

Doctoral (PhD) Thesis

Biopsychosocial Aspects of Temporomandibular Pain and Dysfunction

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Introduction

Temporomandibular disorder (TMD) is a collective term for musculoskeletal disorders affecting the temporomandibular joint and surrounding structures with main characteristics comprising pain and dysfunction. The defining symptom of TMD is facial pain, which can appear in the joint and/or masticatory muscles, but it can also be referred to other areas of the head and neck, and in many cases it becomes chronic.

The prevalence of TMDs in the population is about 10%, but isolated symptoms can show a significantly higher incidence. Each year, approximately 4% of TMD-free adults develop a new, clinically verifiable disorder.

TMD often co-occurs with other chronic diseases such as fibromyalgia, headaches, tinnitus, irritable bowel syndrome or sleep disorders, which may refer to the presence of common etiological factors. Due to the multifactorial etiology, the role of general health and psychosocial factors, an interdisciplinary approach and the use of the biopsychosocial model are necessary for better understanding and providing effective treatment of TMD.

Characteristics of temporomandibular pain

Pain in patients with TMD most often occurs in the temporomandibular joint and the masticatory muscles, often affecting both areas. The pain is usually intermittent, while a smaller proportion of patients also report continuous pain. The prevalence is at least twice as high in women as in men, the suspected reasons are of psychological, genetic and hormonal nature.

The impact of temporomandibular pain on the quality of life can be significant, as the affected region plays an important role in essential functions, e.g., chewing, speaking, expressing emotions. Its frequent concomitants are allodynia (increased sensitivity to normal stimuli) and hyperalgesia (increased pain sensation to pain-inducing stimuli), which can be explained by the phenomenon of central sensitization. Since TMD pain is often not related to visible structural or pathological abnormalities, and some patients also show neuropathic features, diagnosis and treatment can be challenging.

The association between psychological-behavioral factors and TMD

The relationship between the psychological state and TMD is characterized by the so-called circular causality: psychological factors are suspected to play a role in the development of TMD (as risk, initiating or maintaining factors), while chronic pain and disturbance of jaw functions often significantly influence the patient's general wellbeing, quality of life and psychosocial status. Chronic pain is often associated with negative emotions such as fear or frustration, which can contribute to dysfunctional behavior patterns such as pain avoidance.

Research has shown that somatic and anxiety symptoms, depression and higher stress levels are more common among people with TMD. Somatization and increased somatic symptom perception can predict the development of new TMD. Moreover, the individual's coping pattern also significantly influences the development and chronicity of the disease: adaptive coping mechanisms can help reduce the effects of pain, while maladaptive strategies can lead to worsening symptoms.

The presence and effects of stress among students in higher education

Young adulthood, especially the period of higher education, is a period of increased psychological stress, which favors the development of numerous mental disorders. The higher stress levels experienced at this time may result from increased academic workload, exams, financial difficulties, family expectations and challenges in social relationships. In addition to normative stress (which is related to the characteristic changes of the given life stage), unexpected events, such as accidents or illnesses, can further aggravate the situation by resulting in so-called accidental crises.

Individual coping strategies for stress can be adaptive or maladaptive. Adaptive coping, such as effective problem-solving, can improve performance and quality of life. In contrast, maladaptive reactions, such as alcohol consumption, procrastination or aggression, can lead to depression, burnout or even suicidal thoughts in the long term.

According to epidemiological data, 12-50% of students suffer from some form of psychological disorder. Stress often contributes to somatic symptoms, such as headaches, fatigue, or sleep disorders. These problems have a significant impact on students' quality of life, academic performance, and long-term psychosocial wellbeing.

For university students, the semester period is characterized by a structured, regular daily routine, while an exam period is more irregular and stressful. The exam period thus offers an opportunity to study changes in students' psychosocial wellbeing and stress-related disorders.

The biopsychosocial model

The biopsychosocial model was created by recognizing the multidimensional nature of pain. According to the model, pain cannot be explained solely by biological factors, but the integrated effect of psychological (emotional and behavioral) and social (relational, cultural, financial) factors must also be considered. This is especially true in the case of chronic pain, when psychosocial components determine the experience of pain and, in the long term, the individual's quality of life.

The experience of pain is influenced by interactive processes between higher brain centers of the central nervous system (thalamus, limbic system, cortex). This is the so-called pain matrix, which determines the experience of pain, pain-induced behavior, subjective pain sensation and its impact on the individual's psychological functions. In the presence of chronic pain, the influence of a psychosocial component on these factors is expected to be increased. Therefore, the use of the biopsychosocial model is necessary to understand and describe chronic pain, including painful TMDs.

The role of the biopsychosocial model in the diagnosis of TMDs

Since, like other chronic, painful diseases, the most common forms of TMDs are also related to the psychological state of the patient, it was a logical step to incorporate the biopsychosocial model into the diagnosis of TMDs. Its first systematic appearance was the RDC/TMD (Research Diagnostic Criteria for Temporomandibular Disorders, 1992). The RDC/TMD assessed the patient along two axes: Axis I provided the clinical (physical) diagnosis, while Axis II evaluated the psychosocial status. This system provided diagnosis in a standardized way, based on precise definitions, thus not only improving diagnostic accuracy, but also facilitating epidemiological research and creating a basis for an integrated assessment of the aforementioned factors in relation to TMD.

The Diagnostic Criteria for Temporomandibular Disorders (DC/TMD)

The Diagnostic Criteria for Temporomandibular Disorders (DC/TMD) was created and published in 2014 after the validation studies of the RDC/TMD, as a result of its further development. The DC/TMD is designed not only for research applications, but also for clinical purposes. The system has kept its two-axis structure: it assigns the biopsychosocial factors of Axis II to the clinical diagnoses of Axis I.

The DC/TMD ensures diagnostic accuracy with detailed patient examination protocols, diagnostic algorithms and standard questionnaires, the validity of which has been confirmed by international studies. The diagnoses obtained in this way are characterized by high sensitivity and specificity in most cases and can be confirmed with imaging procedures (e.g., CT, MRI) if necessary.

For the accurate use of the system, preliminary calibration is required for professionals, thus ensuring the reliability and uniformity of diagnoses.

Aims of our study

The first goal of our research was to create the Hungarian version of the DC/TMD and perform its cultural adaptation. Using the adapted DC/TMD, our aim was to assess and compare the prevalence and degree of main symptoms of TMD, primarily TMD-related facial pain, as well as the degree of biopsychosocial factors (pain, anxiety, depression, jaw function limitation and oral parafuncions) in dental students during the semester and in the exam period. We examined how the different nature of the two periods affects the mentioned variables and whether a correlation can be revealed between the changes in the individual factors.

The aim of our research was to verify the following hypotheses:

1. The incidence and extent of TMD symptoms and biopsychosocial factors are greater during the exam period than during the semester.
2. Anxiety, depression and oral parafuncions experienced during the semester can predict pain incidence in the exam period.
3. There is a correlation between changes in biopsychosocial factors and the presence of pain.

Materials and methods

Creating the Hungarian version of the DC/TMD and its cultural adaptation

The validity of the DC/TMD is supported by international research, but since the system requires active participation of the patient, it needs to be translated into the given language and culturally adapted to be used in a reliable way in the new language environment. The language version to be created must also be able to perform measurements in standardized way in the target population.

Translation and adaptation is a complex, sequential process that takes place under the coordination of INfORM (a member organization of the IADR), ensuring maximum equivalence between the source and the target versions. This guarantees the validity of the diagnostic system and the international comparability of research data.

To perform the translation-adaptation process, we created a working group of eight members at the University of Pécs Medical School in 2015. The process consisted of a total of 10 steps, which resulted in the publication of the Hungarian version of the DC/TMD.

Examiner training (calibration)

In order to be able to use the Hungarian DC/TMD version in a reliable manner, the specialist (S.I.) performing the examination had to be calibrated first, which took place in 2018 at the Department of Dentistry, Malmö University during a several-day training course. The calibration covered all three elements of the system: accurate execution of the patient examination, evaluation of the questionnaires, and use of the diagnostic algorithms.

For the purpose of our research, evaluation of the questionnaires was particularly important, in terms of the assessment of both clinical and biopsychosocial factors.

Evaluating the associations between temporomandibular pain and biopsychosocial factors in university students

We tested our hypotheses in two steps: first, on a smaller group of students ("pilot-study", stage 1), then based on the results, and by clarifying the research criteria, we administered the DC/TMD questionnaires to a larger sample group (stage 2).

The plan of this research was approved by the Regional Research Ethics Committee of the University of Pécs Clinical Center (ID number: 6448-PTE2020).

Participants

In both stages of the research, students of the Hungarian language program of the Department of Dentistry at University of Pécs were involved. Participation was voluntary, students could indicate their intention to participate after reading the consent form. As part of the declaration, students also received detailed information about the nature, purpose, and time of the research. Data was collected anonymously.

Materials

Data was collected using the Hungarian DC/TMD questionnaires, at two occasions: once in the middle third of the semester period (T1) and again in the second half of the exam period (T2), ensuring that the answers in the questionnaires refer to the period of interest.

In stage 1, among the Axis I factors, the main symptoms of TMD (pain, headache, joint noises, jaw locking) were examined using the Symptom Questionnaire. In the second stage, the presence and severity of TMD-pain was assessed, for which we used the TMD-Pain Screener instrument. Axis II parameters in both stages were evaluated using the Graded Chronic Pain Scale version 2 (pain intensity, pain-related disability and interference), Jaw Functional Limitation Scale (limitations in mandibular functions), GAD-7 (anxiety), PHQ-9 (depression) and Oral Behaviors Checklist (oral parafunctions). For the latter

questionnaire, we used a shortened version in stage 1 and the full questionnaire in stage 2, analyzing parafunctions during sleep and waking hours separately.

Data analysis

In stage 1, we analyzed the frequency of the main symptoms of TMD – pain, headache, joint sounds, locking – comparing the T1 and T2 periods. In stage 2, participants were divided into four groups based on the presence and change of pain in T1 and T2: “no pain,” “new pain,” “remitting pain,” and “continuous pain.”

The intensity of the pain and the degree of interference/disability were characterized by the CPI (Characteristic Pain Intensity), IS (Interference Score) and DP (Disability Points) values calculated from the responses to the Graded Chronic Pain Scale. In stage 2, based on these parameters, students were classified into categories of pain grade (0-4).

The level of anxiety and depression was assessed using total score values of the GAD-7 and PHQ-9 questionnaires. In the 2nd stage, we classified students into categories of anxiety and depression based on the scores and analyzed changes of these between the two periods. Jaw functional limitations and changes in oral parafunctions were evaluated in the same way.

In the 2nd stage of the study, T1 scores of anxiety, depression, parafunctions during sleep and waking hours were compared among the different TMD pain groups in order to assess the possible predictive power of these factors before the onset of increased stress.

In stage 1, the frequency of TMD symptoms was compared using a cross-tabulation analysis and chi-square test. Paired t-test and Wilcoxon rank sum test were used to compare pain intensity scores, while the relationship between anxiety, depression and pain intensity was examined using Spearman's rank correlation. Oral parafunction scores from the two assessments were compared using Wilcoxon rank sum test.

In stage 2, one-way analysis of variance (ANOVA) was used to compare the TMD-pain groups in terms of changes in anxiety, depression, jaw functional limitation, and oral parafunctions between T1 and T2.

Since anxiety, depression and oral parafunction scores follow a non-normal distribution, their difference in the pain groups and their change between T1 and T2 was examined using an independent sample Kruskal-Wallis test.

For all analyses, $p < 0.05$ was considered significant.

Results

Stage 1

59 students participated in the study (71% female, 29% male), mean age was 22.6 years.

Temporomandibular pain occurred in 15 students (25.4%) during the semester period (T1) and in 31 students (52.5%) during the exam period (T2), which represents a significant increase ($p=0.003$). The frequency of TMD-related headache ($p=0.343$), joint sounds ($p=0.216$) and joint locking (closed: $p=0.331$, open: $p=0.059$) increased, but not significantly.

Among the biopsychosocial factors, pain intensity (CPI) showed a significant increase during the exam period ($p=0.014$), as did the level of anxiety ($p<0.001$) and depression ($p=0.001$). Among the examined oral parafunctions, frequency of three activities increased significantly in T2: clenching teeth during waking hours ($p=0.019$), grinding teeth during waking hours ($p=0.013$), and holding, tightening or tensing facial muscles ($p=0.001$).

Stage 2

In this stage of the study, 213 students were contacted and a total of 102 students provided complete and comparable responses on both occasions. The mean age of the final sample was 23.7 years, 62.5% were female and 37.5% were male.

24.5% of the students (25) had pain during the semester period (T1), and 23 of them also had pain during the exam period (T2). 43.3% (33) of the initially pain-free students developed new pain at T2, and 44 students remained pain-free. Only 2 students experienced pain remission.

In the whole sample, both CPI and IS scores were significantly higher at T2 than at T1 ($p<0.001$ for CPI and $p=0.003$ for IS). When examining the “continuous pain” group separately, the increase in pain intensity was not significant. This was also reflected in the change in pain grade groups: by the exam period, the number of cases in the “0” category decreased significantly, while those in the higher categories (especially in grade 1) increased.

Both depression and anxiety scores were significantly higher at T2 ($p<0.001$ for both). The proportion of those in the “normal” category decreased, while the proportion of those in the more severe categories increased significantly ($p<0.001$).

During the semester period, the “continuous pain” group had higher anxiety scores compared to the other groups ($p=0.022$). There was no such difference between the groups in the case of depression.

Scores of oral parafunctions during sleep and waking hours also increased significantly by T2 ($p<0.001$). At T1, the “continuous pain” group showed higher parafunctional scores than the “no pain” group. Jaw functional limitations also increased significantly by T2 ($p<0.001$), especially in the “new pain” group ($p=0.002$).

Discussion

We found significant difference between the semester and exam periods in terms of incidence and degree of temporomandibular pain, and the presence and extent of biopsychosocial variables.

In stage 1, the incidence of TMD-pain doubled by the exam period, affecting more than half of the students. We did not find significant changes regarding the other major symptoms of TMD, therefore, in stage 2, we specifically focused on TMD-pain. Similar change was observed in stage 2, as the proportion of students reporting new pain during the exam period was over 40%, while pain remission occurred only in a very small number of individuals. It is true for both stages that the incidence of TMD was more frequent even during the semester period than data reported by previous studies.

In both stages pain intensity was higher during the exam period, but when the continuous pain group was assessed separately, the increase was not significant. Correspondingly, although a shift towards more severe pain grade categories was observed, this was primarily reflected in an increase in the number of cases of grade 1 and relatively small number of students were included in the more severe TMD-pain categories.

The frequency and degree of biopsychosocial factors (anxiety, depression, oral parafunctions) and the limitation of jaw functions also showed a significant increase between the two assessment times. Numerous students from the “normal” and “mild” categories of anxiety and depression shifted into the groups of more severe categories. Jaw functional limitations were particularly obvious among students with new pain. However, there was no significant difference between the pain groups in the changes of anxiety, depression and oral parafunctions between time points T1 and T2. The temporal change and increase of these factors are therefore not necessarily related to the onset or persistence of pain.

Our results suggest that the degree of anxiety and the occurrence of oral parafunctions during the semester period may have a predictive power regarding the persistence of TMD-pain. In accordance with the results of previous research, this highlights that the self-regulation mechanisms of the body and individual coping patterns play a significant role in both the course of pain and the presence and change of biopsychosocial factors.

Our research also pointed out that the process from the onset of TMD-pain to become chronic is complex and associated with the effects of stress and other psychological factors. University exam periods act as a prominent risk factor, since the psychological state and behavioral changes of students significantly influence the perception of pain and its progression. These results highlight the importance of an integrated assessment of biopsychosocial factors in both the diagnosis and therapy of TMDs.

Summary of results and conclusions

Based on the results of our research, the following new findings can be stated:

1. During the exam period, symptoms of anxiety and depression were identifiable in a significantly larger proportion of students than during the semester period, and the level of biopsychosocial factors also reached a significantly higher level. In parallel, significantly more students reported temporomandibular pain than during the semester.
2. Higher anxiety and oral parafunction values in the semester period predicted the persistence of facial pain. Oral parafunctions occurred to a greater extent in those with continuous pain than in students without pain. From this, we can conclude that these factors also play a role in the complex mechanisms of chronic pain modulation. In case of depression, such predictive ability could not be identified.
3. No direct (causal) relationship was found between the change of temporomandibular pain in time and the change of biopsychosocial variables. It is assumed that the relationship between these factors is complex, in which mechanisms involving general systemic functions also play a role.

Publication list

Publications related to the thesis

1. **Somoskövi I**, Radácsi A, Nagy Á, Radnai M. A Diagnostic Criteria for Temporomandibular Disorders (DC/TMD) magyar nyelvű változatának létrehozása. [Developing the Hungarian version of the Diagnostic Criteria for Temporomandibular Disorders] *Fogorv Sz* 2018;111(2):44-51. **Q4**
2. **Somoskövi I**, Radnai M, Dergez T, Radácsi A, Tiringer I, Nagy Á. A depresszió és a szorongás, valamint a temporomandibularis diszfunkció feltételezett összefüggésének vizsgálata. [Evaluation of the suspected relationship between depression, anxiety and temporomandibular dysfunction] *Fogorv Sz* 2020;113(2):57-66. **Q4**
3. **Somoskövi I**, Radnai M, Ohrbach R, Dergez T, Tiringer I, Radácsi A, Nagy Á. Associations between temporomandibular pain and biobehavioral variables in dental students in response to an external stressor. *J Oral Facial Pain Headache* 2023;37(3):167-176. doi: 10.11607/ofph.3239. **Q1; IF (2023): 1,900**

Publications not related to the thesis

1. **Somoskövi I**, Herényi G, Szabó GT, Gurdán Z, Szabó G. Fogszabályozás céljából végzett fogeltávolítás gyakorisága. [Frequency of tooth removal because of orthodontic reasons] *Fogorv Sz*. 2008 Dec;101(6):225-30. **Q4**

Conference presentations related to the thesis

1. **Somoskővi I**, Szentpéteri A, Fele G. Új lehetőségek a temporomandibuláris ízületi rendellenességek diagnosztikájában. A Magyar Gyermekfogászati és Fogszabályozási Társaság Vándorgyűlése, Pécs, 2007
2. **Somoskővi I**. Összefüggések keresése az okklúzió és a temporomandibuláris rendellenességek között az ortodonciai gyakorlatban. A Magyar Gyermekfogászati és Fogszabályozási Társaság Szimpóziuma, Pécs, 2016
3. **Somoskővi I**, Radnai M. A Diagnostic Criteria for Temporomandibular Disorders (DC/TMD) magyar nyelvű változatának létrehozása. A Magyar Fogpótlástani Társaság Kongresszusa, Debrecen, 2017
4. **Somoskővi I**, Radácsi A, Farkas N, Nagy ÁK. Relationship between Lateral Pterygoid Pain, Disc Displacement and Mandibular Movements. IADR/AADR/CADR General Session & Exhibition (online poster presentation), Washington, 2020
5. **Somoskővi I**. A TMI kórképek diagnosztikai és terápiás lehetőségei az alapellátásban (A fogorvosi alapellátás aktuális kérdései), Vállalkozó Fogorvosok Egyesülete, Miskolc (online), 2021
6. **Somoskővi I**. A temporomandibuláris diszfunkció és fájdalom pszichológiai vonatkozásai. A Magyar Fogpótlástani Társaság XXIV. Kongresszusa, Budapest, 2021
7. **Somoskővi I**. Jelenlegi nézeteink a temporomandibuláris diszfunkcióról: okklúzió, pszichológia, vagy más? Nyári továbbképzés fogorvosoknak, Pécs, 2022
8. **Somoskővi I**. A temporomandibuláris diszfunkció és a fogszabályozás kapcsolata. Magyar Orthodontusok Társasága, Budapest, 2022
9. **Somoskővi I**. Ne féljünk a kattanástól! Vagy mégis? Magyar Orthodontusok Társasága Kongresszusa, Pécs, 2023
10. **Somoskővi I**. TMD a gyakorló fogorvos szemszögéből. A Magyar Fogpótlástani Társaság XXV. és a Magyar Gnatológiai Társaság I. Kongresszusa, Pécs, 2023
11. **Somoskővi I**. Temporomandibularis dysfunctio és ennek jelentősége a fejfájások kialakulásában. (Fejfájások ellátása a minden napokban, PTE AI-FMK) Pécs, 2024

Conference presentations not related to the thesis

1. **Somoskövi I**, Herényi G, Papócsi G. Fogszabályozás céljából végzett fogeltávolítás gyakorisága. A Magyar Gyermekfogászati és Fogszabályozási Társaság Vándorgyűlése, Debrecen, 2005
2. **Somoskövi I**, Dr. Benke B, Szabó Gy. A fogszabályozás és fogpótlástan együttműködése gyermekkorban (esetbemutató poszter). A Magyar Gyermekfogászati és Fogszabályozási Társaság Vándorgyűlése, Pécs, 2007

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