JBACHS
Journal of Basic and Clinical Health Sciences

J Basic Clin Health Sci 2024; 8: 710-718
https://doi.org/10.30621/jbachs.1533578
RESEARCH ARTICLE

COMPARISON OF THE EFFECTS OF A SIX-WEEK PHYSIOTHERAPY PROGRAM ON TEMPOROMANDIBULAR DISORDER PATIENTS WITH AND WITHOUT POSTERIOR EDENTULISM: A QUASI-EXPERIMENTAL STUDY

Selnur NARIN ARAL[1*], Rubeysa TUREDİ[2], Gulcan COSKUN AKAR[3]

[1] Dokuz Eylul University, Faculty of Physical Therapy, Department of Orthopaedic Physiotherapy and Rehabilitation, Izmir, Türkiye
[2] Dokuz Eylul University, Institute of Health Sciences, Department of Physical Therapy and Rehabilitation, Izmir, Türkiye
[3] Ege University, Faculty of Dentistry, Department of Prosthodontics, Izmir, Türkiye

ORCID: S.N.A. 0000-0001-8781-7918; R.T. 0000-0002-4099-5220; G.C.A. 0000-0002-9343-9228

Corresponding author: Rubeysa Turedi, **E-mail:** r.turedi@ogr.deu.edu.tr
Received: 15.08.2024; **Accepted:** 05.09.2024; **Available Online Date:** 30.09.2024

Cite this article as: Narin-Aral S, Turedi R, Coskun-Akar G. Comparison of the Effects of a Six-Week Physiotherapy Program on Temporomandibular Disorder Patients with and without Posterior Edentulism: A Quasi-Experimental Study. J Basic Clin Health Sci 2024; 8: 710-718.

ABSTRACT

Purpose: The impact of posterior edentulism on the management of temporomandibular disorder remains unclear, with a paucity of studies examining the influence of posterior edentulism on symptoms. The objective of this study is to investigate the relationship between posterior edentulism and bruxism, tinnitus, and depression in temporomandibular disorder patients and to compare treatment outcomes in two groups with and without posterior edentulism.

Material and Methods: In a quasi-experimental controlled trial, 26 patients with temporomandibular disorder participated in a six-week intervention, including manual therapy, massage, postural exercises and kinesiotaping. The patients were divided into 13 in the posterior edentulous group and 13 in the full dentate group. The participants attended 12 physiotherapy sessions, twice a week, over six weeks. Outcome measures, including bruxism, tinnitus, joint clicking, Beck Depression Inventory, and cervical range of motion, were evaluated at baseline and the end of the six weeks.

Results: The six-week physiotherapy program significantly improved bruxism, tinnitus, cervical range of motion, and depression ($p<0.05$). The posterior edentulous group showed significantly greater improvement in cervical range of motion compared to the full dentate group ($p<0.05$).

Conclusion: Physiotherapy effectively reduces temporomandibular disorder symptoms and highlights the importance of considering posterior edentulism in comprehensive temporomandibular disorder management.

Keywords: Bruxism, depression, temporomandibular disorder, tinnitus, physiotherapy

INTRODUCTION

Temporomandibular disorder (TMD) is a clinical condition that refers to functional disorders associated with the temporomandibular joint (TMJ) and surrounding tissues, such as pain and restricted mandibular movement. Various factors, including trauma, malocclusion, fibrocartilage disc dysfunction, muscle hyperfunction, and psychosocial factors, may influence the formation of TMD (1). Posterior edentulism can cause damage the TMJ, such as resorption of the articular eminence and disc displacement. This results in a loss of occlusal support, which is a critical factor contributing to degenerative changes in the TMJ (2). Symptoms of dysfunction become more common as the duration and extent of edentulism, the number of missing teeth and quadrants involved increase (3). Clinical symptoms may include TMJ pain, joint noise, ear pain, bruxism, tinnitus, restricted mandibular movement, and headaches (4). Fallahi HR et al. (5) showed that partial edentulism is an important etiological factor for TMJ disorders. Therefore, it is recommended to replace the lost teeth and create a stable occlusion (6).

Bruxism is a parafunction characterized by excessive and abnormal activation of the mandibular muscles, resulting in clenching or grinding of the teeth (7). Bruxism is often associated with anxiety, malocclusion, sleep disorders, stress and the side effects of certain medications. It may cause excessive stress and pressure on the TMJ and surrounding tissues due to overloading of the mandibular muscles, leading to pain, fullness, and tinnitus in the ear (7). Continuous clenching may cause damage to the articular disc, resulting in TMD. Studies have reported a positive correlation between TMD pain and self-reported bruxism diagnosis. The occurrence of self-reported parafunctional habits has also been identified as a significant predictor of TMD onset (8,9).

Tinnitus is frequently associated with TMD. Trigger points in the masseter, lateral and medial pterygoids, sternocleidomastoid (SCM), upper trapezius, and scalene muscles can cause tinnitus (10). In a study by Buergers et al. (11) to investigate the relationship between tinnitus and TMD, tinnitus was eight times higher in patients with TMD. Still, improvements in tinnitus symptoms were reported due to splinting and physiotherapy.

Psychosocial stress factors are believed to play a role in the development of TMD-related pain, particularly muscle pain experienced during chewing. Individuals afflicted with TMD exhibit elevated levels of anxiety, stress, somatic awareness, pain catastrophising, depression and kinesiophobia when compared to control groups (12,13). Stress may lead to parafunctional activities such as clenching and grinding.

The existing literature indicates that the optimal treatment programme and dosage for TMD have yet to be determined. Due to the complexity of TMD, a multidisciplinary approach among healthcare professionals is necessary. TMD patients commonly experience symptoms such as headaches, neck and shoulder pain, and postural abnormalities. Physiotherapy can help manage these symptoms by improving the strength and flexibility of relevant muscles.

This study aims to examine the relationship between posterior edentulism and bruxism, tinnitus, and depression in patients with TMD and to compare the treatment outcomes between two groups with and without posterior edentulism. We hypothesize that there will be differences in the response to treatment between posterior edentulous and full dentate TMD patients.

MATERIALS AND METHODS

Study design

The study was a quasi-experimental controlled trial conducted at Dokuz Eylul University. The study was conducted in accordance with the Declaration of Helsinki of 1975 (as revised in 2013), and the research was approved by the Dokuz Eylul University, Non-Interventional Clinical Research Ethics Committee with protocol number GOA-7337 (Date: 29.06.2022, Decision No: 2022/22-02).

Participants

The study participants were selected from patients diagnosed with myofascial TMD. The inclusion criteria were individuals aged between 18 and 70 years who were diagnosed with myofascial TMD according to the Research Diagnostic Criteria for TMD, experienced TMJ pain lasting for at least three months, complained of headache and neck pain, and had not used intraoral appliances.

Exclusion criteria for participants were history of neck or jaw fractures, trauma, diagnosis of fibromyalgia, degenerative changes, rheumatic or neurological problems, TMJ disc displacement, postoperative conditions or burns involving the cervical or

Table 1. Comparison of initial values of Full Dentate Group and Posterior Edentulous Group

Outcomes		Full Dentate Group N=13 X±*SD* *Med(Min-Maks)*	Posterior Edentulous Group N=13 X±*SD* *Med(Min-Maks)*	Between-group
Bruxism		1.54±0.52	1.46±0.78	*t*:0.30; *p*:0.77
Tinnitus		n:5	n:8	X^2:1.38; *p*:0.23
TMJ clicking		1.38±1.45	0.85±1.21	*t*:1.03; *p*:0.31
Cervical range of motion				
Lateral flexion	**R**	31.32±7.00	30.02±9.11	*t*:0.41; *p*:0.69
	L	30.56±9.12	32.59±7.33	*t*:-0.63; *p*:0.54
Rotation	**R**	69.92±7.89	69.73±9.27	*t*:0.06; *p*:0.95
	L	74.67(46.70-86.50)	71.20(46.17-86.00)	*z*:0.90; *p*:0.38
Flexion		56.73±8.92	52.94±11.03	*t*:0.96; *p*:0.34
Extension		63.74±16.13	65.35±7.89	*t*:-0.32; *p*:0.75
Beck Depression Inventory		12.08±9.14	16.62±9.35	*t*:-1.25; *p*:0.22

L: left; n: number of people; p: p value; R: right; SD: Standard deviation; t: Independent t-test; TMJ: Temporomandibular Joint; X^2: Ki kare test; z: Mann-Whitney U Test

temporomandibular region, previous orofacial treatment within the last 12 months, use of analgesics or muscle relaxants within 8 hours before physiotherapy, hypermobility of cervical movements, acute infections, any systemic disorder, or osteoporosis.

The objective of the study was clearly delineated, and written informed consent was obtained from all participants.

Study procedure

Patients diagnosed with TMD were classified into two groups based on the presence of posterior tooth contact loss: the full dentate group (FDG) and the posterior edentulous group (PEG). The study involved 26 patients with TMD, with 13 in the PEG and 13 in the FDG. The same programme was applied to all patients.

Outcome measures

All measurements were performed by the same physiotherapist at baseline and after six weeks. The study's primary outcome measure was bruxism, while secondary outcome measures included tinnitus, TMJ clicking, depression, and cervical range of motion (ROM).

Bruxism, tinnitus, and TMJ clicking: Participants self-reported their bruxism and tinnitus. Bruxism was recorded as one point if observed exclusively during the daytime or exclusively at night, and as two points if observed both during the daytime and at night. A score of 1 was assigned to participants who reported experiencing tinnitus, whereas a score of 0 was assigned to those who did not report any complaints of tinnitus. The clicking sound of the TMJ was evaluated using a scoring system that ranged from 0 to 4. This assessment considered both the right and left sides of the joint, as well as the opening and closing movements of the mouth. One point was assigned for each condition, resulting in a total possible score of 4.

Psychological situation: The patients' mental well-being was assessed using the Beck Depression Scale, a self-assessment scale developed by Beck (14), and its Turkish validity and reliability were established by Hisli (15) in 1989. The scale comprises 21 questions, each scored from 0 to 3. The findings indicate that a score of 0-9 corresponds to minimal depression, 10-16 to mild depression, 17-29 to moderate depression, and 30-63 to severe depression (11,12).

Cervical ROM: The study measured the patients' active neck flexion, active extension, active lateral flexion in both directions, and active rotation in both directions. Recent research has shown that smartphone apps can replace universal goniometers (16). The Clinometer smartphone application was used to measure cervical joint movements. This application has been shown to have excellent validity and reliability in measuring the lower cervical ROM in patients with chronic cervical pain (17). Each measurement was conducted three times, and the mean value of these repetitions was documented.

Intervention

All patients received the same 12 physiotherapy sessions twice a week for six weeks. The physiotherapy programme applied myofascial

Table 2. Baseline and follow-up results for bruxism, tinnitus, click sound and Beck Depression Inventory of each group

Outcomes		Baseline X±SD	Follow-up X±SD	Within-group†	Between-group‡
Bruxism	**FDG**	1.54±0.52	1.08±0.49	*MH*:2.45 *p*:0.01*	*t*:1.68; *p*:0.11
	PEG	1.46±0.78	0.77±0.44	*MH*:2.71 *p*:0.01*	
Tinnitus	**FDG**	n:5	n: 4	*McNemar p*:0.98	X^2:2.22; *p*:0.13
	PEG	n: 8	n: 1	*McNemar p*:0.03*	
TMJ clicking	**FDG**	1.38±1.45	1.54±1.81	*MH*:-0.29 *p*: 0.77	*t*:1.79; *p*:0.09
	PEG	0.85±1.21	0.54±0.88	*MH*:1.07 *p*:0.29	
Beck Depression Inventory	**FDG**	12.08±9.14	8.31±6.12	*t*:2.65 *p*:0.02*	*z*:1.59 *p*:0.12
	PEG	16.62±9.35	8.31±10.18	*t*:3.37 *p*:0.01*	

† t: dependent t-test; z: independent t-test; ‡ t: independent sample t test ; X^2: Fisher's Excat test; FDG: Full Dentate Group; MH: Marginal Homogeneity test; ; n: number of people; PEG: Posterior Edentulous Group; p, p value; SD: standard deviation; *: p<0.05.

releases, massage, trigger point compression, suboccipital release, stretching, and posture exercises to the SCM, scalene, trapezius, and pectoral muscles to relax the cervical region. Kinesiotape was applied once a week to the SCM and upper trapezius. The sessions lasted approximately one hour. Physiotherapy aimed to relax the cervical spine, strengthen weak muscles, and correct posture to reduce strain on the TMJ and masticatory muscles.

Data processing and statistical analysis

The sample size was estimated using G*Power Software (version 3.1.9.7) A margin of error (α) of 0.05, 90% power (β), and an effect size (Cohen's d) of 1.02, derived from a similar study, were used to determine the sample size (18). This resulted in 13 participants in each group, comprising 26 participants. The confidence interval was set at 95%. All data were recorded and analyzed using the SPSS (Statistical Package for Social Sciences) for the Windows 22 programme. To determine the normality of the distribution, we used the Shapiro-Wilk test, kurtosis and skewness values, and a histogram graph. Two independent groups were compared using the independent sample t-test and Mann-Whitney U test. The difference between two related numerical variables was analyzed using the paired sample t-test and Wilcoxon test. Fisher's exact test was used to examine relationships between independent categorical variables, and McNemar and marginal homogeneity tests examined relationships between dependent categorical variables. A significance level of 0.05 was used to interpret the obtained values.

RESULTS

The study assessed 37 patients with TMD, of whom 29 met the inclusion criteria. Three participants withdrew from the study for personal reasons: two from the FDG and one from the PEG. Therefore, 26 participants were included in the final analysis, of whom 88.5% (n:23) were female, and 11.5% (n:3) were male. Regarding educational level, 30.8% (n:8) had completed high school, 53.8% (n:14) had an associate's or bachelor's degree, and 15.4% (n:4) had a doctorate. Of the participants, 73.1% (n:19) were non-smokers, while 26.9% (n:7) had a history of smoking. Any participant did not report alcohol consumption. The mean age of the patients was 38.7 years. In the FDG, the mean age was 36.46 (±14.03) years, whereas in the PEG, it was 41.00 (±14.27) years. The mean body mass index (BMI) was 23.73±5.22 in the FDG and 24.52±4.98 in the PEG. In addition, the mean symptom duration (in years) was 4.78±5.67 in the FDG and 4.45±3.26 in the PEG. No statistically significant differences in age, BMI, and symptom duration were observed between the groups (p>0.05).

Bruxism

There was no statistically significant difference between the groups in bruxism before and after the

Table 3. Comparison of cervical range of motion before and after the treatment.

Outcome measures		Groups	Pre-treatment X±*SD* *Med(Min-Maks)*	Post-treatment X±*SD* *Med(Min-Maks)*	Within group†	Between groups ‡
Lateral flexion	**R**	Full Dentate	31.32±7.00	39.21±6.49	*t*:-7.04 ***p*:0.00***	*t*:-2.39; ***p*:0.03***
		Posterior Edentolus	30.02±9.11	43.28±7.81	*t*:-6.79 ***p*:0.00***	
	L	Full Dentate	30.56±9.12	42.35±6.56	*t*:-5.60 ***p*:0.00***	*t*:-0.55; *p*:0.59
		Posterior Edentolus	32.59±7.33	45.83±6.48	*t*:-8.43 ***p*:0.00***	
Rotation	**R**	Full Dentate	69.92±7.89	77.84±9.38	*t*:-6.56 ***p*:0.00***	*t*:0.36; *p*:0.72
		Posterior Edentolus	69.73±9.27	76.95±7.59	*t*:-4.81 ***p*:0.00***	
	L	Full Dentate	74.67(46.70-86.50)	81.53(63.53-96.37)	*z*:-2.97 ***p*:0.00***	*t*:-1.14; *p*:0.27
		Posterior Edentolus	71.20(46.17-86.00)	83.73(62.87-87.67)	*z*:-2.90 ***p*:0.00***	
Flexion		Full Dentate	56.73±8.92	59.08±5.64	*t*:-0.87 *p*:0.40	*t*:1.07; *p*:0.30
		Posterior Edentolus	52.94±11.03	59.82±8.53	*t*:-2.11 ***p*:0.04***	
Extension		Full Dentate	63.74±16.13	76.05±8.33	*t*:-4.13 ***p*:0.00***	*t*:1.31; *p*:0.20
		Posterior Edentolus	65.35±7.89	72.82±8.68	*t*:-3.41 ***p*:0.01***	

† t: Dependent sample t test ; z: Wilcoxon test, ‡ t: Independent sample t test; SD: standard deviation; p: p value; *: p<0.05.

treatment (p>0.05, Table I). Both groups showed a significant within-group improvement in bruxism after treatment (p<0.05, Table 2).

Tinnitus

At baseline, there was no significant difference in tinnitus values between the two groups. (p>0.05, Table I). Although no statistically significant difference was observed in intra-group changes in the FDG (p>0.05), a statistically significant intra-group difference was observed in the PEG (p<0.05, Table 2). It was determined that all participants who experienced tinnitus before treatment no longer experienced it after treatment.

TMJ clicking

There was no statistically significant difference in any measurements within or between groups for TMJ clicking (p>0.05, Table 2).

Cervical ROM

Both groups exhibited statistically significant differences in the pre-treatment and post-treatment outcomes for the measurements of lateral flexion, rotation, and extension ROM (p<0.05). In particular, there was a statistically significant improvement in flexion in the PEG (p<0.05), whereas the FDG did not exhibit a statistically significant change (p>0.05, Table 3). Additionally, the PDG demonstrated a statistically significant improvement in right lateral flexion following the intervention (p<0.05).

Beck Depression Inventory

Similarly, both groups showed a statistically significant difference in Beck Depression Inventory scores before and after treatment (p<0.05, Table 2). The data indicates that there is no statistically significant difference between the two groups (p>0.05).

DISCUSSION

The study involved 26 participants, with a mean age of 38.7 years. There were no significant differences in age, BMI, or symptom duration between the groups. Following a six-week physiotherapy programme comprising manual therapy, taping and exercise, both groups showed significant improvements in bruxism, Beck Depression Inventory and cervical ROM scores following treatment, while there were no significant differences within-group scores in TMJ clicking. The

PEG demonstrated a more significant improvement in cervical flexion and right lateral flexion compared to the FDG. Additionally, tinnitus resolved for all participants in the PEG who had experienced it before treatment.

The study sample consisted of 88.5% (n:23) females and 11.5% (n:3) males with a mean age of 38.7 years. According to the literature, the prevalence of TMD is reported to be twice as high in women as in men and to peak between the ages of 20 and 40 years. Therefore, our sample in this study is consistent with the literature.

The relationship between bruxism and posterior edentulism has been extensively studied. However, further research is still required. While some studies suggest an association between clenching and grinding and posterior tooth loss (19), others indicate the opposite. According to a Japanese survey of sleep bruxism and tooth loss due to aging, bruxism increases with age, regardless of tooth loss (20). Similarly, in our study, there was no significant difference between TDG and PDG when comparing bruxism values. Quintero et al. (21) reported a decrease in bruxism complaints after a 10-week postural awareness training to correct head posture in children experiencing sleep bruxism. Following our 6-week posture exercises, specifically designed to correct head and upper body posture, there was an improvement in bruxism complaints in both groups of our patients. The improvement in bruxism may be attributed to a combination of factors, including muscle relaxation, stress reduction, improved posture, implementation of relaxation techniques, and potentially enhancing stress management skills during treatment.

Tinnitus commonly co-occurs with TMD. A systematic review and meta-analysis examining the relationship between tinnitus prevalence and TMD reported that the majority of tinnitus in patients with TMD ranged from 35.8% to 60.7%. In comparison, this rate was 9.7% to 26.0% in the group without TMD (22). Systematic reviews conducted in 2019 supported this opinion and emphasized that symptoms of TMD should be considered in patients complaining of tinnitus (23,24). We also investigated the presence of tinnitus in the participants and found that 50% of our sample size reported experiencing it. Trigger points in the masticatory or neck muscles, such as the SCM (10), can cause tinnitus. The masseter muscle can remain contracted for extended periods due to parafunctional habits, stress, and occlusal changes, forming trigger points. We believe that posterior edentulism can lead to a deterioration in occlusion, causing the mandible to be positioned posteriorly. This can result in the head of the condyle putting pressure on the meatus acousticus, which can lead to an overload of the masseter muscles and an increase in tinnitus. Despite this hypothesis, our study did not reveal a significant difference in tinnitus between the PDG and TDG prior to treatment. A statistically significant improvement in tinnitus symptoms was observed on PDG after our six-week treatment period. The reduction in tinnitus is due to the positive effect of exercise and manual therapy on the posterior position of the mandible, relieving overloaded muscles and correcting head posture.

Studies in the literature have shown that physiotherapy can reduce TMJ clicking (25). In contrast, the results of our study did not demonstrate a statistically significant difference in clicking sounds following the completion of the treatment period. The lack of change in the clicking sound can be attributed to the absence of interventions targeting the masticatory muscles and joint stabilization in our physiotherapy programme. Instead, the interventions focused on the neck and back regions without including exercises to regulate mandibular and joint movements or to promote joint stabilization.

Impaired chewing quality, dysfunctional muscles, and posture changes in TMD patients may restrict movement in the cervical joints. Several studies have shown that cervical ROM is lower in patients with TMD than in healthy individuals (26–28). Limitations were observed in the cervical ROM of the participants in our study, but no differences were found between the groups. Piekartz and Haul reported a significant increase in cervical ROM in patients with headache and TMD who received cervical and orofacial manual therapy (29). In parallel with this study, we observed a significant increase in both groups' lateral flexion, rotation, and extension values after treatment. Although the flexion angle significantly increased PDG, this was not the case in TDG. The absence of significant improvement in the FDG may be attributed to an insufficient treatment programme or the symptoms having a more complex etiology.

Furthermore, the FDG might have better proprioception, leading to a more precise perception of muscle flexibility limits and preventing excessive strain during measurements. In addition, the improvement in right lateral flexion after treatment was found to be different between the groups. The

difference in right lateral flexion values between the groups is our decision not to sub-group based on right or left TMJ involvement and our belief that there may be different tension levels in the trapezius muscles between the groups.

Several studies in the literature have shown that mental state disorders increase the prevalence of TMD (12,30). There is a bidirectional causal relationship between psychosocial factors and TMD. Resende et al. (31) reported that psychological problems not only increase the prevalence of TMD but may also exacerbate symptoms. Patients with TMD may experience limitations such as difficulty chewing, inability to open the mouth sufficiently, pain in the jaw, joint noises, and inability to lie on the chin, which can lead to psychological problems such as stress, high anxiety, and depression (32). Our study is consistent with the literature, as both groups showed mild symptoms of depression at baseline. At the end of the physiotherapy, all patients had significant improvement, and the severity of depression was minimized. We attribute the improvement in depression to patients' increased ROM and functionality, reduced pain, and improved quality of life. A study conducted on TMD patients with somatic tinnitus showed a significant reduction in depressive symptoms in patients who received exercise training and manual therapy (33). This study supports our findings that manual therapy and exercise training can improve the psychosocial status of TMD patients.

The results suggest improvements in certain outcomes for both treatment groups, but the differences between the groups were not statistically significant for the variables examined. Further research with extended treatment durations and longer follow-up periods may be needed to better understand the effectiveness of the interventions.

Limitations

The study has some limitations. There were more female patients than male patients in the sample. Additionally, monitoring the daily home exercises that the patients had to perform was challenging, and the patients were not categorized based on the involvement of their right or left TMJ.

CONCLUSION

In conclusion, this study emphasizes the intricate relationship between posterior edentulism and TMD symptoms, highlighting the need for further investigation into its impact on treatment outcomes. The results reveal the key role of physiotherapy in effectively managing TMD symptoms and emphasize the importance of a multidisciplinary approach involving dentists and physiotherapists in addressing posterior edentulism within comprehensive treatment strategies.

In addition, the study brings to light the potential psychological effects, such as depression and anxiety, associated with posterior edentulism and TMD, suggesting that mental health support should be integrated into treatment plans. It is recommended that future research prioritise longitudinal studies in order to gain a deeper understanding of the long-term effects of various treatment modalities on TMD symptoms in patients with posterior edentulism. Furthermore, future studies should explore more specific treatment designs, such as grouping participants based on the number of missing teeth or comparing different age ranges, as age may influence outcomes. Additionally, different treatment modalities, including exercises and manual therapy more specifically targeting the jaw, could also be investigated to provide clearer guidance for advancing research and improving clinical outcomes.

Acknowledgements: None.

Authors' Contributions: All authors were involved in study inception and design, and critical manuscript revision. Selnur Narin Aral worked on the study's design and interpretation of data. Rubeysa Turedi contributed to study design and planning, data collection, analysis, and interpretation of results. Gulcan Coskun Akar played a role in study design, data collection, and interpretation.

Conflict of Interest: The authors declare that they have no conflict of interest to disclose.

Ethical Approval: This study was conducted in accordance with the Declaration of Helsinki of 1975 (as revised in 2013), and the research was approved by the Dokuz Eylul University, Non-Interventional Clinical Research Ethics Committee with protocol number GOA-7337 (Date: 29.06.2022, Decision No: 2022/22-02).

Funding: No funding is declared for this article.

Peer review: Externally peer reviewed.

REFERENCES

1. Minervini G, D'Amico C, Cicciù M, Fiorillo L. Temporomandibular joint disk displacement: etiology, diagnosis, imaging, and therapeutic approaches. Journal of Craniofacial Surgery 2023;34(3):1115–1121.
2. Srivastava V, Dutt P, Chand P, Singh BP. Factors related to tooth loss among population: a cross-sectional study. Int J App Dent Sci 2018;4:31–33.
3. Chiang M, Li T, Yeh H, Su C, Chiu KC.

Evaluation of missing-tooth effect on articular eminence inclination of temporomandibular joint. Journal Of Dental 2015;10(4):383–387.
4. Dimitroulis G. Management of temporomandibular joint disorders: a surgeon's perspective. Aust Dent J 2018;63:S79–90.
5. Fallahi HR, Alikazemi M, Javidi P, Kazemi P, Behbudi A, Zanganeh T. Evaluation of the relationship between partial edentulism and TMJ disorders. Biosci Biotechnol Res Asia 2016;13(3):1725–1729.
6. Amin M, Khan A, Khan MA. Frequency of common signs of temporomandibular disorders in patients with reduced occlusal support due to partial edentulism. Pakistan Oral & Dental Journal 2019;39(2):206–211.
7. Jiménez-Silva A, Peña-Durán C, Tobar-Reyes J, Frugone-Zambra R. Sleep and awake bruxism in adults and its relationship with temporomandibular disorders: a systematic review from 2003 to 2014. Acta Odontol Scand 2017;75(1):36–58.
8. Dubner R, Slade GD, Ohrbach R, Greenspan JD, Fillingim RB, Bair E, et al. Painful temporomandibular disorder: decade of discovery from OPPERA studies. J Dent Res 2016;95(10):1084–1092.
9. Manfredini D, Lobbezoo F. Relationship between bruxism and temporomandibular disorders: a systematic review of literature from 1998 to 2008. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 2010;109(6):e26-e50.
10. Rocha CACB, Sanchez TG. Myofascial trigger points: another way of modulating tinnitus. Annals of Otology, Rhinology & Laryngology 2007;166:209–214.
11. Buergers R, Kleinjung T, Behr M, Vielsmeier V. Is there a link between tinnitus and temporomandibular disorders? J Prosthet Dent 2014;111(3):222–227.
12. Quartana PJ, Buenaver LF, Edwards RR, Klick B, Haythornthwaite JA, Smith MT. Pain catastrophizing and salivary cortisol responses to laboratory pain testing in temporomandibular disorder and healthy participants. J Pain 2010;11(2):186–194.
13. Visscher CM, Ohrbach R, Van Wijk AJ, Wilkosz M, Naeije M. The Tampa Scale for kinesiophobia for temporomandibular disorders (TSK-TMD). Pain 2010;150(3):492–500.
14. Beck AT, Steer RA, Carbin MG. Psychometric properties of the Beck Depression Inventory: Twenty-five years of evaluation. Clin Psychol Rev 1988;8(1):77–100.
15. Hisli N. Beck Depresyon Envanterinin gecerliligi uzerine bit calisma (A study on the validity of Beck Depression Inventory.). Psikoloji Dergisi 1988;6:118–122.
16. Keogh JWL, Cox A, Anderson S, Liew B, Olsen A, Schram B, et al. Reliability and validity of clinically accessible smartphone applications to measure joint range of motion: A systematic review. PLoS One. 2019;14(5):e0215806.
17. Rodriguez-Sanz J, Carrasco-Uribarren A, Cabanillas-Barea S, Hidalgo-Garcia C, Fanlo-Mazas P, Lucha-Lopez MO, et al. Validity and reliability of two Smartphone applications to measure the lower and upper cervical spine range of motion in subjects with chronic cervical pain. J Back Musculoskelet Rehabil 2019;32(4):619–627.
18. Calixtre LB, Oliveira AB, de Sena Rosa LR, Armijo-Olivo S, Visscher CM, Alburquerque-Sendín F. Effectiveness of mobilisation of the upper cervical region and craniocervical flexor training on orofacial pain, mandibular function and headache in women with TMD. A randomised, controlled trial. J Oral Rehabil 2019;46(2):109–119.
19. Gökçe B, Destan UI, Özpinar B, Sonugelen M. Comparison of mouth opening angle between dentate and edentulous subjects. Cranio 2014;27(3):174–179.
20. Kato T, Velly AM, Nakane T, Masuda Y, Maki S. Age is associated with self-reported sleep bruxism, independently of tooth loss. Sleep and Breathing 2012;16(4):1159–1165.
21. Quintero Y, Restrepo CC, Tamayo V, Tamayo M, Vélez AL, Gallego G, et al. Effect of awareness through movement on the head posture of bruxist children. J Oral Rehabil 2009;36(1):18–25.
22. Mottaghi A, Menéndez-Díaz I, Cobo JL, González-Serrano J, Cobo T. Is there a higher prevalence of tinnitus in patients with temporomandibular disorders? A systematic review and meta-analysis. J Oral Rehabil 2019;46(1):76–86.
23. Omidvar S, Jafari Z. Association between tinnitus and temporomandibular disorders: a systematic review and meta-analysis. Annals of Otology, Rhinology & Laryngology

2019;128(7):662–675.
24. Skog C, Fjellner J, Ekberg EC, Häggman-Henrikson B. Tinnitus as a comorbidity to temporomandibular disorders—a systematic review. J Oral Rehabil 2019;46(1):87–99.
25. Madani AS, Mirmortazavi A. Comparison of three treatment options for painful temporomandibular joint clicking. J Oral Sci 2011;53(3):349–354.
26. Ferreira MP, Waisberg CB, Conti PCR, Bevilaqua-Grossi D. Mobility of the upper cervical spine and muscle performance of the deep flexors in women with temporomandibular disorders. J Oral Rehabil 2019;46(12):1177–1184.
27. Greenbaum T, Dvir Z, Emodi-Perelmam A, Reiter S, Rubin P, Winocur E. Relationship between specific temporomandibular disorders and impaired upper neck performance. Eur J Oral Sci 2020;128(4):292–298.
28. Grondin F, Hall T, Laurentjoye M, Ella B. Upper cervical range of motion is impaired in patients with temporomandibular disorders. Cranio 2015;33(2):91–99.
29. von Piekartz H, Hall T. Orofacial manual therapy improves cervical movement impairment associated with headache and features of temporomandibular dysfunction: a randomized controlled trial. Man Ther 2013;18(4):345–350.
30. de Almeida Hoff E, Grossi RK, Bozzetti Pigozzi L, Bueno CH, Pattussi MP, Rossi T, et al. Depression and the risk of developing temporomandibular disorders in different diagnostic groups: a systematic review with meta-analysis. Cranio 2024;1-13.
31. de Resende CMBM, Alves AC de M, Coelho LT, Alchieri JC, Roncalli G, Barbosa GAS. Quality of life and general health in patients with temporomandibular disorders. Braz Oral Res 2013;27(2):116–121.
32. Reis PHF, Laxe LAC, Lacerda-Santos R, Münchow EA. Distribution of anxiety and depression among different subtypes of temporomandibular disorder: a systematic review and meta-analysis. J Oral Rehabil 2022;49(7):754–767.
33. Delgado De La Serna P, Plaza-Manzano G, Cleland J, Fernández-De-Las-Peñas C, Martín-Casas P, Díaz-Arribas MJ. Effects of cervico-mandibular manual therapy in patients with temporomandibular pain disorders and associated somatic tinnitus: a randomized clinical trial. Pain Medicine 2020;21(3):613–624.