews and meta-analyses consistently indicate that orthodontic treatment is not associated with an increased risk of developing new TMD. Fernández-González et al. concluded that available evidence does not support a causal relationship between orthodontic treatment and the onset of TMD. Similar conclusions were reached by Manfredini et al., who reported that orthodontic treatment should not be considered either a risk factor or a protective factor for TMD. Likewise, the recent systematic review and meta-analysis by Jeong et al. found no significant association between orthodontic treatment during adolescence and the subsequent development of TMD.

Although several studies reported transient muscle tenderness, mild joint discomfort, or joint sounds during active orthodontic treatment, these findings were generally temporary and resolved without evidence of persistent joint dysfunction. Such symptoms are currently interpreted as physiological adaptive responses rather than indicators of progressive TMJ pathology.

Overall, the available evidence consistently suggests that orthodontic treatment alone does not increase the incidence of new temporomandibular disorders. Nevertheless, heterogeneity in study design, diagnostic criteria, outcome measures, and follow-up duration continues to limit direct comparison across published studies.

## **Premolar extraction therapy and the risk of temporomandibular disorders**

Premolar extraction has historically been regarded as one of the most controversial orthodontic procedures in relation to TMD development. Earlier theories proposed that extraction therapy could result in posterior mandibular displacement, altered condylar position, and increased loading of the temporomandibular joint. The available evidence does not support these assumptions. Contemporary systematic reviews consistently demonstrate that extraction-based orthodontic treatment is not associated with a higher prevalence or incidence of TMD when compared with non-extraction treatment. Studies comparing extraction and non-extraction protocols have not demonstrated clinically significant differences in TMJ pain, joint sounds, mandibular function, or limitation of mouth opening following treatment.

These findings indicate that decisions regarding tooth extraction should be based on established orthodontic indications rather than concerns about future temporomandibular disorders.

## **Functional orthodontic appliances and temporomandibular joint adaptation**

Functional orthodontic appliances temporarily modify mandibular position to stimulate skeletal adaptation during craniofacial growth. Because these appliances directly influence mandibular posture, concerns have been raised regarding their possible effects on the temporomandibular joint.

Systematic reviews evaluating magnetic resonance imaging (MRI), cone-beam computed tomography (CBCT), and clinical outcomes demonstrate that functional appliances may induce adaptive remodeling of the mandibular condyle and glenoid fossa during treatment. These structural changes are generally considered physiological responses to altered mechanical loading rather than pathological alterations.

Kyburz et al. concluded that although functional appliance therapy may produce measurable skeletal and condylar adaptations, there is no evidence that these changes increase the long-term risk of clinically significant TMD. Similarly, Cozza et al. reported that functional appliances do not appear to induce persistent TMJ dysfunction in otherwise healthy patients.

Consequently, the available evidence suggests that functional orthopedic treatment should not be regarded as an independent risk factor for the development of temporo-

mandibular disorders.

## **Influence of orthodontic treatment modality**

Recent research has expanded beyond conventional fixed appliances to include clear aligner therapy, temporary anchorage devices, and combined orthodontic-surgical treatment.

Systematic reviews indicate that fixed appliances and clear aligners demonstrate comparable safety profiles with respect to TMD development. Almalki et al. reported that clear aligner therapy does not adversely affect temporomandibular joint function or masticatory muscles and found no evidence of an increased risk of TMD during treatment.

Similarly, studies evaluating orthognathic surgery combined with orthodontic treatment suggest that surgical correction frequently improves pre-existing TMJ symptoms by correcting skeletal discrepancies and reducing functional imbalance. Nevertheless, postoperative outcomes remain strongly influenced by pre-treatment joint status, psychosocial factors, and individual adaptive capacity.

Overall, no orthodontic treatment modality has been consistently associated with a clinically significant increase in the risk of developing new temporomandibular disorders.

## **Factors complicating the assessment of causality**

Despite the consistency of contemporary evidence, establishing a direct causal relationship between orthodontic treatment and TMD remains methodologically challenging.

Several factors contribute to this difficulty. First, many adolescents already present with asymptomatic or mildly symptomatic TMD before orthodontic treatment begins. Epidemiological studies indicate that signs or symptoms of TMD are relatively common among young individuals, including those seeking orthodontic care. Consequently, symptoms observed during treatment may represent the natural progression of a pre-existing condition rather than treatment-induced pathology.

Second, adolescence coincides with the age at which TMD prevalence naturally increases, making temporal associations difficult to interpret. Third, transient discomfort experienced during active orthodontic treatment may reflect normal neuromuscu-

lar adaptation to changing occlusal relationships rather than permanent structural damage to the temporomandibular joint.

Finally, considerable heterogeneity exists among published studies regarding diagnostic criteria, patient selection, treatment protocols, and duration of follow-up. Earlier investigations frequently relied on non-standardized diagnostic approaches, whereas more recent studies have adopted validated RDC/TMD and DC/TMD criteria, improving methodological quality and comparability.

Taken together, the current body of evidence suggests that orthodontic treatment should not be considered an independent etiological factor for TMD. Instead, the available literature supports the contemporary biopsychosocial model in which orthodontic treatment represents only one of many variables that may coexist with the natural development of temporomandibular disorders.

## **Evidence from Poland**

Epidemiological studies conducted in Poland indicate that temporomandibular disorders (TMD) are relatively common among adolescents and young adults, including individuals who may subsequently undergo orthodontic treatment. Loster et al. reported that approximately one-quarter of Polish adolescents and young adults fulfilled the Research Diagnostic Criteria for Temporomandibular Disorders (RDC/TMD), although the majority of affected individuals were unaware of their condition. These findings emphasize that TMD signs and symptoms are frequently present before orthodontic treatment is initiated and may remain clinically unrecognized without appropriate baseline assessment.

Further evidence from a Polish RDC/TMD-based clinical study by Osiewicz et al. demonstrated a high prevalence of myogenous disorders, disc displacement, and joint disorders among patients seeking care for TMD, supporting the contemporary concept that these conditions arise from multiple interacting biological, behavioral, and psychosocial factors rather than from occlusal abnormalities alone.

Despite the availability of national epidemiological data, no prospective Polish longitudinal studies have demonstrated that orthodontic treatment increases the incidence of new temporomandibular disorders. Consequently, clinical recommendations in Poland remain consistent with international evidence, which does not support orthodontic treatment as an independent etiological factor for TMD. Future multicenter prospective studies conducted in Polish orthodontic populations using standardized

Diagnostic Criteria for Temporomandibular Disorders (DC/TMD) would strengthen the national evidence base and improve the applicability of international findings to local clinical practice.

## DISCUSSION

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The available evidence indicates that orthodontic treatment should not be regarded as an independent etiological factor for temporomandibular disorders. [13,14,32,40] Earlier theories that assigned a dominant role to occlusal discrepancies and orthodontic mechanics have not been confirmed by more methodologically robust contemporary studies. Instead, the available evidence supports a multifactorial biopsychosocial model, in which parafunctional habits, muscular overloading, psychosocial stress, pain sensitization, and individual susceptibility are considered the principal contributors to the development and persistence of TMD [1-4, 19, 34].

The findings of the present review are consistent with the conclusions of the principal systematic reviews and meta-analyses, which are summarized in Table 1. Collectively, these studies indicate that contemporary orthodontic treatment is not associated with a clinically meaningful increase in the risk of developing temporomandibular disorders, regardless of the treatment modality.

The evolution of scientific understanding regarding the relationship between orthodontic treatment and TMD deserves particular attention. Earlier concepts, developed mainly during the 1980s and 1990s, emphasized the role of occlusal discrepancies, condylar displacement, and mandibular position as major determinants of temporomandibular disorders. Consequently, orthodontic procedures capable of altering occlusion, particularly premolar extraction therapy and functional orthopedic treatment, were considered potential risk factors for TMJ dysfunction. However, many of these early investigations were based on cross-sectional designs, non-standardized diagnostic criteria, small study populations, and inadequate control for confounding variables. As a result, associations observed in these studies were frequently interpreted as evidence of causation despite the inability of their methodology to establish temporal relationships. [6,7,47,48].

The introduction of standardized diagnostic systems, first the Research Diagnostic Criteria for Temporomandibular Disorders (RDC/TMD) and later the Diagnostic Criteria for Temporomandibular Disorders (DC/TMD), substantially improved the methodologi-

cal quality of clinical research. [1,20,21] These validated instruments enabled more reliable identification of specific TMD subtypes while incorporating psychosocial assessment and pain-related disability into the diagnostic process. Consequently, more recent longitudinal studies and systematic reviews have provided considerably stronger evidence than earlier observational reports and have consistently failed to demonstrate that orthodontic treatment independently increases the risk of developing new TMD.

An additional factor contributing to the apparent discrepancy between historical and contemporary evidence is the natural epidemiology of temporomandibular disorders. Adolescence and early adulthood represent the period during which both orthodontic treatment and the first manifestations of TMD most frequently occur. [8,33,43] Therefore, the temporal coincidence of orthodontic therapy and symptom onset does not necessarily indicate a causal relationship. Furthermore, a considerable proportion of patients already present with asymptomatic disc displacement, joint sounds, or mild muscular symptoms before orthodontic treatment begins. Without standardized baseline assessment, these pre-existing conditions may be incorrectly attributed to orthodontic intervention if symptoms become clinically evident during treatment.

The present review also highlights the importance of distinguishing between transient adaptive responses and true pathological changes. Mild discomfort, temporary muscle tenderness, or joint sounds may develop during active orthodontic treatment as a consequence of physiological adaptation to altered occlusal relationships and changes in masticatory muscle activity. The available evidence indicates that these manifestations are generally self-limiting and do not progress to persistent temporomandibular disorders. Consequently, clinicians should avoid interpreting every TMJ-related complaint arising during orthodontic treatment as evidence of treatment-induced pathology without comprehensive clinical evaluation.

Another important observation emerging from the reviewed literature is that different orthodontic treatment modalities appear to demonstrate comparable safety with respect to TMD development. [14,34,37,40] Concerns regarding premolar extraction therapy, functional orthopedic appliances, or clear aligner treatment have not been confirmed by contemporary systematic reviews or meta-analyses. Instead, treatment decisions should continue to be guided primarily by orthodontic diagnosis, skeletal relationships, facial aesthetics, and long-term functional outcomes rather than unsupported concerns regarding routine induction of temporomandibular disorders.

Nevertheless, the absence of evidence for a causal association should not be interpreted as evidence that individual patients cannot develop TMD symptoms during orthodontic treatment, as these symptoms may arise from the natural course of the disorder or other coexisting risk factors.

From a clinical perspective, orthodontic treatment should therefore not be avoided solely because of concerns regarding routine induction of TMJ pathology. Likewise, the onset of TMD symptoms during orthodontic treatment should not automatically be interpreted as a direct consequence of orthodontic mechanics, particularly in patients with pre-existing symptoms or parafunctional behaviors. Recommended components of baseline TMJ screening before orthodontic treatment are summarized in Table 2.

These observations also have important implications for patient communication. [1,20,21] Concerns regarding the potential development of temporomandibular disorders frequently influence patients' expectations and may contribute to anxiety before treatment. Presenting evidence-based information regarding the multifactorial etiology of TMD and the lack of convincing evidence supporting a causal relationship with orthodontic treatment may improve informed consent and facilitate realistic expectations. At the same time, clinicians should continue to perform careful baseline TMJ examinations and document pre-existing signs and symptoms, allowing appropriate interpretation of any complaints arising during treatment.

Table 1. Summary of the current evidence on the association between orthodontic treatment and the development of temporomandibular disorders

| AUTHOR                    | YEAR | STUDY TYPE                          | PRINCIPAL FINDINGS                                                                                           | REF. |
|---------------------------|------|-------------------------------------|--------------------------------------------------------------------------------------------------------------|------|
| Luther et al.             | 2010 | Cochrane systematic review          | No evidence that orthodontic treatment is an effective treatment for TMD and no evidence that it causes TMD. | [13] |
| Fernández-González et al. | 2015 | Systematic review                   | Orthodontic treatment is not associated with an increased risk of developing TMD.                            | [14] |
| Manfredini et al.         | 2016 | Systematic review                   | Current evidence does not support a causal relationship between orthodontic treatment and TMD                | [32] |
| Kyburz et al.             | 2019 | Systematic review and meta-analysis | Functional appliances do not appear to induce clinically significant TMJ pathology.                          | [34] |
| Jeong et al.              | 2024 | Systematic review and meta-analysis | Adolescent orthodontic treatment is not associated with increased TMD risk.                                  | [15] |
| Zhang et al.              | 2023 | Systematic review and meta-analysis | No significant association between orthodontic treatment and TMD development was identified.                 | [40] |

Table 2. Suggested baseline temporomandibular joint (TMJ) screening before orthodontic treatment

| CLINICAL DOMAIN      | EXAMPLES                                                 |
|----------------------|----------------------------------------------------------|
| Pain assessment      | Preauricular pain, muscle tenderness, headache           |
| Joint sounds         | Clicking, crepitus, intermittent locking                 |
| Mandibular mobility  | Maximum opening, deviation, limitation                   |
| Muscular examination | Tenderness of masseter and temporalis muscles            |
| Functional habits    | Bruxism, clenching, nail biting                          |
| Psychosocial factors | Stress, anxiety, sleep disturbances                      |
| Previous treatment   | History of TMD therapy or trauma                         |
| Imaging indications  | Persistent pain, locking, suspected structural pathology |

## Strengths and limitations

The main strength of this review is the inclusion of recent systematic reviews, meta-analyses, and clinical studies, providing a contemporary overview of the relationship between orthodontic treatment and temporomandibular disorders. The review also incorporates current diagnostic concepts, including the DC/TMD framework, and considers different orthodontic treatment modalities.

Several limitations should be acknowledged. The available evidence is heterogeneous with respect to diagnostic criteria, study design, follow-up duration, treatment protocols, and outcome assessment. Much of the underlying primary evidence was derived from observational studies, which limits the ability to establish causal relationships between orthodontic treatment and TMD. As a narrative review, this study did not include a formal risk-of-bias assessment or quantitative synthesis. In addition, only English-language publications were included, and the literature search covered studies published up to February 2025.

## CONCLUSION

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The available evidence does not support orthodontic treatment as an independent etiological factor for temporomandibular disorders. Orthodontic treatment involving premolar extraction has not been shown to increase the risk of developing TMD compared with non-extraction treatment. Functional orthodontic appliances may produce adaptive changes in the temporomandibular joint, but the available evidence does not indicate that they cause persistent joint dysfunction. No orthodontic treatment modality has been consistently associated with a higher risk of developing new temporomandibular disorders. Orthodontic treatment decisions should therefore be based on established orthodontic and skeletal indications rather than concerns about TMD development. Further long-term prospective studies using standardized DC/TMD diagnostic criteria are needed.

## DISCLOSURE

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### Author Contributions

Conceptualization: Justyna Polko, Izabela Migdał. Methodology: Justyna Polko, Weronika Kwaśnica. Literature search: Justyna Polko, Izabela Migdał, Weronika Kwaśnica, Zuzanna Galicka, Tomasz Horodniczy, Maja Witek, Zuzanna Jeziorska, Bartosz Szymajda, Katarzyna Raczek, Jakub Czapkiewicz. Literature analysis and interpretation: Justyna Polko, Izabela Migdał, Zuzanna Jeziorska. Writing, original draft preparation: Justyna Polko. Writing, review and editing: Izabela Migdał, Weronika Kwaśnica, Zuzanna Galicka, Tomasz Horodniczy, Maja Witek, Zuzanna Jeziorska, Bartosz Szymajda, Katarzyna Raczek, Jakub Czapkiewicz. Supervision: Justyna Polko.

## Artificial Intelligence Statement

The authors used artificial intelligence tools solely for language editing and manuscript formatting assistance. All scientific content, interpretation of the literature, and final responsibility for the manuscript remain with the authors.

## Conflict of Interest

The authors declare no conflicts of interest.

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