

Assessment and Management Approaches for Temporomandibular Disorders in Orthodontic Practice: A Survey-Based Study

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ABSTRACT

This study aimed to assess how temporomandibular disorder (TMD) diagnostics are integrated into routine orthodontic care and to explore how identified TMD symptoms influence treatment planning and therapy decisions. A survey was distributed to all officially registered orthodontists in Germany, collecting information on their professional experience, TMD-related specialization, and specific clinical practices. Responses were anonymized, organized, manually verified, and statistically analyzed. Fisher's exact tests were used to evaluate differences in TMD-related procedures based on professional experience and specialization. Out of 2,359 questionnaires sent, 630 were completed and analyzed. Most respondents reported performing either a brief TMD screening or a comprehensive functional assessment. Only 21.1% rely solely on patient medical history for evaluation. A secondary full functional assessment was conducted by 33% during ongoing orthodontic treatment and by 56.6% only when initial findings indicated pathology. Non-painful temporomandibular joint (TMJ) clicking identified prior to therapy influenced treatment planning in 60.1% of respondents. Merely 4.3% reported taking no further action when TMD symptoms were present before treatment. While professional experience did not significantly affect diagnostic procedures, a specialization in TMDs did. The findings reveal a gap between research evidence and routine practice in German orthodontics, potentially leading to more extensive TMD evaluations, which, however, do not pose adverse health effects for patients.

Keywords: TMD screening, Temporomandibular disorder, Orthodontic treatment, Orthodontic therapy, TMD, Functional occlusal factors, Temporomandibular joint clicking

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Introduction

Temporomandibular disorders (TMDs) represent a significant public health concern, affecting up to 34% of people worldwide [1]. Classified as a subset of craniofacial pain, TMDs encompass painful or dysfunctional conditions involving the masticatory muscles, the temporomandibular joint (TMJ) and related structures, or both. The internationally recognized taxonomy of TMDs divides them into four main categories: TMJ disorders, masticatory muscle disorders, headache-related disorders, and conditions impacting associated structures [2]. Common symptoms include restricted or abnormal mandibular movement, TMJ clicking, headaches, and facial pain [3-5]. The etiology of TMDs is multifactorial, with contributions from macro- and micro-trauma, psychosocial influences, genetic and hormonal factors, as well as other systemic conditions [4, 5]. Historically, TMDs were linked to dental malocclusions, with static and dynamic occlusion thought to play a primary role in symptom development during the 1970s and 1980s [6-8]; however, subsequent clinical studies have demonstrated that occlusal factors have a relatively minor influence [9].

Patients seeking orthodontic treatment exhibit a higher prevalence of TMDs compared to the general population, ranging from 21.1% to 73.3% [5, 10]. Orthodontics focuses on detecting and preventing dental and jaw anomalies, promoting proper development of the stomatognathic system, and correcting dentofacial irregularities. A traditional goal is to optimize static and dynamic occlusion, thereby improving masticatory function. Specific occlusal features, such as class II malocclusion, unilateral crossbite, unstable occlusal contacts, or lateral forced bites, have been identified as strong risk factors for TMD development [5, 11, 12]. Temporary alleviation of occlusal interferences using an occlusal splint may help reduce existing pain [13, 14]. Orthodontic interventions can influence the onset or progression of TMDs, but there is currently no robust evidence demonstrating a direct link between post-treatment occlusal changes and TMD development. Multiple reviews and epidemiological studies have reported either weak or no correlations [15-17], and no definitive causal relationship between orthodontic therapy and TMDs has been established, nor have specific triggering or protective factors been identified [15, 18, 19].

Performing a TMD-focused assessment prior to orthodontic treatment appears essential, beyond legal or forensic considerations. A brief pre-treatment screening is generally advised to rule out existing TMD signs or symptoms and to address them before starting orthodontic therapy. Additionally, early detection of asymptomatic conditions, such as TMJ compression forces that have not yet caused clinical issues, may be possible. However, whether these compensated anatomical variations impact subsequent orthodontic treatment and should therefore be factored into treatment planning remains uncertain [20].

Clinical practice, both nationally and internationally, employs various protocols for evaluating potential TMDs. A comprehensive assessment should include mandibular motion, the stomatognathic musculature (including cervical muscles), TMJs and their limiting structures, and both static and dynamic occlusion. Considering psychogenic factors is also recommended [21, 22]. When selecting a diagnostic protocol, high sensitivity, specificity, and inter-rater reliability are critical. Both the Diagnostic Criteria for Temporomandibular Disorders (DC/TMD) and the Research Diagnostic Criteria for Temporomandibular Disorders (RDC/TMD) protocols demonstrate strong performance across these key criteria [2, 23].

Evaluating a potential temporomandibular disorder (TMD) can demand considerable time from clinicians. Consequently, some experts advocate that patients without symptoms who are about to undergo comprehensive dental rehabilitation or orthodontic therapy should initially undergo a short functional screening rather than a full assessment. Only when initial screening identifies possible abnormalities is a complete functional analysis recommended. Such preliminary screenings are quicker, simpler, and less costly. For example, the German Society for Functional Diagnostics and Therapy (DGFDT) screening form begins by asking patients about pain or difficulty when opening their mouth, followed by assessment of five parameters with yes/no responses. Depending on the outcomes, more detailed diagnostic procedures may then be suggested. According to the German Pain Society, minimum examinations for suspected TMD should include a pain-focused medical history, a whole-body drawing, evaluation of psychogenic factors such as stress or depression, and panoramic radiographs [24]. Additional imaging modalities, such as MRI, may be warranted for further diagnosis or to guide management [22].

The present study aimed to determine how TMJ assessments are integrated into routine orthodontic practice, considering both the orthodontists' level of experience and any specialization in TMD. Specifically, the study focused on how functional diagnostic measures are generally implemented, the timing of their use, and the influence on routine treatment, rather than on the specifics of diagnostic or therapeutic procedures. Patients seeking orthodontic care due to existing TMDs were not included. By conducting a nationwide survey of all officially registered orthodontists in Germany, the study provides a representative picture of how frequently TMJ assessments are performed, when they occur in the treatment process, and how they influence clinical decisions in private European orthodontic practices.

Materials and Methods

Ethical clearance was obtained from the Ethics Committee of the Medical Faculty of the University of Cologne (approval number 20-1099, date: 7 July 2020). All specialist orthodontic practices listed on official German dental association websites were eligible for inclusion. Questionnaires were mailed in August 2020, and all participants provided written informed consent. Only responses returned within a three-month inclusion period were considered in the analysis.

Returned questionnaires were entered into Microsoft Excel 2016 using Remark Office version 14.0 and manually verified. The survey included eight questions covering respondents' professional background, TMD specialization, and clinical procedures (Appendix A). Ambiguous or incomplete responses were treated as missing data.

Out of 2,359 questionnaires sent, 27 were returned as undeliverable. A total of 630 completed questionnaires were received and analyzed, yielding a 27% response rate. Due to some incomplete responses, the effective sample size for analysis ranged from $n = 605$ to $n = 627$, depending on the specific question. Sample size calculations indicated that $n = 325$ would be sufficient to detect small-to-moderate differences between groups (standardized effect size of 0.2), so the achieved sample size was more than adequate.

Statistical analyses were conducted using IBM SPSS version 16.0.0.1. Case-wise deletion was used to handle missing data, which were assumed to be completely at random (MCAR). Little's test supported this assumption (test statistic = 53.4, $p = 0.497$). Continuous variables were summarized using means and standard deviations, while categorical data were reported as absolute and relative frequencies. For inferential analyses, respondents were divided into groups based on professional experience (<25 vs. ≥ 25 years since licensure) and presence or absence of TMD specialization. Group differences were assessed using Fisher's exact test. For robustness, chi-squared and Yates' corrected chi-squared tests were also performed; results were consistent across methods, so Fisher's exact test outcomes are reported. Group differences were expressed as odds ratios with confidence intervals, and statistical significance was defined as $p < 0.05$.

Results and Discussion

The orthodontists who responded to the survey had an average duration of private practice of 17.64 ± 9.69 years, while the average professional experience since licensure was 25.26 ± 9.44 years. Most participants reported that their practices did not specialize in TMD diagnostics or therapy ($n = 474$, 76.3 percent), and the majority of orthodontists did not hold an additional qualification in this area ($n = 462$, 73.8 percent).

Diagnostics prior to orthodontic treatment

Overall, 67% of respondents ($n = 422$) indicated that they consistently conduct a brief physical examination or screening/minimal diagnostics before initiating orthodontic treatment. Only 15.7 percent ($n = 99$) reported performing a full functional analysis for all patients prior to therapy, while 36.8 percent ($n = 232$) stated that a complete functional analysis was carried out only if the initial screening yielded abnormal findings. Additionally, 21.1% ($n = 133$) conducted TMD screening exclusively when patients reported symptoms during the interview or through their medical history. About 13.8 percent ($n = 87$) always referred patients to a TMJ specialist if either the patient history or initial screening indicated potential issues. A small fraction, 2.5% ($n = 16$), reported not performing any TMJ examination before orthodontic treatment.

Some respondents indicated multiple approaches. For instance, 2.9% ($n = 18$) performed both a brief screening and a complete physical assessment prior to starting treatment. A total of 22.5 percent ($n = 144$) conducted an initial screening and reserved a complete functional analysis for cases where abnormalities were detected. Meanwhile, 5% ($n = 33$) reported performing a physical examination themselves (either brief screening or full analysis) but subsequently referred patients to a specialized colleague for further evaluation.

Figure 1 presents a detailed comparison of all affirmative responses regarding pre-orthodontic diagnostic procedures, stratified according to professional experience and TMD specialization (**Figure 1**).

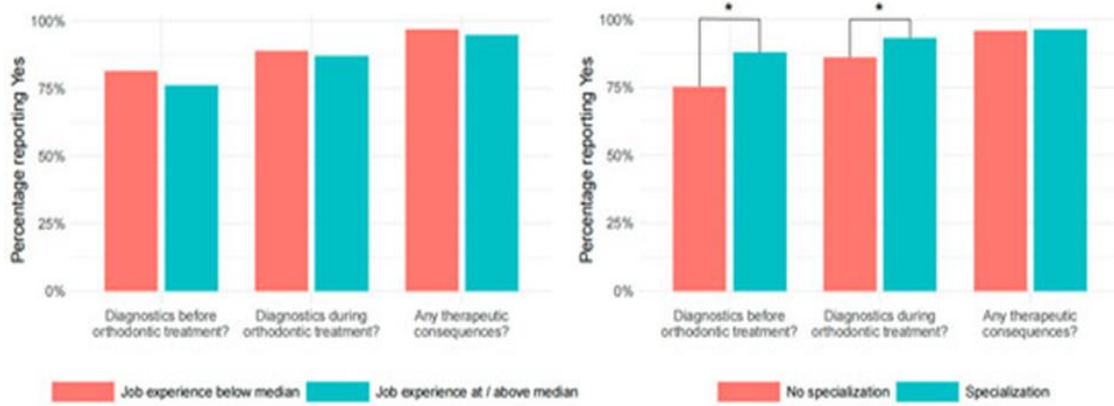


Figure 1. Management of TMD-related diagnostics before and during orthodontic treatment, and the corresponding therapeutic implications—comparison by professional experience (left) and TMD specialization (right). * $p < 0.05$

Diagnostics during orthodontic treatment

Regarding ongoing orthodontic care, 33% of respondents ($n = 204$) reported conducting a complete functional analysis at least once during treatment, regardless of initial findings. The majority of specialists, 56.6 percent ($n = 350$), stated that a full functional analysis is only performed if abnormalities were identified during the initial evaluation. Meanwhile, 10.4% of respondents ($n = 64$) indicated that they generally do not perform a complete functional analysis throughout orthodontic therapy.

Figure 1 illustrates the distribution of affirmative responses for all diagnostic procedures carried out during the course of treatment, stratified by both professional experience and specialization (**Figure 1**).

Therapeutic implications

Pre-treatment detection of non-painful TMJ clicking alone influenced treatment planning for 60.1% of respondents ($n = 370$). When TMD symptoms were present, 38.3 percent ($n = 232$) provided pre-orthodontic therapy in their own practice, whereas 21.3 percent ($n = 129$) consistently referred patients to a specialist. A further 35% ($n = 212$) reported referring patients only in more complex cases, and 4.3 percent ($n = 26$) indicated that orthodontic treatment was initiated irrespective of TMD symptoms.

Figure 1 also displays the distribution of responses regarding therapeutic decisions following TMD diagnostics, differentiated by professional experience and TMD specialization (**Figure 1**).

Impact of experience and TMD specialization

Tables 1 and 2 summarize variations in clinical practices between orthodontists with differing levels of professional experience and TMD-related specialization. The data include diagnostic procedures conducted before and during orthodontic therapy, as well as treatment decisions based on the diagnostic findings.

Table 1. Differences in diagnostic and therapeutic approaches with respect to orthodontists' professional experience

	Professional Experience Below Median			Professional Experience At/Above Median			Difference			
	n	Total	Rel. Freq.	n	Total	Rel. Freq.	OR	CI Lower	CI Upper	p-Value
Typically conduct a brief screening	205	290	0.71	208	327	0.64	0.725	0.509	1.031	0.072
Typically conduct a full functional analysis	45	290	0.16	52	327	0.16	1.029	0.652	1.631	0.912
Perform a full functional analysis if initial screening shows abnormalities	112	290	0.39	116	327	0.35	0.874	0.621	1.229	0.452

Perform a full functional analysis only if the patient reports symptoms	57	290	0.20	74	327	0.23	1.195	0.796	1.800	0.377
No functional assessment performed	7	290	0.02	8	327	0.02	1.014	0.317	3.329	1.000
TMJ clicking affects orthodontic treatment planning	172	284	0.61	192	319	0.60	0.984	0.700	1.383	0.934
Refer patient if symptoms or abnormal findings are present	48	290	0.17	38	327	0.12	0.663	0.407	1.075	0.082
Provide TMD treatment before starting orthodontic therapy in symptomatic patients	268	289	0.93	294	324	0.91	0.768	0.407	1.425	0.384
Offer pre-orthodontic TMD therapy within one's own practice	94	290	0.32	134	327	0.41	1.447	1.027	2.043	0.030 *
Conduct additional diagnostic evaluation during orthodontic treatment (either routinely or based on initial findings)	258	290	0.89	285	327	0.87	0.842	0.498	1.412	0.536

Note: * *p*-value < 0.05. OR = odds ratio; CI lower = lower bound of 95% confidence interval; CI upper = upper bound of 95% confidence interval.

Table 2. Differences in diagnostic and therapeutic approaches with respect to orthodontists' specialization in the field of TMDs

	No Specialization			Specialization			OR	CI Lower	CI Upper	Difference <i>p</i> -Value
	n	Total	Rel. Freq.	n	Total	Rel. Freq.				
Typically conduct a brief screening	310	462	0.67	111	164	0.68	1.027	0.692	1.536	0.923
Typically conduct a full functional analysis	54	462	0.12	43	164	0.26	2.680	1.665	4.302	<0.001 *
Perform a full functional analysis if initial screening shows abnormalities	163	462	0.35	67	164	0.41	1.267	0.863	1.853	0.221
Perform a full functional analysis only if the patient reports symptoms	110	462	0.24	23	164	0.14	0.522	0.305	0.865	0.008 *
No functional assessment performed	15	462	0.03	1	164	0.01	0.183	0.004	1.209	0.083
TMJ clicking affects orthodontic treatment planning	263	456	0.58	106	158	0.67	1.495	1.007	2.237	0.039 *
Refer patient if symptoms or abnormal findings are present	79	462	0.17	7	164	0.04	0.217	0.082	0.482	<0.001 *
Provide TMD treatment before starting orthodontic therapy in symptomatic patients	422	459	0.92	150	163	0.92	1.012	0.509	2.133	1.000
Offer pre-orthodontic TMD therapy within one's own practice	136	462	0.29	96	164	0.59	3.377	2.299	4.983	<0.001 *
Conduct additional diagnostic evaluation during orthodontic	397	462	0.86	153	164	0.93	2.275	1.152	4.913	0.012 *

treatment (either routinely or based on initial findings)

Note: * p -value < 0.05. OR = odds ratio; CI lower = lower bound of 95% confidence interval; CI upper = upper bound of 95% confidence interval

There is generally no evidence that orthodontists with more years of practice adopt different clinical approaches compared to those with fewer years, except in one specific area. No significant differences were detected between the two experience groups regarding the implementation of brief screenings (**Table 1**, $p = 0.072$; odds ratio = 0.725) or full functional assessments prior to orthodontic treatment (**Table 1**, $p = 0.912$; odds ratio = 1.029). While seasoned orthodontists are slightly more inclined to carry out a comprehensive functional analysis following an initially notable screening, this tendency does not reach statistical significance (**Table 1**, $p = 0.452$; odds ratio = 0.874). Other clinical decisions—such as responses to patient-reported symptoms, evaluation of non-painful TMJ clicking, referral practices, or opting not to perform any TMJ examination—showed no meaningful differences between practitioners with over or under 25 years of experience (**Table 1**, $p > 0.05$). The sole area of significant distinction was that experienced orthodontists were more likely to provide TMD treatment in their own practice prior to starting orthodontic therapy (**Table 1**, $p = 0.030$; odds ratio = 1.447).

Orthodontists specialized in TMD management demonstrated notable differences in practice patterns. They were significantly more likely to perform a full functional assessment before treatment (**Table 2**, $p < 0.001$; odds ratio = 2.680) and less likely to rely solely on patient-reported symptoms for initiating examinations (**Table 2**, $p = 0.008$; odds ratio = 0.522). TMJ clicking was given greater clinical weight by specialists (**Table 2**, $p = 0.039$; odds ratio = 1.495), who also referred fewer patients to colleagues for abnormal findings or symptoms (**Table 2**, $p < 0.001$; odds ratio = 0.217) and managed TMD therapy themselves more frequently (**Table 2**, $p < 0.001$; odds ratio = 3.377). Moreover, specialists performed additional functional analyses during orthodontic treatment, either routinely or following abnormal initial findings, significantly more often than non-specialists (**Table 2**, $p = 0.012$; odds ratio = 2.275).

Figure 1 provides a visual summary of the responses regarding pre-treatment and intra-treatment procedures, as well as the subsequent clinical actions taken in response to TMD findings, with stratification by experience and specialization. Practitioners with less than 25 years of experience did not show significant differences compared to more experienced colleagues in conducting brief or comprehensive screenings in patients without prior symptoms (**Figure 1**, $p > 0.05$). Similarly, no significant differences were observed for TMD-related diagnoses during treatment (**Figure 1**, $p > 0.05$) or for therapeutic decisions, including treatment plan adjustments for TMJ clicking, specialist referrals, or initiating TMD therapy before orthodontic care (**Figure 1**, $p > 0.05$).

Among specialists, a significantly larger proportion reported performing TMD diagnostics both before (**Figure 1**, $p < 0.001$; odds ratio = 2.356) and during treatment (**Figure 1**, $p = 0.012$; odds ratio = 2.275) compared to non-specialists, while their approach to subsequent therapeutic actions based on TMD findings did not differ meaningfully from non-specialists (**Figure 1**, $p > 0.05$).

A meta-analysis reported that the global prevalence of TMDs ranges between 31% and 34% [1], while in Europe, it was estimated at 29%. Among children and adolescents, the prevalence drops to around 11% [25], highlighting that TMD is a commonly occurring disorder. Considering these prevalence rates alongside the findings of the present study, there is a clear need for standardized diagnostic methods to assess the functional aspects of the stomatognathic system, not solely for research purposes but also to improve clinical consistency.

Evidence-based guidance on managing TMDs before and during orthodontic treatment remains limited. The absence of specific clinical recommendations may hinder orthodontists from providing fully comprehensive care, potentially affecting patient outcomes. Nevertheless, this survey indicates that German orthodontists recognize TMD-related risks and are willing to allocate time for TMJ examinations prior to initiating orthodontic therapy.

As with any study relying on questionnaires, the results are susceptible to certain biases. Selection bias may have occurred if orthodontists who prioritize TMD diagnostics and management were more likely to participate. In our sample, experienced practitioners (average 25 years) were slightly overrepresented compared to the general population of German orthodontists (average 19 years; Federal Dental Association data). Both heightened interest in TMDs and above-average experience could have influenced responses, potentially attributing greater importance to TMD diagnostics in orthodontic care. Social desirability bias may also have affected responses, particularly for questions on controversial practices, although anonymization was applied to reduce this effect.

The study achieved a relatively high response rate compared to similar surveys conducted in Germany [26, 27]. However, since no personal data were collected and questionnaires were mailed, there was no opportunity to follow up with non-respondents. This limitation prevented a potential second wave of the survey to clarify additional questions arising from initial results. Consequently, complete anonymization, while preserving privacy, should be considered a design limitation, and future research could address this by employing a pseudonymized online survey format.

Across all respondents, regardless of experience or specialization, there was broad agreement on the value of including a brief TMD screening as part of the initial orthodontic evaluation. About two-thirds of orthodontists reported routinely performing such screenings prior to treatment.

The appropriateness of screening alone—versus relying solely on medical history or performing a full functional analysis—remains debated. Screening is less time-intensive than comprehensive physical examinations, and skipping it could result in undetected TMDs, which may legally be considered a treatment error in occlusion-altering procedures [28]. Conversely, routine screening could prompt unnecessary diagnostic follow-ups and potential overtreatment of clinically insignificant conditions [29]. Furthermore, when a patient's history indicates TMD-related symptoms, a complete functional analysis may be necessary, potentially rendering initial screening redundant.

Orthodontic treatment should be postponed in patients experiencing pain that may indicate TMDs. Experimental studies have demonstrated that induced pain in the masticatory muscles significantly alters mandibular movement, complicating orthodontic procedures [30]. Currently, there is no evidence-based consensus on whether a complete functional examination of the stomatognathic system is necessary. Nonetheless, from a legal standpoint, performing at least a brief TMJ screening can help protect practitioners against liability if TMD symptoms arise during or after treatment [28]. In this survey, only 2.5% of participants reported not conducting any TMD assessment before starting orthodontic therapy, though it cannot be determined whether legal considerations influenced this low rate. Neither professional experience nor TMJ specialization showed any association with this behavior.

Recommendations for repeated comprehensive functional assessments during treatment are limited and generally restricted to patients who develop symptoms [31]. Accurate diagnosis, coupled with pausing orthodontic therapy and addressing TMD symptoms, is essential. Overall, 87% of respondents indicated performing at least one full functional analysis during orthodontic treatment, with a higher proportion (93%) among TMD specialists. Notably, 33% of orthodontists conduct this analysis regardless of initial findings, a practice that warrants critical evaluation in terms of cost and clinical benefit.

The clinical significance of recurrent, painless TMJ clicking remains uncertain, as recent studies suggest it does not correlate with an increased risk of TMDs and may represent a harmless variation of normal function [29, 32]. One large-scale study found TMJ clicking in at least one joint in 20% of adults aged 20–81, while restricted mouth opening occurred in only 9%, TMJ pain in 2.7%, and masticatory muscle pain in 1.3% [33]. Some evidence links malocclusion to TMJ clicking [34]; however, in this survey, 60.1% of respondents reported that TMJ clicking influenced their orthodontic planning. Given the lack of correlation between TMJ clicking and TMD risk [27], this approach lacks an evidence-based foundation. The tendency to weigh TMJ clicking more heavily was significantly higher among specialists ($p = 0.039$). Previous research has similarly shown that many practitioners still favor occlusal adjustment or selective grinding as a treatment for TMD symptoms, including TMJ clicking [35, 36].

Most surveyed orthodontists indicated that TMD findings would influence treatment decisions, either by initiating TMD therapy in their own practice or referring patients to a specialist. Only 4.3% reported they would proceed with orthodontic therapy regardless of findings, and 2.5% stated they do not perform any TMD-related assessments prior to treatment. This raises questions about the purpose of TMD examinations if no therapeutic action is taken. No significant associations were found with professional experience or specialization. It remains unclear whether experienced practitioners might downplay TMD concerns due to expectations of improvement through orthodontics, a topic that warrants further investigation.

This study provides a snapshot of how TMD patients are managed within orthodontic practice in Germany, including insights into examination types, such as joint palpation and pain assessment. However, detailed information about the specific protocols used in practice remains limited. The survey revealed a highly heterogeneous approach: only 1.4% of respondents ($n = 9$) reported using the RDC/TMD or DC/TMD diagnostic systems, and just 7.8% ($n = 49$) employed pain or depression questionnaires (data not shown). This variability

underscores the need for standardized guidelines and targeted professional training to ensure consistent, evidence-based TMD diagnostics in orthodontics.

Conclusion

Orthodontists in Germany generally demonstrate a strong awareness of their responsibility regarding TMD diagnostics. However, the implementation of screenings, comprehensive functional assessments, and TMD therapy within orthodontic care shows considerable variation, revealing a gap between current scientific evidence and routine clinical practice. This discrepancy, reflecting both an evidence–practice gap and inconsistent standard procedures, is not unique to orthodontics but represents a broader challenge in dentistry. Neither extended professional experience nor specialization in functional diagnostics appears to result in a more evidence-based approach among German practitioners.

The findings highlight not only variability in overall management strategies but also differences in specific diagnostic and therapeutic practices. Further research is warranted to explore aspects such as imaging methods, types of splint therapy, applied diagnostic protocols, and their clinical effectiveness within the context of orthodontic treatment in Germany.

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