Catastrophizing and Hypervigilance Influence Subjective Sleep Quality in Painful TMD Patients

Rodrigo Lorenzi Poluha, DDS, MSc, PhD
Department of Dentistry
State University of Maringa
Maringa, Brazil

Giancarlo De la Torre Canales, DDS, MSc, PhD
Department of Dentistry
Ingá University Center
Maringa, Brazil;
Clinical Research Unit
Centro de Investigação Interdisciplinar Egas Moniz, Egas Moniz—Cooperativa de Ensino Superior
Caparica, Portugal

Dyna Mara Ferreira, DDS, MSc, PhD
Juliana Stuginski-Barbosa, DDS, MSc, PhD
Paulo César Rodrigues Conti, DDS, MSc, PhD
Bauru Orofacial Pain Group
University of São Paulo
Bauru, Brazil;
Department of Prosthodontics
Bauru School of Dentistry
University of São Paulo
Bauru, Brazil

Correspondence to:
Dr Giancarlo De la Torre Canales
Interdisciplinar Investigation Center Egas Moniz,
University Institute Egas Moniz
Quinta da Granja, 2829-511 Monte de Caparica - Caparica - Portugal
Email: giank_28@hotmail.com

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Aims: To determine sleep quality and associated factors in a group of patients with painful TMDs. **Methods:** The medical records of 80 patients with arthralgia and/or myofascial pain were reviewed and compared to a healthy control group. Data about sex, age, subjective pain, physical activity, social activity, subjective sleep quality (Pittsburgh Sleep Quality Index [PSQI]), pain vigilance (Pain Vigilance and Awareness Questionnaire [PVAQ]), and pain catastrophizing (Pain Catastrophizing Scale [PCS]) were collected. Relationships between PSQI, age, pain intensity, PVAQ, and PCS in the TMD group were also analyzed. Data from the control group were used to transform the PSQI results into T-scores, which were then used to divide the TMD group into two subgroups: normal and impaired sleep. **Results:** TMD patients presented a significantly higher ($P < .001$) PSQI score than the control group. Also, in the TMD group, there was a low to moderate correlation between PSQI and pain intensity and a significant correlation between PVAQ and PCS. The impaired sleep group presented a significantly higher ($P < .001$) PSQI T-score than the normal sleep group. Univariate analysis showed that subjective pain, social activity, and the PCS total and subscale scores differed significantly between the different PSQI T-score groups. The comparison between TMD pain patients and control subjects showed a significantly higher prevalence of T-score discordance in almost all PSQI components in TMD patients with impaired sleep. **Conclusion:** Subjective sleep quality in painful TMD patients could be associated with and influenced by psychosocial factors (catastrophizing and hypervigilance), social activity, and pain intensity. *J Oral Facial Pain Headache 2023;37:47–53. doi: 10.11607/ofph.3269*

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The literature indicates bidirectional relationships between poor sleep and pain and between chronic craniofacial pain and sleep.[1] Sleep disorders are strong predictors of chronic pain development.[2] In addition, studies have reported sleep problems in 50% to 89% of patients having some type of chronic pain,[3] with disrupted sleep and impaired sleep initiation/maintenance often reported as the main characteristics of poor sleep quality.[4]

The association between sleep disorders and painful temporomandibular disorders (TMDs) is well documented. Up to 90% of TMD patients have comorbid sleep disorders,[5] with 70% and 43%, respectively, meeting the criteria for one or two or more sleep disorders.[6] Sleep problems such as respiratory effort-related arousals,[7] insomnia,[8] and self-reported poor sleep quality[9] have been implicated as perpetuating factors in TMD patients who do not respond to treatment.[10] In addition, a recent systematic review reported that there is fair evidence to support an association between TMDs and sleep quality.[11] Also, the OPPERA (Orofacial Pain: Prospective Evaluation and Risk Assessment) study showed that symptoms of obstructive sleep apnea and poor subjective sleep quality could predict the development of first-onset painful TMDs among adults without a history of TMDs.[12]

Persistent painful TMD patients often present with psychosocial distress.[13,14] Systematic reviews have reported prevalence rates of 28.5% to 76.6% and 21.4% to 60.1% for moderate to severe

somatic and depressive symptoms, respectively, as well as higher levels of pain catastrophizing, in TMD pain patients.[15–17] In fact, the assessment of pain catastrophizing is of primary importance because of its predictive value for the development of chronic pain in many conditions, including TMDs.[18] Therefore, it can be hypothesized that there is a relationship between psychosocial factors and poor sleep quality in TMD patients. Although studies have established a possible relationship between psychosocial factors such as anxiety and depression and poor sleep quality, as well as its influence in TMD patients,[19,20] the measurement of affective states and coping skills (eg, pain catastrophizing, hypervigilance) has received relatively little attention in studies of sleep and pain.[2]

These factors may help delineate the mechanisms of the association between sleep and TMDs, as studies have demonstrated that sleep disturbances partially mediate the associations of pain catastrophizing with clinical pain and pain-related interference in a sample of TMD patients.[21,22] Also, studies have reported that chronic pain syndromes such as TMDs diminished social activity,[23] which worsens further when chronic pain conditions appear as comorbidities affecting common daily life. In the same way, some clinical observations have suggested that patients with musculoskeletal pain experience an increase in pain during exercise or even when executing simple daily activities,[13–15] even though the majority of available reports conclude that regular physical activity decreases pain symptoms.[9,10] In addition, it has been suggested that higher and lower prevalence rates of TMD pain are associated with moderate- and low-intensity exercises, respectively.[24] Additionally, the literature has demonstrated that more active people reported better sleep quality compared to those who were less active, concluding that physical activity and sleep are related.[25] Thus, it could be hypothesized that physical and social activity could also affect the relationship between TMDs and sleep. Therefore, the aim of this study was to determine the prevalence of impaired sleep and associated factors in a group of patients with painful TMDs.

Materials and Methods

This observational retrospective cross-sectional study was approved by the Ethics Committee for Research Involving Human Beings of the Bauru School of Dentistry, University of São Paulo, Brazil (Number: 2.223.225/2017). This study was conducted in accordance with the recommendations of the STROBE (Strengthening the Reporting of Observational Studies in Epidemiology) guidelines and the Helsinki Declaration.[26]

Study Sample and Sleep Quality Evaluation

This study was conducted in an outpatient clinic of the Bauru Orofacial Pain Group between January and August 2017. The medical records of 141 patients who were submitted to clinical examination according to the Research Diagnostic Criteria for Temporomandibular Disorders (RDC/TMD) were evaluated.[27] The Diagnostic Criteria for Temporomandibular Disorders (DC/TMD) was not used, since its Portuguese version was unavailable when the present study was performed. A total of 80 patients (64 women with a mean ± SD age of 37.5 ± 14.29 years and 16 men with a mean ± SD age of 37.06 ± 15.60 years) with arthralgia and/or myofascial pain were included. A total of 61 patients with only temporomandibular joint (TMJ) derangement without pain were excluded. The control group consisted of 85 sex- and age-matched healthy volunteers without signs and symptoms of painful or nonpainful TMDs from a previous study by the same research group.[28]

All patients completed the validated Portuguese version of the Pittsburgh Sleep Quality Index (PSQI).[29] The PSQI is a valid and reliable instrument used for measuring sleep quality and disturbances over a 1-month period. The PSQI includes 19 items (scores ranging from 0 to 3) that generate 7 component scores: subjective sleep quality (C1), sleep latency (C2), sleep duration (C3), habitual sleep efficiency (C4), sleep disturbances (C5), use of sleeping medication (C6), and daytime dysfunction (C7). The sum of the scores from the 7 components yields the global PSQI score (ranging from 0 to 21). A higher global score represents worse sleep quality.

Clinical Data

The following clinical data were collected:

- Gender.
- Age.
- Subjective pain: Self-reported facial pain intensity at the time of examination was measured using a 0–10 visual analog scale (VAS), where 0 represented no pain and 10 represented the worst pain imaginable.[30]
- Physical activity: Patients were asked using a nonvalidated question about their level of physical activity (little or none, moderate, or a lot) and were considered positive for physical activity if they reported doing a lot or moderate aerobic exercise. They were considered negative for physical activity if they reported little or no exercise.
- Social activity: Patients were asked using a nonvalidated question about their level of social activity (little or none, moderate, or a lot) and were considered positive for social activity if

they reported high or moderate levels of social or leisure activity. They were considered negative if they reported little or no social activity. Social activity included recreational and leisure activities, hobbies, outings, and family gatherings.

Pain Vigilance and Awareness Questionnaire

The Pain Vigilance and Awareness Questionnaire (PVAQ) is a self-reported questionnaire consisting of 16 items designed to measure attention to pain.[31] The items are rated on a 6-point scale (from 0 = never to 5 = always), and the final score is the sum of all individual items. The psychometric properties of the questionnaire have shown acceptable values for retention (corrected item–total score correlations ranging from 0.36 to 0.76) and reliability (Cronbach's alpha = 0.92).[32]

Pain Catastrophizing Scale

The Pain Catastrophizing Scale (PCS) is a self-administered questionnaire that measures the impact of catastrophic thoughts on past painful experiences.[33] This instrument has 13 items asking about the degree of the patient's described thoughts or feelings related to pain. The items are rated on a 5-point scale ranging from 0 (not at all) to 4 (all the time), and the total score is the sum of all individual items, which can range from 0 to 52.[33] The instrument consists of three subscales: hopelessness (items 8, 9, 10, and 11), magnification (items 6, 7, and 13), and rumination (items 1, 2, 3, 4, 5, and 12).[34] Its psychometric properties have shown acceptable values for factorial validity (robust–comparative fit index = 0.98) and reliability (Cronbach's alpha = 0.95).[35] For statistical analysis, both the PCS total and subscale scores were used.

Data Analysis

Quantitative outcomes (age, pain intensity, and scores from the PSQI, PVAQ, and PCS) are presented as mean and SD values. Categorical variables are described as percentages (sex, TMD diagnoses, and physical and social activity).

Data normality was assessed using Kolmogorov-Smirnov test, and a $\log_{10}$ transformation was performed when the test results were significant, considering an alpha level of 5% ($P < .050$). Spearman correlation adjusted with Bonferroni correction for multiple comparisons was used to analyze the relationships between PSQI, age, pain intensity, and the other psychosocial variables (PVAQ and PCS) in the TMD group.

Component and total scores of PSQI were transformed into T-scores based on reference data.[36] First, patient data were transformed into *z*-scores using the formula: *z*-score = (value for a single patient − mean of controls) / SD of controls. As both *z*-scores and T-scores are standardized scores, *z*-scores can be easily transformed into T-scores by multiplying the *z*-score by 10 (SD of the T-score distribution) and then adding 50 (the mean of the T-score distribution). Therefore, the formula: T-score = 10 (*z*-score) + 50 was applied to each patient's data for each psychosocial parameter. A T-score of 50 indicates an individual value equal to the group mean of healthy controls. T-scores between 40 and 60 were considered to be the normal range (as defined by the mean ± SD). A T-score above 60 was considered to be higher than the healthy reference group. Data from age- and sex-matched healthy controls from a previous paper by the same research group were used as the control group (n = 85).[28] Therefore, the TMD sample was divided into two groups, taking as a cut-off reference the sleep assessment data from previous research[28]: TMD patients with impaired sleep (T-score ≥ 61) and TMD patients with normal sleep (T-score ≤ 60).

To compare data from TMD patients and control individuals, which was used for T-score transformation, *t* test was used. Variables that could be associated with the impaired sleep group according to PSQI total score were explored in a univariate analysis using chi-square test for categorical variables and *t* test for continuous variables. A *P* value of < .05 was considered statistically significant for all analyses. Data were analyzed using Minitab software.

Table 1 Spearman Correlation Between PSQI and Examined Variables in TMD Patient Group

Variable	Correlation	*P*
Age	0.158	.161
Pain intensity	0.418	< .001*
PVAQ	0.258	.021*
PCS total	0.363	.001*
PCS rumination	0.311	.005*
PCS magnification	0.335	.002*
PCS helplessness	0.339	.002*

Results

TMD patients presented a significantly higher ($P < .001$) PSQI score (8.13 ± 4.14) compared to control individuals (5.83 ± 3.05).

Within the TMD sample, patients with impaired sleep presented a significantly higher ($P < .001$) PSQI T-score (11.84 ± 2.43) than patients with normal sleep (4.95 ± 2.18). The univariate analysis showed that pain, social activity, and PCS total and subscale scores were significantly different between groups (Table 1).

Comparison of the PSQI component scores showed significantly higher scores in the C1, C3, C4, C5, and C6 domains, as well as total score (Table 2), in TMD patients.

Table 2 Comparison of Demographic Clinical and Psychologic Variables Between PSQI T Score Groups

Variables		TMDs with impaired sleep (n = 37)	TMDs with normal sleep (n = 43)	*P*
TMD diagnoses, n (%)	Arthralgia	9 (24.32)	15 (34.88)	.507
	Myofascial pain	13 (35.14)	11 (25.58)	
	Arthralgia and myofascial pain	15 (40.54)	17 (39.53)	
Gender, n (%)	Female	31 (83.78)	33 (76.74)	.430
	Male	6 (16.22)	10 (23.26)	
Age, mean (SD)		40 (13.8)	35.2 (14.8)	.065
Pain (0–10), mean (SD)		6.486 (2.7)	4.535 (2.5)	.009*
Physical activity	Positive, n (%)	10 (27.03)	13 (30.23)	.752
	Negative, n (%)	27 (72.97)	30 (69.77)	
Social activity	Positive, n (%)	17 (45.95)	29 (67.44)	.05*
	Negative, n (%)	20 (54.05)	14 (32.56)	
PVAQ, mean (SD)		47.7 (13.9)	43.9 (13.6)	.262
PCS total, mean (SD)		28.9 (14.1)	20.8 (12.2)	.008*
PCS rumination, mean (SD)		12.51 (7.2)	9 (5.9)	.021*
PCS magnification, mean (SD)		6.49 (3.2)	4.56 (3.4)	.012*
PCS helplessness, mean (SD)		9.86 (5.0)	7.26 (4.6)	.019*

Table 3 Mean and Frequency of T Score Above 60 of PSQI Results for Painful TMD Patients Compared to Healthy Controls

	TMD patients (n = 80)		Control individuals (n = 85)		
PSQI parameter	T-score, mean (SD)	Above 60, n (%)	T-score, mean (SD)	Above 60, n (%)	*P*
Total score	57.55 (13.5)	37 (46.2)	50 (10)	19 (22.4)	< .001*
Subjective sleep quality (C1)	56.71 (13.7)	37 (46.2)	50 (10)	19 (22.4)	< .001*
Sleep latency (C2)	51.75 (10.4)	12 (15)	50 (10)	8 (9.4)	.274
Sleep duration (C3)	54.99 (14.9)	24 (30)	50 (10)	10 (11.7)	.014*
Habitual sleep efficiency (C4)	56.57 (18.0)	28 (35)	50 (10)	14 (18.8)	.005*
Sleep disturbances (C5)	54.88 (13.5)	34 (42.5)	50 (10)	17 (20)	.010*
Use of sleeping medication (C6)	57.43 (12.3)	36 (45)	50 (10)	15 (17.6)	< .001*
Daytime dysfunction (C7)	50.627 (7.9)	7 (8.8)	50 (10)	0	.656

Spearman correlation showed a low to moderate but significant correlation ($P < .02$) between PSQI and pain intensity, PVAQ, and PCS (Table 3) in the TMD group.

Discussion

Adequately characterizing the painful TMD population with poor sleep by assessing affective states and coping skills could provide new evidence to consolidate the associations between these variables, which will certainly influence the clinical decision-making process. This retrospective study revealed the factors associated with poor sleep quality in painful TMD patients. The null hypothesis was rejected, and the main findings were: TMD patients presented a significantly higher PSQI score than control patients; a significant correlation was found between self-reported poor sleep quality and pain intensity, hypervigilance, and catastrophizing in the TMD group; TMD patients with impaired sleep had significantly higher scores for pain, PCS total and subscale scores, and less social activity; and TMD patients with impaired sleep had a higher PSQI total score, as well as higher scores for almost all subscale components. These findings suggest that TMD patients with poor sleep could benefit from treatments targeting affective states and coping skills to improve subjective sleep quality.

The significantly higher PSQI total score found in TMD patients is in accordance with the findings of other studies[5,9,37,38] that also reported a higher percentage of poor sleepers in TMD groups. The present study found a correlation between PSQI and self-reported pain intensity. Other chronic pain studies have reported this correlation and suggested that sleep disturbances are prevalent in chronic pain patients, although they are not always associated with mood disturbances.[39] Additional studies have reported that factors other than pain may contribute to subjective poor sleep,[40] since they did not find a relationship between poor sleep and pain.[39,41] Therefore, a more complex patient characterization is needed to understand the relationship between PSQI and pain in the TMD field.

Recent data have shown that the increase in self-reported sleep problems in women with TMDs is due more to depressive symptoms than pain intensity.[40] TMD patients with poor sleep report more symptoms of anxiety and distress,[5,37] suggesting that sleep, pain, and negative mood are associated, but a definition of the temporal dynamics among these factors is lacking. On the other hand, relatively little attention has been paid to the measurement of affective states and coping skills within studies of sleep and pain.[2]

The present research also explored other psychologic factors that could influence the self-reported sleep quality–pain relationship in TMD patients, such as pain catastrophizing and hypervigilance. A significant positive correlation between self-reported sleep quality and pain catastrophizing was found in the TMD group, and significantly higher PCS total and subscale scores were found among TMD patients with impaired sleep. These findings are partially in accordance with the results of Buenaver et al,[42] who found that ruminative catastrophizing thoughts were associated with poorer self-reported sleep quality and increased self-reported pain. Additionally, in the present study, an association was also found between magnification and helplessness. One possible explanation for this association is that people who strongly catastrophize pain generally have poorer sleep quality because they cannot suppress intrusive pain-related thoughts before bed.[43] It is important to highlight that Buenaver et al[42] and the present study are the only ones reporting the mediating role of pain catastrophizing in poor sleep and self-reported pain intensity in TMD pain individuals. On the other hand, Vitiello et al[44] suggested that sleep disturbances affect pain by lowering pain thresholds and amplifying the transmission of pain signals, which results in increased attention to pain and more negative pain-focused emotions and cognitions resulting in a positive feedback-loop pattern for the relationships between poor sleep, increased pain, and negative pain-focused feelings and thoughts.[44]

Likewise, a correlation between PSQI and PVAQ in the TMD group was found in the present study. To the present authors' knowledge, this is the first study to report such a correlation in a population with painful TMD and poor sleep. Pain patients are known to show significantly higher somatic awareness and/or hypervigilance; ie, sensations related to their own bodies.[45,46] From a physiologic point of view, hypervigilance to pain may result in the strengthening of facilitatory connections between the anterior cingulate cortex and the periaqueductal gray matter, contributing to the maintenance and/or exacerbation of pain and also to a decrease in pain modulation, thereby also contributing to the phenomenon of central sensitization.[47] Therefore, it is reasonable to hypothesize that pain hypervigilance could at least act as a mediator of the relationship between poor sleep and pain. However, further studies are needed to elucidate this issue.

The present study also found that TMD patients with impaired sleep had significantly lower social activity, which could indicate that this factor is a possible influence on poor sleep quality in socioemotional functioning. Notwithstanding, it is important to mention that the present study used a nonvalidated question to assess the levels of social activity. A recent systematic review concluded that sleep loss and insomnia affect emotional reactivity and socioemotional functioning in several ways, although the overall results are somewhat contradictory.[48] Given that sleep affects socioemotional functioning and is associated with the psychopathology of TMD onset,[2] understanding how socioemotional functioning and task performance are related to sleep is an important aspect for future research. On the other hand, even though some reports have concluded that regular physical activity ameliorates pain symptoms in chronic pain disorders,[49–51] the present study did not find an association between physical activity with painful TMDs and subsequent sleep quality. The use of a nonvalidated question to assess physical activity in the present study and the small sample size could have influenced this result. In addition, the lack of assessment of the intensity of the exercises practiced in the studied population could also explain this lack of association, since the literature has pointed out that the intensity of exercises influences the prevalence of TMD pain.[24]

TMD patients with impaired sleep had significantly higher scores for almost all of the PSQI components (C1, C3, C4, C5, C6), as well as a higher total score. It is quite interesting that, although TMD patients with impaired sleep showed higher consumption of sleep medications, the quality, duration, efficiency, and disturbance of sleep were worse in this group of patients. However, the present study did not evaluate the specific drugs taken by these patients. For example, chronic use of benzodiazepines is known to affect sleep behavior by inhibiting the rapid eye movement (REM) and non-REM phases of sleep, which could contribute to the exacerbation of pain.[52]

It is important to translate these results to clinical practice. The results of the present study support some therapies for poor sleep, catastrophization, and hypervigilance:

- Sleep disturbances: use of cognitive behavioral therapies such as sleep hygiene education, relaxation training, and education about sleep regulation, stimulus control instructions, and sleep restriction therapy[53]
- Catastrophization: use of cognitive behavioral interventions such as thought monitoring and cognitive restructuring, waitlist control, and activity-based interventions[54]

- Hypervigilance: meditation and breathing techniques[55]

The retrospective design, small sample size, and absence of clinically objective measurements in this study can all be considered limitations. Additionally, no data about other concomitant sleep disorders (eg, insomnia, sleep apnea), use of medications, or painful comorbidities were collected, which certainly could have influenced these results. Also, the fact that the questions used to assess physical and social activity were not validated must be considered, as this may have affected the results as well. It is recommended that future studies with prospective assessments of pain (including painful comorbidities), sleep (including concomitant sleep disorders and medications), and psychologic variables may provide stronger evidence and better knowledge of the relationship between sleep and pain in TMD patients.

Conclusions

Considering the limitations of this study, it can be concluded that TMD patients with impaired sleep present higher levels of pain intensity, less social activity, more catastrophizing thoughts, and more hypervigilance. These factors could be associated with poor sleep quality in this population.

Clinical Implications

Assessing affective states and coping skills in clinical practice could provide a better picture of the painful TMD population with poor sleep quality and certainly help in the clinical decision-making process.

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ORCID IDs: Poluha: https://orcid.org/0000-0001-7180-6448; Canales: https://orcid.org/0000-0002-0921-342X; Ferreira: https://orcid.org/0000-0001-5166-8519; Stuginski-Barbosa: https://orcid.org/0000-0002-7805-5672; Conti: https://orcid.org/0000-0003-0413-4658

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