Does the Prevalence of Temporomandibular Disorders Increase as a Result of Tooth Loss or Prosthetic Rehabilitation?

Emőke Takács *, Ibolya Süveges, Péter Schmidt, Szilvia Ambrus, Bálint Jász, Péter Hermann, Szandra Körmendi, Máté Jász

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Article

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Emőke Takács [1], Ibolya Süveges [2], Péter Schmidt [2], Szilvia Ambrus [2], Bálint Jász [2], Péter Hermann [2], Szandra Körmendi [2] and Máté Jász [2,*]

[1] Semmelweis University, Faculty of Dentistry, Department of Prosthodontics, Budapest, Hungary. emoke.takacs@semmelweis.hu.

[2] Semmelweis University, Faculty of Dentistry, Department of Prosthodontics, Budapest, Hungary.

* Correspondence: emoke.takacs@semmelweis.hu

Abstract: Objectives: The relationship between occlusion and temporomandibular joint disorder has been the subject of extensive research, yet the findings have been contradictory. In this study we re-examined data from a national screening examination from a novel perspective. The aim was to examine the correlation between partial edentulism, preexisting prosthodontic appliances, and TMD symptoms. **Methods**: A retrospective analysis was conducted on data from a representative national oral epidemiological pathfinder survey. In our analysis, we investigated the registered TMD symptoms in three groups: patients with extensive tooth loss; patients with replaced teeth and patients with stable occlusion were considered as control group. **Results**: The present study utilised data from a total of 3,342 patients. A significantly higher prevalence of TMD symptoms was observed in the group with extensive tooth loss (28.2%) compared to the control group (21.56%, p=0.0141). Similarly, a significantly higher prevalence of TMD symptoms was observed in the group with restored dentition (25.3%, p=0.0480) compared to the control group. No significant difference was observed in the frequency of symptoms between the group with tooth loss and the group with replaced teeth. **Conclusions**: Significant correlation was found between the three examined groups. A comparison of the control group with both the extensive tooth loss and the restored dentition groups revealed a significantly higher prevalence of TMD symptoms in the latter two groups. This indicates that edentulism may be a contributory factor in the development of TMD symptoms, although replacing the missing teeth alone does not appear to eliminate this effect.

Keywords: temporomandibular disorder; TMD; occlusion; tooth loss; prosthodontic rehabilitation

1. Introduction

The potential links between occlusal factors and temporomandibular disorders (TMD) have been a subject of investigation for decades, yet neither a definitive proof nor a comprehensive refutation has emerged. A number of studies have identified a correlation between occlusal factors and TMD [1–3] while others have not [4–6]. Okeson [7] provides a useful framework for interpreting the disparate results of previous studies. He posits that if occlusal deviations were the primary etiological factor in TMD, all studies would yield a significant correlation. Conversely, if there were no underlying relation, no research could prove such a correlation. Our own clinical experience lends further support to this hypothesis: a number of different etiological factors, including occlusion, and the individual's reduced adaptive capacity may contribute to the development of TMD.

In the present study, we re-examined data from a representative, national screening examination that was previously conducted on a large number of Hungarian patients from a novel perspective.

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The results of this screening have been previously published [8–15], however, these studies did not investigate the relationships between missing teeth, prosthetic appliances, and TMD.

The most commonly employed classification system for tooth loss is the Kennedy classification. [16] In Hungary, a logical and straightforward classification system for partial edentulism was developed at Semmelweis University: the Fábián and Fejérdy classification. [17,18] This classification is based on an analysis of the forces acting on the future prosthetic appliance. Each class is determined by the position of the remaining teeth, which may compensate for the chewing forces acting on the dental prosthesis. As a consequence, the classification also furnishes a recommendation regarding the most appropriate prosthetic device type. In the representative national screening examination, tooth loss was classified in accordance with this system.

The Fábián and Fejérdy classification method assesses the maxillary and mandibular dental arches separately. Consequently, even if the same teeth are missing due to the different shape of the alveolar ridges, the upper and lower jaws may be assigned to different classes. The nomenclature differentiates between three principal classes (Classes 1 to 3), two or three subclasses (1A, 1B, 2A, 2B, 2A/1), and it distinguishes between the total edentulous situation (T) and the case with no tooth loss (Class 0). In Class 1, a fixed prosthetic appliance can be constructed, as there are no torque forces present (1A) or the torque can be compensated (1B) with the extension of the bridge. In Class 1A, a sufficient number of occlusal units are present in each quadrant, thereby maintaining a stable occlusion. This class is analogous to Kennedy Class III, whereby the remaining tooth on either side of the edentulous area can be utilized as an abutment. In Classes 2 and 3, the extent of tooth loss necessitates the fabrication of either a removable or a complex denture, which is constructed in accordance with the established principles of prosthodontics. In these classes, the absence of stable occlusion is attributed to the extensive edentulous area(s) situated posterior to the remaining teeth. Class 2 is analogous to Classes I and II in the Kennedy classification, whereas Class 2A/1 encompasses subtotal edentulism with one or two remaining teeth.

A review of the literature reveals a multitude of examples wherein authors have investigated the relationship between tooth loss and TMD. In a study published in 2023, Liu et al. investigated the relationship between congenital edentulism and the occurrence of TMD. The study included 583 patients with congenital edentulism and 586 controls. The results indicated a significant association between congenital edentulism and the occurrence of both intra-articular and pain-related TMD. Additionally, the number of quadrants with missing teeth was found to correlate with the incidence of TMD. [19]

Also in 2023, Rawat conducted a systematic review of 13 selected publications, which indicated that tooth loss affects the function of the temporomandibular joint. The negative effect increases with the number of missing teeth, and the absence of posterior teeth is associated with greater damage to the joint. However, due to the complexity of TMD development, it cannot be definitively stated that tooth loss causes TMD. [20]

Very little data is available in the existing literature on the effects of prosthodontic appliances on the temporomandibular joint. In 2023, Manfredini et al. conducted an investigation to address two key questions: "Can prosthodontic rehabilitation be used as a treatment for TMD?" and "Can prosthodontic rehabilitation cause TMD?" However, they were unable to include any articles in the planned systematic review due to the unavailability of high-quality clinical or randomized clinical trials on this topic. [21]

De Boever, in a review published in 2000, concluded that there is no evidence that occlusal therapy or prosthodontic rehabilitation prevents the development of TMD. He therefore recommends that prosthetic rehabilitation of TMD patients should only be considered after conservative therapy and symptom relief.[22]

The aim of our study is to examine the correlation between partial edentulism, preexisting prosthodontic appliances, and TMD symptoms. The null hypothesis is that there is no increase in the prevalence of TMD with tooth loss and denture wear.

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2. Materials and Methods

A retrospective analysis was conducted on data from a representative national oral epidemiological pathfinder survey. This was carried out by calibrated physicians and assistants from the Clinic for Prosthodontics at Semmelweis University, Budapest. The survey was based on WHO criteria (World Health Organization, 1997). The survey was conducted over a two-year period, from 2003 to 2004, and ethical approval was obtained from the Regional and Institutional Committee for Scientific and Research Ethics of Semmelweis University (SE TUKEB 206/2003).

In order to determine the appropriate sample size for the representative survey, the limits for a 95% binomial confidence interval (CI) for prevalence were calculated as a function of the sample size. In order to ensure an adequately precise estimation of the prevalence value, a sample size was deemed sufficient if the associated upper/lower bound ratio was equal to or greater than 2. Given that 4000 subjects yielded a ratio of 1.9 for the estimation of a 1% prevalence, this figure was considered an appropriate compromise between the requirements for precision and the sensitivity of resource use.

Dental screening was conducted in conjunction with a chest X-ray examination. In Hungary, the chest X-ray screening programme has a long history, having originally been introduced with the objective of detecting tuberculosis infection. All Hungarian adults aged 18 and above receive postal invitations every five years. Even though this examination is no longer mandatory, a high rate of participation by citizens is observed. A total of 304 locations were randomly selected from the comprehensive list of chest X-ray stations in Hungary, thereby ensuring representation of all settlement types. To calculate the appropriate sample compositions, data on gender and age groups were used at each location in accordance with the Hungarian Central Statistical Office data. Socio-economic characteristics were not taken into account directly during the sample selection; however, as this variable correlates in Hungary with the geographical region, it was also included. All patients who had volunteered to participate and had provided a written declaration of consent were screened.

The survey team comprised seven calibrated examiners and five data recorders, all of whom were affiliated with the Clinic for Prosthodontics at Semmelweis University. All team members had previously undergone theoretical and practical training and calibration. The inter-examiner reliability during the calibration of the examiners demonstrated almost perfect agreement, with a Cohen's kappa value of 0.85.

Dental screening examinations were conducted in a portable dental X-ray chair with a headrest, utilizing appropriate artificial lighting and a range of diagnostic instruments, including a dental probe, dental mirror, dental forceps and a WHO probe.

A questionnaire was used to record the following information about the participants: gender, age, settlement type, educational level, general health status, oral hygiene-related habits, frequency of dental visits, and smoking-related information.

In this study, the clinical data obtained from the dental examination were subjected to analysis. The condition of each tooth was recorded according to the following categories: intact, decayed, filled, prepared for fixed prostheses, or missing. In cases where applicable, the type of edentulousness and the existing prosthodontic appliances were recorded. Partial edentulous cases were classified according to the Fábián and Fejérdy classification of partial edentulousness. Additionally, signs and symptoms of TMD were documented, including pain that occurred or worsened during jaw movements, tempromandibular joint noises, and limited jaw movements.

In our analysis, we investigated the registered TMD symptoms in three groups: patients with extensive tooth loss (L), where the subjects had prosthodontic Classes 1B or 2 according to the Fábián and Fejérdy classification; patients with replaced teeth (R), if any type of tooth replacement was present; while patients with stable occlusion without extensive tooth loss (Classes 0 and 1A according to the Fábián and Fejérdy classification), and without prosthodontic appliance were considered as control group (C). If the two jaws belonged to different classes, the more extensive tooth loss was taken into account. If there was a prosthetic restoration only in one of the dental arches, even one single crown, the patient was set in the R group.

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The statistical analyses of the data were conducted using the chi-square test and Fisher's exact test.

3. Results

A total of 6,397 individuals were offered the opportunity to participate in the screening process at the designated sites. Of these, 28% (1,791 persons) did not respond. The majority of these individuals cited a lack of time as the reason for their non-participation. Of the 4,606 participants, those belonging to Class 2A/1, 3 or T according to the Fábián and Fejérdy classification – indicating complete edentulism or the presence of a maximum of three teeth – were excluded from the present study (n = 1,264; 27.4%). This was because the objective was to examine the relationship between tooth loss, partial dentures and TMD.

The present study encompasses data from 3,342 subjects. The study population consisted of 1,341 males (40.1%) and 2,001 females (59.9%). The mean age of the participants was 43.9 years (standard deviation ±15 years). The group with extensive tooth loss (L) comprised 429 individuals (12.8%), with a mean age of 50.4 ± 12.95 years. The gender distribution in this group was 217 males (50.6%) and 212 females (49.4%). The group with replaced teeth (R) consisted of 1568 individuals (47%), with a mean age of 51.1 ± 12.6 years. Of these, 490 (31.25%) were men and 1078 (68.75%) were women. A total of 1,345 participants (40.2%) were included in the control group (C), wherein the occlusion remained intact. Their mean age was 33.51 ± 11.9 years, of whom 634 (47.1%) were male and 711 (52.9%) were female.

A total of 808 cases (24.18%) exhibited symptoms consistent with TMD. The most prevalent symptoms were joint noises, present in 786 individuals (23.52%). Pain was reported by 48 participants (1.44%), while limited jaw movement was observed in only 12 cases (0.36%). In 36 patients (1.08%), two major symptoms occurred simultaneously, and in one patient (0.03%), all three major symptoms of TMD were present. (Table 1)

Table 1.

Characteristics	Total (n= 3342)
Age (mean±SD)	43,9 (±15)
Gender	
Males (%)	1341 (40,1)
Females (%)	2001 (59,9)
Groups of missing teeth	
Normal dentition (%)	1345 (40,2)
Tooth loss (%)	429 (12,8)
Prosthetics (%)	1568 (47)
TMD signs and symptomes*	
Overall (%)	808 (24,18)
Pain (%)	48 (1,44)
Clicking (%)	786 (23,52)
Dysfunction (%)	12 (0,36)
2 symptoms (%)	36 (1,08)
3 symptoms (%)	1 (0,03)

* in proportion of the whole examined population .

The gender distribution exhibited a notable discrepancy, with 31% of patients presenting with symptoms being male and the majority (69%) being female. Of the 1,341 male subjects examined, 248 (18.49%) exhibited symptoms, whereas among the 2,001 female subjects, 560 (27.99%) presented with TMD symptoms. It is noteworthy that a greater proportion of female patients reported limitations in mouth opening (1.79% vs 0.81%) and pain in the temporomandibular joint (TMJ) or orofacial area (7.5% vs 2.42%). These differences between the sexes were found to be statistically significant ($p < 0.05$), with the exception of mouth opening limitation. The distribution frequency of the different

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symptoms was similar in both sexes, with joint noise occurring in the overwhelming majority of cases. In the case of male patients, joint noise was identified in 98.79% of those exhibiting symptoms, while in the case of female patients, it was identified in 96.61%. (Table 2)

Table 2.

	Total (n=3342)	**Males n=1341 (40,13%)**	Females n=2001 (59,87%)
Any TMD symptoms			
Yes (%)	808 (24,18)	**248 (18,49)**	560 (27,99)
No (%)	2534 (75,82)	**1093 (81,51)**	1441 (72,01)
Type of symptoms*			
Pain (%)	48 (5,94)	**6 (2,42)**	42 (7,5)
Clicking (%)	786 (97,28)	**245 (98,79)**	541 (96,61)
Dysfunction (%)	12 (1,49)	**2 (0,81)**	10 (1,79)

* in proportion of symptomatic persons by gender.

Upon examination of the occurrence of TMD symptoms across the three groups, a notable discrepancy was observed in the frequency of occurrence. A significantly higher prevalence of TMD symptoms was observed in the group with extensive tooth loss (28.2%) compared to the control group (21.56%, p=0.0141). Similarly, a significantly higher prevalence of TMD symptoms was observed in the group with restored dentition (25.3%, p=0.0480) compared to the control group. No significant difference was observed in the frequency of symptoms between the group with tooth loss and the group with replaced teeth (28.2% and 25.3%, respectively).

With regard to the individual symptoms, a similar difference was observed with respect to joint noise symptoms. The occurrence of these symptoms was significantly higher in both the missing and replaced teeth groups compared to the control group. The p-values for these comparisons were 0.0052 and 0.0173, respectively. (Table 3)

Table 3.

	Total (n= 3342)	**No missing teeth (Controll) n=1345**	**Tooth loss n=429**	**Prosthetic work n=1568**
Age (years)	43,9 (±15)	33,51±11,9	50,4±12,95	51,1±12,6
Symptoms				
Yes (%)	808 (24,18)	290 (21,56)	121 (28,2)	397 (25,3)
No (%)	2534 (75,82)	1055 (78,44)	308 (71,8)	1171 (74,7)
Type of symptoms*				
Pain (%)	48 (5,94)	13 (4,48)	10 (8,26)	25 (6,3)
Clicking (%)	786 (97,28)	281 (96,9)	118 (97,52)	387 (97,48)
Dysfunction (%)	12 (1,49)	6 (2,07)	2 (1,65)	4 (1,00)
2 symptoms (%)	39 (4,83)	10 (3,45)	9 (7,44)	18 (4,43)
3 symptoms (%)	1 (0,12)	0	0	1 (0,25)

* in proportion of symptomatic persons in the given group .

4. Discussion

The results of the representative screening study conducted in Hungary have been previously evaluated from a number of different perspectives. These include the general epidemiological perspective [23], the perspective of dental caries [13], the perspective of periodontology [10], and the perspective of prosthodontics [8,9,15]. Also previously published studies have addressed a number of other topics, including oral mucosal lesions [11], nutritional and oral hygiene habits [14], and the association between temporomandibular joint disorders and certain orthodontic abnormalities [12].

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In this article, we re-examine previously known data from a new perspective, namely whether there is an association between the prevalence of temporomandibular disorders and the presence of extensive tooth loss or prosthodontic restoration.

A review of the literature reveals numerous studies that are comparable to our own research. Tallents and colleagues investigated the potential association between the absence of posterior teeth and temporomandibular disorder. A comparison was made between the findings of temporomandibular joint magnetic resonance imaging (MRI) in patients with asymptomatic and pain-related TMD symptoms and the number of missing premolar and molar teeth. It was found that the presence of TMD pain and MRI-confirmed disc dislocation (DD) was significantly positively correlated with the number of missing premolar and molar teeth. [24]

Dulcić et al. also investigated tooth loss in the supporting zones, employing the Eichner Classification to distinguish between the examined groups. Their findings revealed a significant discrepancy between Eichner's class II and III with regard to the prevalence and severity of TMD symptoms in both genders. [25]

In their retrospective cross-sectional study, Chatzopoulos et al. examined the relationship between TMD, parafunctional habits, and missing teeth based on patient questionnaires and radiographs. The results demonstrated a statistically significant correlation between the number of missing teeth, gender, age, and the manifestation of TMD symptoms (difficulty in opening and closing, clicking, TMJ pain, and chewing difficulty). TMD was more prevalent in women and younger individuals. [26] However, only chewing difficulty was found to be positively correlated with the number of missing teeth, and this complaint is not clearly linked to TMD.

It is noteworthy that an epidemiological study conducted in Pomerania demonstrated a statistically significant correlation between muscle or temporomandibular joint (TMJ) tenderness and the loss of occlusal support, with this correlation being observed exclusively in male subjects. [27]

In an article examining the relationship between missing posterior teeth and TMD by Wang et al., a slight correlation was identified between the occurrence of TMD and the age, gender, and number of missing teeth of the patients based on multivariable logistic regression analysis. Furthermore, this study investigated the distribution of missing teeth in terms of the number of dental quadrants affected. The distribution of missing teeth was found to be associated with the occurrence of TMD. The findings suggest that the probability of developing TMD is increased in individuals with a higher prevalence of quadrants with missing posterior teeth, particularly in young women. [28]

De Sousa and colleagues sought to identify potential associations between malocclusion or the presence of five or more missing teeth and TMD. Their findings indicated that these factors contribute only minimally to the development of TMD. [29]

Published in 2016, Malheiros and colleagues found that the severity of TMD was higher in totally edentulous patients, but they were unable to confirm any significant differences between partially edentulous and dentate patients. [30]

The results of the aforementioned studies are consistent with those obtained in our investigation. We found significant correlation between the three examined groups, comprising individuals with and without tooth loss and restoration (L, C and R). A comparison of the control group with both the extensive tooth loss and the restored dentition groups revealed a significantly higher prevalence of TMD symptoms in the latter two groups. This indicates that edentulism may be a contributory factor in the development of TMD symptoms, although replacing the missing teeth alone does not appear to eliminate this effect. In light of the fact that the data collection was conducted almost two decades ago, it is pertinent to consider the developments that have taken place in the field of gnathology, including the introduction of the face-bow and the gradual education of the use of adjustable articulators, which first began in Hungary in 2005 at Semmelweis University. [31] The majority of the examined dentures were manufactured using mean-value articulators, without consideration of the individual movement trajectories of the patients.

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The association between occlusion and TMD has also been investigated through the analysis of national surveys conducted in other countries. A comparable study to the present research was conducted in Finland as part of the nationally representative Health 2000 Survey, with data collection taking place between 2000 and 2001. [32] In 2013, Sipilä et al. published their findings regarding the impact of tooth loss and the use of prosthetic appliances on the clinical manifestations of TMD. The authors concluded that complete edentulism, the use of complete dentures, and the wearing of poorly maintained removable dentures were associated with pain-related TMD symptoms in women. Furthermore, they found that these associations were influenced by psychosocial factors.

The results of our clinical study are in accordance with these findings, with a notably high proportion, nearly a quarter of the examined individuals exhibiting TMD. The data demonstrated a twofold predominance of women among those living with TMD. A significantly higher proportion of women than men exhibited at least one of the major symptoms of TMD. Furthermore, although the most prevalent abnormality in both sexes, occurring in over 97% of patients with the symptom, was joint noise, in addition to this, pain in the joint or masticatory muscles was observed with greater frequency among women.

A systematic literature review was conducted in 2024 comprising 21 publications. The objective was to examine the relationships between malocclusion and temporomandibular joint morphology, as well as the impact of tooth loss and bruxism on TMD. In the investigation of TMD and tooth loss, eight studies were selected for analysis. Of these, three examined morphometric features on radiographs. Two studies identified TMD symptoms through the use of self-reported questionnaires, while three others performed and described clinical examinations. These three publications concluded that pain and joint noises correlated with the number of missing teeth. Their findings are consistent with the results of our analysis, which indicated a higher prevalence of TMD symptoms in the group with extensive tooth loss compared to the control group. As outlined in the systematic review, the findings indicate that malocclusion is linked to alterations in the temporomandibular joint, tooth loss is associated with an increased prevalence and characteristics of TMD, and bruxism is linked to TMD symptoms, including myofascial pain, disc displacement, joint pain, and muscle disorders. [33]

5. Limitations

It is important to acknowledge the limitations of the present study. The date of data collection should be included, provided that it was gathered between 2003 and 2004. At the time of data collection, the diagnostic criteria for Temporomandibular Disorder were not yet as clearly defined as they are today. Consequently, the DC TMD protocol was only described in 2014 [34], and there was no Hungarian translation of the diagnostic criteria published in 1992 (RDC/TMD). [35] This indicates that the reliability of the data is contingent upon the clinical experience of the data collectors. The data presented herewith therefore represent a snapshot of a previous point in time.

6. Conclusions

Although our study, which is based on the results of a screening test, would not meet the selection criteria set by Manfredini et al., it suggests that the answer to the questions they posed (Can prosthodontic rehabilitation be used as a treatment for TMD? Can prosthodontic rehabilitation be a cause of TMD?) is negative [21]. In other words, if the fabrication of dentures were an efficacious therapeutic modality for TMD, the cohort with restored dentition would exhibit a diminished prevalence of TMD. Conversely, if TMD were a consequence of the treatment, the prevalence of TMD would be heightened in this cohort.

In light of the aforementioned considerations, it is reasonable to conclude that patients requiring prosthodontic restoration, regardless of whether they exhibited TMD symptoms prior to the procedure, are unlikely to experience an improvement in their TMD status following the fabrication of the denture. It may, however, be advisable to consider De Boever's proposal [22] that patients

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presenting with TMD should only be offered prosthetic treatment once their symptoms have reached a satisfactory level of remission.

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Data Availability Statement: The datasets used and/or analysed during the current study are available from the corresponding author upon reasonable request.

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Conflicts of Interest: The authors declare no conflicts of interest.

Abbreviations

The following abbreviations are used in this manuscript:

TMD	Temporomandibular Disorder
TMJ	temporomandibular joint

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