Influence of cognitive performance on the response to pain education guidelines in patients with chronic painful temporomandibular disorders

Influência do desempenho cognitivo na resposta às orientações de educação sobre a dor em pacientes com disfunção temporomandibular dolorosa crônica

Amaury Martins Prado[1], Mirela Cristina da Silva[1], Alex Moreira Mélo[2], Melissa de Oliveira Melchior[2,3], Laís Valencise Magri[1,2,4]

DOI 10.5935/2595-0118.20220063-en

ABSTRACT

BACKGROUND AND OBJECTIVES: Patients with painful temporomandibular disorders (TMD) may present cognitive performance alterations, making it difficult to understand and adhering to self-management strategies offered in pain education interventions. The aim of this study was to analyze the response to self-management guidelines in patients with chronic painful TMD due to cognitive performance.

METHODS: Sample of 45 patients (35.5 years) with chronic painful TMD according to Diagnostic Criteria for Temporomandibular Disorders (DC/TMD). Cognitive performance was assessed using the Montreal Cognitive Assessment (MoCA) test. The Brazilian Portuguese Central Sensitization Inventory (CSI-BP) was also applied to measure central sensitization and numerical rating scale to assess the perception of pain intensity. The intervention consisted of self-care guidelines for pain management with homemade methods, through a video and a printed tutorial. After an interval of 15 days, a new evaluation was made to verify whether the self-management guidelines promoted pain-related changes in the sample studied and whether there were differences between participants with adequate and altered cognitive performance (groups obtained after the application of the test).

RESULTS: The mean MoCA for the sample was 23.3±2.5 (lower than expected cognitive performance). A strong inverse correlation was found between the cognitive performance and pain intensity scores, indicating the tendency to have lower cognitive performance when there is greater intensity of pain (r=-0.77 and p=0.03). There was no correlation between cognitive performance and central sensitization (p>0.05). The group with better cognitive performance presented better response to pain education strategies.

CONCLUSION: There is a trend towards worse cognitive performance according to the increase in perception of painful intensity. In addition, low cognitive performance seems to impair the use and efficacy of pain education-based intervention for patients with painful TMD, which is considered an important strategy for its management.

Keywords: Cognition, Temporomandibular joint disorders, Chronic pain

RESUMO

JUSTIFICATIVA E OBJETIVOS: Pacientes com disfunção temporomandibular (DTM) dolorosa podem apresentar alterações de desempenho cognitivo dificultando a compreensão e adesão às estratégias de automanejo oferecidas em intervenções de educação sobre dor. O objetivo deste estudo foi analisar a resposta às orientações de automanejo em pacientes com DTM dolorosa crônica em função do desempenho cognitivo.

MÉTODOS: Amostra de 45 pacientes, com idade média de 35,5 anos, com DTM dolorosa crônica segundo o *Diagnostic Criteria for Temporomandibular Disorders* (DC/TMD). O desempenho cognitivo foi avaliado por meio do teste *Montreal Cognitive Assessment* (MoCA). Foi também aplicado o *Brazilian Portuguese Central Sensitization Inventory* (CSI-BP) para mensuração da sensibilização central e a escala numérica para avaliar a percepção de intensidade dolorosa. A intervenção consistiu em orientações de autocuidado para o manejo da dor com métodos caseiros, por meio de um vídeo e de um tutorial impresso. Após um intervalo de 15 dias, foi feita nova avaliação para verificar se as orienta-

Amaury Martins Prado – https://orcid.org/0000-0002-8607-3598;
Mirela Cristina da Silva – https://orcid.org/0000-0003-1932-0816;
Alex Moreira Mélo – https://orcid.org/0000-0002-0433-2681;
Melissa de Oliveira Melchior – https://orcid.org/0000-0003-4943-1242;
Laís Valencise Magri – https://orcid.org/0000-0001-8050-4396.

1. Ribeirão Preto University, Dentistry School, Ribeirão Preto, SP, Brazil.
2. Ribeirão Preto Dentistry School, University of São Paulo, Department of Restorative Dentistry, Ribeirão Preto, SP, Brazil.
3. University of São Paulo, School of Nursing, Department of Psychiatric Nursing and Human Sciences - Ribeirão Preto, SP, Brazil.
4. University of São Paulo, School of Philosophy, Sciences and Languages, Department of Psychology, Ribeirão Preto, SP, Brazil.

Submitted on August 31, 2022.
Accepted for publication December 16, 2022.
Conflict of interests: none – Sponsoring sources: none.

HIGHLIGHTS

- Pain intensity has an inverse association with cognitive performance in patients with painful temporomandibular disorders.
- Cognitive performance appears to interfere with the utilization and effectiveness of pain education-based intervention for patients with painful temporomandibular disorders.
- Patients with painful temporomandibular disorders tend to have lower than expected cognitive performance.

Correspondence to:
Alex Moreira Mélo
E-mail: alexmelo@usp.br

ções de automanejo promoveram mudanças relacionadas à dor na amostra estudada e se houve diferenças entre os participantes com desempenho cognitivo adequado e alterado (grupos obtidos após a aplicação do teste).
RESULTADOS: A média do MoCA para a amostra foi de 23,3 ± 2,5 (desempenho cognitivo abaixo do esperado). Foi encontrada forte correlação inversa entre os escores do desempenho cognitivo e da intensidade de dor, indicando a tendência de haver menor desempenho cognitivo ao passo que há maior intensidade de dor (r=-0,77 e p=0,03). Não houve correlação entre o desempenho cognitivo e a sensibilização central (p>0,05). O grupo com melhor desempenho cognitivo apresentou melhor resposta às estratégias de educação sobre a dor.
CONCLUSÃO: Há uma tendência de pior desempenho cognitivo de acordo com o aumento na percepção de intensidade dolorosa. Além disso, o baixo desempenho cognitivo parece prejudicar o aproveitamento e eficácia da intervenção baseada em educação sobre a dor para pacientes com DTM dolorosa, a qual é considerada importante estratégia para seu manejo.
Descritores: Cognição, Disfunção temporomandibular, Dor crônica.

INTRODUCTION

The set of signs and symptoms that involve muscle and joint changes related to the stomatognathic system is characterized as temporomandibular disorder (TMD), and its three main clinical indicators are pain, jaw opening limitations and joint noises, which are present in a percentage of 5% to 50% of the population[1-3]. Very commonly, patients have difficulty performing simple tasks such as brushing their teeth, chewing and yawning, since the painful symptoms and joint and muscle limitations of TMD can compromise oral functions and influence health and well-being[4]. The maintenance of this condition can lead to pain chronification and central sensitization (CS), making its management complex.
According to the Orofacial Pain: Prospective Evaluation Risk Assessment (OPPERA) study, the main longitudinal study to investigate the risks related to TMD development, the presence of multiple coexisting health conditions, non-painful orofacial symptoms, self-reported oral parafunction, high frequency of somatic symptoms, poor sleep quality, and the genetic influence of certain polymorphisms already identified and related to this clinical condition were identified as risk factors[5].
Additionally, the context of chronic pain involves social, family, emotional and cognitive aspects, which must be considered in the management of this condition, extrapolating the treatment approach to a biopsychosocial look[6,7]. According to studies involving analyses of functional magnetic resonance imaging, patients with chronic pain present alterations in the brain structure and function in regions and networks not only involved in pain processing, but also in cognitive and emotional aspects[8].
On this path, some cognitive aspects are deficient and related to the painful experience of patients with a chronic pain phenotype, such as memory and concentration loss, especially during acute pain crises[9-11].
There has been speculation that activities related to executive function may also be compromised in these patients, resulting in higher levels of distraction, reduced performance of cognitive skills and behavioral changes such as hypervigilance and pain catastrophizing[8,12]. Pain catastrophizing is related to brain areas involved in pain processing, attention to pain, emotion, motor activity and reduction of pain inhibition top down[8,13].
One of the means of TMD clinical treatment is counseling and guidance for pain self-management, which consists of explaining to patients the etiological factors of the disease and guiding them on how to reduce overload and harmful habits to temporomandibular joint (TMJ), masticatory muscles, and their adjacent structures[14].
To this end, guidelines are presented on sleep hygiene, compresses of moist heat and massage in the painful region, performing aerobic physical activities, stretching the cervical region, controlling parafunctional habits, consistency of food to be consumed, among others that can be performed by patients in their daily lives[15,16].
Thus, these orientations contribute to pain relief, providing patients with a better quality of life, once they learn to deal/manage pain and reduce anxiety and fear related to its threatening status[14]. However, for comprehension of the orientations and the consequent motivation to execute them, the integrity of cognitive aspects such as attention, memory, concentration, reasoning, executive functions, and language is necessary.
Regarding the literature and the importance of pain education strategies, the need for a better understanding of cognitive variables and their associations with the chronic pain condition is clear, since these influence the understanding of orientations, taking into account that pain education programs in multimodal treatments of these patients are of utmost importance.
The aim of this study was to analyze the response to self-management guidelines of patients with chronic painful TMD as a function of cognitive performance.

METHODS

This is a non-randomized (quasi-experimental) clinical trial that followed the CONSORT[17] recommendations.
The sample was established from a calculation based on the number of consultations per semester in the TMD and orofacial pain units of the University of Ribeirão Preto (*Universidade de Ribeirão Preto* – UNAERP) and the Ribeirão Preto School of Dentistry (*Faculdade de Odontologia de Ribeirão Preto* – FORP/USP), whose case-taking capacity has been approximately 80 patients per semester in the last 10 years. This is a population of patients who seek care for TMD and orofacial pain through the Unified Health System (*Sistema Único de Saúde* – SUS) in Ribeirão Preto city region.
The representative sample, according to the population normally absorbed in the services, with a sampling error of 10% and confidence interval of 95%, would be at least 36 patients. The calculation was performed using an online statistical software (https://comentto.com/calculadora-amostral/). During the data collection period the number of participants evaluated was higher than stipulated in the sample calculation to ensure possi-

ble losses and exclusions, reaching the end with a total sample of 45 participants (32 women and 13 men).

Inclusion criteria were age between 18 and 45 years, diagnosis of chronic painful TMD according to the Diagnostic Criteria for Temporomandibular Disorders – Brazilian Portuguese version (DC/TMD)[18], regardless of gender, who sought treatment in the UNAERP Occlusion, TMD and Orofacial Pain Clinic or at FORP/USP in the first semester of 2021. DC/TMD has high sensitivity and specificity (≥0.86 and ≥0.98 respectively) for any TMD-related pain and was therefore chosen as a diagnostic method to determine the inclusion of participants[18].

Patients who were already undergoing some type of therapeutic intervention for painful TMD and individuals with previous cognitive deficits who were unable to answer the questionnaires were excluded.

After application of the cognitive performance test with the Montreal Cognitive Assessment (MoCA) protocol, participants were divided into groups/clusters of "adequate" (total score equal to or above 26) and "below the cut-off value" (total score below 26) cognitive performance in order to investigate the influence of this variable on the response of the intervention based on pain self-management guidelines for TMD patients.

Cognitive performance measurement (MoCA test)

To evaluate and measure the cognitive skills of the sample, the MoCA protocol was used. This protocol contains a sequence of tests that assess eight cognitive domains: attention, executive functions, calculation, language, working and rescue memory, abstraction, orientation, and visuospatial process, in addition to the verbal fluency test. Thus, the MoCA protocol consists of a brief screening for mild cognitive deficits, whose score predicts the cognitive skills assessed, and scores above 26 are considered normal. The individual's education was adjusted in relation to the overall score of the assessment protocol, as recommended by the authors[19,20].

Pain Measurement

The Brazilian Portuguese Central Sensitization Inventory (CSI-BP) protocol was used to identify patients who are at high risk of having CS or to assess CS-related symptoms. The original CSI was developed by Neblett et al.[21] and translated and validated by Caumo et al.[22] (CSI-BP). Part A contains 25 questions regarding signs and symptoms of CS with the possibility of response on a 4-point Likert scale (0 = "never" and 4 = "always") for each question. The total score can range from zero to 100, with a score of 40 points or more indicating the presence of CS. Part B contains questions about the presence of confirmed diagnoses previously correlated to CS (comorbidities), with the possibility of a dichotomous answer (yes or no) and date record of the diagnosis received[21,22].

Perceived pain intensity of the participants was assessed using a printed numeric scale from zero to 10, where zero represents "no pain" and 10 "unbearable pain" by the Numerical Rating Scale (NRS).

Intervention Protocol: Pain Education Strategy

After the initial exams, the participants watched a video produced by this research team, whose content presented home-based strategies for self-management and pain education recognized in scientific literature as an effective complement to treatment[14]. The video begins with the title: "Self-care guidelines for TMD patients" and continues with verbal and visual explanations on the subject, containing information about what the TMD condition is and its main signs and symptoms. Next, an explanation is given about the importance of home orientations, emphasizing their simplicity to perform and the patient's protagonism for his or her own improvement.

In addition, soft diets, compresses with moist heat on the painful regions for 20 minutes, twice a day, soft and controlled active mouth opening exercises daily, explanations on the role of dental clenching in worsening the painful condition, and directing attention to this type of habit with the intention of avoiding it[23] were also recommended. To this end, the use of reminders scattered around the house and/or workplace was suggested, with statements about loosening the teeth and relaxing the jaw and/or the use of cell phone applications that send messages with the same function of reminding the participant about loosening the teeth[24].

Sleep hygiene was addressed in the video in order to inform about the influence of sleep quality on the painful condition[16]. The guidelines to take care of the quality of sleep included explanations about lying down in bed only at the time to really sleep and at a regular time, as well as avoiding the use of screens and other activities that hinder the development of sleep, avoiding stimulant drinks after 5 pm, performing calm activities such as reading books, listening to calm music, and drinking calming beverages[25]. To control stress and anxiety, this research video brought suggestions such as the practice of sports and physical activities, leisure activities, meditation, and massages. The same visual content of the video was delivered in print to the participants as a tutorial, in order to reinforce the self-management intervention.

Evaluation Moments

All participants who made up the sample were evaluated according to the instruments previously described before the intervention. A period of 20 days was given so that the participants could apply the orientations received. After this period, the CSI-BP[22] and NRS protocols were applied again to evaluate the pain response to self-management instructions.

This study was submitted to the Research Ethics Committee (*Comitê de Ética em Pesquisa* – CEP) of São Paulo State University, Ribeirão Preto Faculty of Dentistry (*Faculdade de Odontologia de Ribeirão Preto da Universidade de São Paulo* – FORP/USP, CAAE: 03383218.7.0000.5419). Data were only collected after CEP's approval. All the research volunteers were informed about objectives, risks and benefits, and signed the Free and Informed Consent Term (FICT).

Statistical analysis

The Shapiro-Wilk normality test was applied, and the sample data showed normal distribution ($p>0.05$). Pearson's correlation test was then applied between the MoCA and pain intensity perception variables (numeric scale from zero to 10). After

this first analysis, Pearson's correlation test was applied between variables MoCA and CSI-BP, and between CSI-BP and perceived pain intensity. Finally, the sample was divided into two groups (clusters) according to the MoCA test: participants with scores equal to or above 26 and participants with scores below 26. The One Way ANOVA statistical test (with Tukey-Kramer post-test) was then used for comparisons between the initial and final evaluations of the CSI-BP variables and perception of pain intensity for the two established groups (clusters). The significance level was ∝=5% (p<0.05).

RESULTS

At the end of the study, 45 patients were analyzed, with a mean age of 35.5±17.4 years and a predominance of females (32 females and 13 males). The average obtained with these patients' CSI data was 47.8±15.5, while the cut-off value of the protocol is 40, suggesting a CS condition in the sample studied. Regarding pain comorbidities, 53% of the sample had comorbidities other than TMD, among which the most frequently reported were fibromyalgia (38%), headaches (54%) and anxiety (58%).

The mean pain intensity reported by the individuals was 7.5±2.4 out of 10, representing high intensity pain, while the mean MoCA test score was 23.3±2.5, indicating lower than expected cognitive performance, since the cut-off value indicated by the scale is 26.

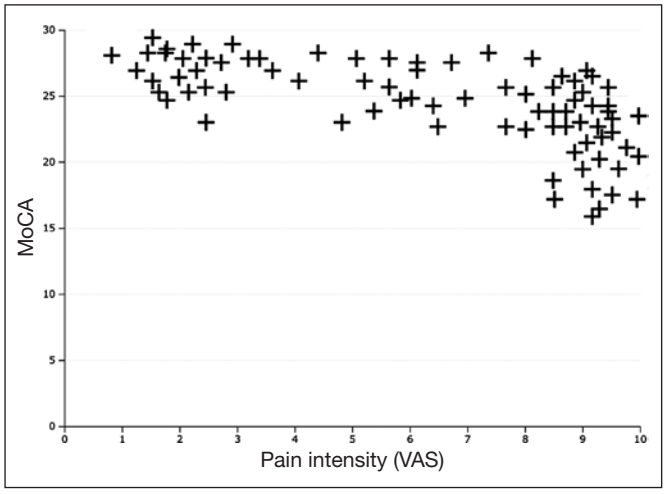

Figure 1. Correlation MoCA versus pain intensity (Pearson's R = -0.76725, n=45)
VAS = visual analogic scale.

Pearson's correlation test was then used between the variables "cognitive performance" and "pain intensity" and "cognitive performance" x "central sensitization". A significant inverse correlation was observed between MoCA score and pain intensity, indicating a tendency to have lower cognitive performance when there is greater pain intensity, as shown in Figure 1 (Pearson's r=-0.767 and p=0.03). The correlation between the variables "cognitive performance" x "CS" was not statistically significant (p=0.74).

After 15 days of the pain education intervention, the final evaluation was then performed. A slight reduction in the participants' CS was observed, now with a mean and standard deviation of 45.5±15.6, but still indicating a CS condition. A reduction in the pain intensity reported by these patients was also verified, with a final mean of 5.1±2.3.

In order to evaluate the intervention with pain education, at the initial and final moments, based on the variables pain intensity and CS, the sample was divided according to the MoCA score into two groups: MoCA<26 (cognitive performance below expected, n=34) and MoCA>26 (expected cognitive performance, n=11). Table 1 presents the mean, standard deviation and p-value of the variables pain intensity and CS for the two groups (clusters), before and after the intervention with pain education (15-day duration). MoCA>26 (expected cognitive performance) group showed lower mean pain intensity and CS at the initial assessment when compared to MoCA<26 (below expected cognitive performance) group. In addition, MoCA>26 group showed better response to the pain education intervention, with greater reduction in pain intensity (p=0.03) and CS (p=0.02).

DISCUSSION

The majority of the study's sample had low cognitive performance, which was related to pain intensity but not to CS. Of the 45 participants in this study, 32 were women. The scientific literature suggests that prevalence of TMD in women is related to the multidimensionality of pain[26-30] and that estrogen may have a biphasic effect on the pain condition of women from fluctuating hormone levels during reproductive age and perimenopause, promoting different types of TMD[5,31,32].

The presence of chronic painful TMD is often associated with the presence of comorbidities, many of which were reported by the sample of participants, besides other signs found to favor CS and make its clinical management more difficult, such as pre-

Table 1. Mean, standard deviation and p-value of pain intensity and central sensitization variables for the groups (clusters) - with MoCA below 26 (below expected cognitive performance) and above 26 (expected cognitive performance), at the initial and final assessment times (before and after the pain education intervention, 15-day duration).

Variables	MoCA < 26 group		MoCA > 26 group	
	Initial	Final	Initial	Final
Pain intensity (NRS)	7.9 ± 3.2	4.9 ± 2.9	5.6 ± 1.8	3.1 ± 0.4
p-value		**0.03***		**>0.05**
Central Sensitization (CSI)	49.8 ± 16.5	43.4 ± 14.5	43.2 ± 12.7	38.8 ± 11.4
p-value		**0.02***		**>0.05**

NRS = Numerical Rating Scale; CSI: Central Sensitization Inventory; MoCA: Montreal Cognitive Assessment. One Way ANOVA analysis (with Tukey-Kramer post-test).

sence of fatigue, low cognitive performance, poor sleep quality, reports of headaches, and signs of depression and anxiety[21,22].

CS can be defined as an amplification of neural signaling within the central nervous system, which causes reduced pain threshold and painful hypersensitivity, i.e., pain disproportionate to external stimulus (hyperalgesia) or even without any stimulus (allodynia), presenting itself as a self-sustaining event[33].

According to the CSI-BP protocol,[21,22] was verified that more than half of the sample studied (53%) showed strong evidence of CS presence, with total scores above 40 (CSI-BP part "A"). Despite the high pain perception, observed through high scores on the numerical scale (7.5±2.4), there was no correlation with the CS scale. This phenomenon is related to the functional state of neurons and nociceptive pathways throughout the neuronal axis[33], while the painful experience is composed of a context very particular to each human being, involving biopsychosocial aspects at different levels and degrees[7], which may justify the result found.

Considering the biopsychosocial model for the treatment of chronic painful TMD and that patients with this condition may present decline in cognitive skills, a test of the sample by means of the MoCA protocol was proposed, in order to relate it to pain intensity and the effectiveness of the intervention based on pain education. In view of the results, was then observed that cognitive performance seems to really suffer the influence of pain intensity and that this condition hinders the intervention by pain education, which requires integrity of cognitive skills. Regions and neural networks involved in pain processing and in cognitive and emotional aspects can be structurally and functionally altered, resulting in cognitive deficits such as memory and reasoning loss, distraction, as well as behavioral changes such as hypervigilance and pain catastrophizing[7-13].

When conventional forms of therapy are combined with pain education, improvement in function and perception of pain is observed in several populations[34,35]. However, cognitive integrity is necessary for this intervention to achieve its objective, which is the patient's learning to self-manage pain control and its related suffering. In this sense, the sample studied showed a reduction in pain perception after the intervention based on education about pain, although it is important to highlight that patients with better cognitive performance characterized a cluster more responsive to this type of intervention. Individuals with impaired cognitive functions, such as focus and long-term memory, were likely unable to focus or remember the self-management guidelines, which were exposed via video and instructional booklet prepared by the research team. This may explain, at least in part, the lesser reduction in pain perception when the group with a score of less than 26 on the MoCA test was evaluated a second time.

It is likely that the improvement in the overall quality of life of patients with painful TMD who undergo pain education interventions is also related to decreased pain sensitivity, which means that symptom management should consider the physical and functional limitations and comorbidities caused by TMD[14]. Therefore, there is a need to discuss better scenarios aimed at implementing biopsychosocial and interdisciplinary models. Since TMD involves different etiologies, structures and clinical signs, treatment should be heterogeneous and respect the differences in each case, aiming at greater comfort when performing daily activities and greater comfort when sleeping[36].

Among the treatment possibilities, interventions based on cognitive-behavioral approaches include several health areas, besides dentistry, such as speech therapy, physical therapy, and medicine, whose professionals must use pain education strategies as an option to complement the management of the chronic pain condition within their specialty, aiming at a better prognosis for patients affected by this dysfunction[37,38,39].

CONCLUSION

There is a trend towards worse cognitive performance according to the increase in perceived pain intensity in the TMD patients' sample. Moreover, low cognitive performance seems to hinder the use and effectiveness of the pain education-based intervention for patients with painful TMD, which is considered an important strategy for its management. Therefore, consideration of the cognitive aspects of patients is important when planning interventions of this type in order to target planning appropriately, including possible referrals and/or strategies aimed at assessing cognitive performance.

AUTHORS' CONTRIBUTIONS

Amaury Martins Prado
Data Collection, Conceptualization, Research, Writing - Preparation of the Original, Software
Mirela Cruz da Silva
Data Collection, Writing - Review and Editing, Validation
Alex Moreira Mélo
Writing - Preparation of the Original, Writing - Review and Editing, Validation, Visualization
Melissa de Oliveira Melchior
Writing - Review and Editing
Lais Valencise Magri
Statistical Analysis, Funding Acquisition, Conceptualization, Resource Management, Project Management, Methodology, Writing - Preparation of the Original, Writing - Review and Editing, Software, Supervision, Validation, Visualization

REFERENCES

1. Manfredini D, Chiappe G, Bosco M. Research diagnostic criteria for temporomandibular disorders (RDC/TMD) axis I diagnoses in an Italian patient population. J Oral Rehabil. 2006;33(8):551-8.
2. Dworkin SF. The OPPERA study: Act One. J Pain. 2011 Nov;12(11 Suppl):T1-3.
3. Okeson JP. Management of Temporomandibular Disorders and Occlusion. 8a ed. St. Louis: Elsevier, 2020. 514p.
4. Peixoto KO, Resende CMBM, Almeida EO, Almeida-Leite CM, Conti PCR, Barbosa GAS, Barbosa JS. Association of sleep quality and psychological aspects with reports of bruxism and TMD in Brazilian dentists during the COVID-19 pandemic. J Appl Oral Sci. 2021;29:e20201089.
5. Slade GD, Ohrbach R, Greenspan JD, Fillingim RB, Bair E, Sanders AE, Dubner R, Diatchenko L, Meloto CB, Smith S, Maixner W. Painful temporomandibular disorder: decade of discovery from OPPERA Studies. J Dent Res. 2016;95(10):1084-92.
6. International Classification of Orofacial Pain, 1st edition (ICOP). Cephalalgia. 2020;40(2):129-221.
7. Ettlin DA, Napimoga MH, Meira E Cruz M, Clemente-Napimoga JT. Orofacial

musculoskeletal pain: An evidence-based bio-psycho-social matrix model. Neurosci Biobehav Rev. 2021;128(1):12-20.
8. Malfliet A, Coppieters I, Van Wilgen P, Kregel J, De Pauw R, Dolphens M, Ickmans K. Brain changes associated with cognitive and emotional factors in chronic pain: A systematic review. Eur J Pain. 2017;21(5):769-86.
9. Apkarian VA, Hashmi JA, Baliki MN. Pain and the brain: specificity and plasticity of the brain in clinical chronic pain. Pain. 2011;152(3 Suppl):S49-S64.
10. Legrain V, Damme SV, Eccleston C, Davis KD, Seminowicz DA, Crombez G. A neurocognitive model of attention to pain: behavioral and neuroimaging evidence. Pain. 2009;144(3):230-32.
11. Ferreira Kdos S, Oliver GZ, Thomaz DC, Teixeira CT, Foss MP. Cognitive deficits in chronic pain patients, in a brief screening test, are independent of comorbidities and medication use. Arq Neuropsiquiatr. 2016;74(5):361-6.
12. Berryman C, Stanton TR, Bowering KJ, Tabor A, McFarlane A, Moseley GL. Do people with chronic pain have impaired executive function? A meta-analytical review. Clin Psychol Rev. 2014;34(7):563-79.
13. da Silva GV, Magri LV, de Oliveira Melchior M, Andrade Leite-Panissi CR, da Silva Gherardi-Donato EC. Mindfulness and pain catastrophization: how are they associated in women with chronic painful temporomandibular disorder (TMD)? Cranio. 2022;20:1-7. ahead of print.
14. Durham J, Al-Baghdadi M, Baad-Hansen L, Breckons M, Goulet JP, Lobbezoo F, List T, Michelotti A, Nixdorf DR, Peck CC, Raphael K, Schiffman E, Steele JG, Story W, Ohrbach R. Self-management programmes in temporomandibular disorders: results from an international Delphi process. J Oral Rehabil. 2016;43(12):929-36.
15. de Freitas RF, Ferreira MÂ, Barbosa GA, Calderon PS. Counselling and self-management therapies for temporomandibular disorders: a systematic review. J Oral Rehabil. 2013;40(11):864-74.
16. de Melo LA, Bezerra de Medeiros AK, Campos MFTP, Bastos Machado de Resende CM, Barbosa GAS, de Almeida EO. Manual therapy in the treatment of myofascial pain related to temporomandibular disorders: a systematic review. J Oral Facial Pain Headache. 2020;34(2):141-8.
17. Moher D, Hopewell S, Schulz KF, Montori V, Gøtzsche PC, Devereaux PJ, Elbourne D, Egger M, Altman DG. CONSORT 2010 explanation and elaboration: updated guidelines for reporting parallel group randomised trials. BMJ. 2010;23;340:c869.
18. Schiffman E, Ohrbach R, Truelove E, Look J, Anderson G, Goulet JP, List T, Svensson P, Gonzalez Y, Lobbezoo F, Michelotti A, Brooks SL, Ceusters W, Drangsholt M, Ettlin D, Gaul C, Goldberg LJ, Haythornthwaite JA, Hollender L, Jensen R, John MT, De Laat A, de Leeuw R, Maixner W, van der Meulen M, Murray GM, Nixdorf DR, Palla S, Petersson A, Pionchon P, Smith B, Visscher CM, Zakrzewska J, Dworkin SF; International RDC/TMD Consortium Network, International association for Dental Research; Orofacial Pain Special Interest Group, International Association for the Study of Pain. Diagnostic Criteria for Temporomandibular Disorders (DC/TMD) for Clinical and Research Applications: recommendations of the International RDC/TMD Consortium Network* and Orofacial Pain Special Interest Group†. J Oral Facial Pain Headache. 2014;28(1):6-27.
19. Martins NIM, Caldas PR, Cabral ED, Lins CCDSA, Coriolano MDGWS. Cognitive assessment instruments used in elderly Brazilians in the last five years. Cien Saude Colet. 2019;24(7):2513-30.
20. Pinto TCC, Machado L, Bulgacov TM, Rodrigues-Júnior AL, Costa MLG, Ximenes RCC, Sougey EB. Is the Montreal Cognitive Assessment (MoCA) screening superior to the Mini-Mental State Examination (MMSE) in the detection of mild cognitive impairment (MCI) and Alzheimer's Disease (AD) in the elderly? Int Psychogeriatr. 2019;31(4):491-504.
21. Neblett R, Cohen H, Choi Y, Hartzell MM, Williams M, Mayer TG, Gatchel RJ. The Central Sensitization Inventory (CSI): establishing clinically significant values for identifying central sensitivity syndromes in an outpatient chronic pain sample. J Pain. 2013;14(5):438-45.
22. Caumo W, Antunes LC, Elkfury JL, Herbstrith EG, Busanello Sipmann R, Souza A, Torres IL, Souza Dos Santos V, Neblett R. The Central Sensitization Inventory validated and adapted for a Brazilian population: psychometric properties and its relationship with brain-derived neurotrophic factor. J Pain Res. 2017;10:2109-22.
23. Armijo-Olivo S, Pitance L, Singh V, Neto F, Thie N, Michelotti A. Effectiveness of manual therapy and therapeutic exercise for temporomandibular disorders: systematic review and meta-analysis. Phys Ther. 2016;96(1):9-25.
24. Goldstein RE, Auclair Clark W. The clinical management of awake bruxism. J Am Dent Assoc. 2017;148(6):387-91.
25. Truong L, Reher P, Doan N. Correlation between upper airway dimension and TMJ position in patients with sleep disordered breathing. Cranio. 2020;8:1-9. Epub ahead of print.
26. Schmid-Schwap M, Bristela M, Kundi M, Piehslinger E. Sex-specific differences in patients with temporomandibular disorders. J Orofac Pain. 2013;27(1):42-50.
27. Jedynak B, Jaworska-Zaremba M, Grzechocińska B, Chmurska M, Janicka J, Kostrzewa-Janicka J. TMD in Females with Menstrual Disorders. Int J Environ Res Public Health. 2021;18(14):7263.
28. Dıraçoğlu D, Yıldırım NK, Saral İ, Özkan M, Karan A, Özkan S, Aksoy C. Temporomandibular dysfunction and risk factors for anxiety and depression. J Back Musculoskelet Rehabil. 2016;29(3):487-91.
29. Nahman-Averbuch H, Sprecher E, Jacob G, Yarnitsky D. The relationships between parasympathetic function and pain perception: the role of anxiety. Pain Pract. 2016;16(8):1064-72.
30. Reissmann DR, John MT, Seedorf H, Doering S, Schierz O. Temporomandibular disorder pain is related to the general disposition to be anxious. J Oral Facial Pain Headache. 2014;28(4):322-30.
31. Robinson JL, Johnson PM, Kister K, Yin MT, Chen J, Wadhwa S. Estrogen signaling impacts temporomandibular joint and periodontal disease pathology. Odontology. 2020;108(2):153-65..
32. Ribeiro-Dasilva MC, Peres Line SR, Leme Godoy dos Santos MC, Arthuri MT, Hou W, Fillingim RB, Rizzatti Barbosa CM. Estrogen receptor-alpha polymorphisms and predisposition to TMJ disorder. J Pain. 2009;10(5):527-33.
33. van Griensven H, Schmid A, Trendafilova T, Low M. Central sensitization in musculoskeletal pain: lost in translation? J Orthop Sports Phys Ther. 2020;50(11):592-6.
34. Van Oosterwijck J, Nijs J, Meeus M, Truijen S, Craps J, Van den Keybus N, Paul L. Pain neurophysiology education improves cognitions, pain thresholds, and movement performance in people with chronic whiplash: a pilot study. J Rehabil Res Dev. 2011;48(1):43-58.
35. Dolphens M, Nijs J, Cagnie B, Meeus M, Roussel N, Kregel J, Malfliet A, Vanderstraeten G, Danneels L. Efficacy of a modern neuroscience approach versus usual care evidence-based physiotherapy on pain, disability and brain characteristics in chronic spinal pain patients: protocol of a randomized clinical trial. BMC Musculoskelet Disord. 2014;8;15:149.
36. Resende CM, Alves AC, Coelho LT, Alchieri JC, Roncalli AG, Barbosa GA. Quality of life and general health in patients with temporomandibular disorders. Braz Oral Res. 2013;27(2):116-21.
37. Wieckiewicz M, Boening K, Wiland P, Shiau YY, Paradowska-Stolarz A. Reported concepts for the treatment modalities and pain management of temporomandibular disorders. J Headache Pain. 2015;16:106.
38. Motomura K, Terasawa Y, Natsume A, Iijima K, Chalise L, Sugiura J, Yamamoto H, Koyama K, Wakabayashi T, Umeda S. Anterior insular cortex stimulation and its effects on emotion recognition. Brain Struct Funct. 2019;224(6):2167-81.
39. Roussel NA, Nijs J, Meeus M, Mylius V, Fayt C, Oostendorp R. Central sensitization and altered central pain processing in chronic low back pain: fact or myth? Clin J Pain. 2013;29(7):625-38.