Subjective Sleep Quality in Temporomandibular Disorder Patients and Association with Disease Characteristics and Oral Health–Related Quality of Life

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Aims: To measure sleep quality in temporomandibular disorder (TMD) patients, to compare it with that of control subjects, and to analyze its association with disease characteristics and oral health–related quality of life (OHRQoL). **Methods:** The collected data included demographics, tobacco use, the Pittsburgh Sleep Quality Index (PSQI), trauma history, presence of coexisting headaches and/or body pain, parafunctional habits, pain scores, muscle tenderness to palpation scores, and the Oral Health Impact Profile-14 (OHIP-14). Differences between groups were examined with Pearson chi-square test for categorical variables and independent *t* test and analysis of variance (ANOVA) for numeric variables. Significant differences were then further tested with multivariate backward stepwise linear regression analysis. **Results:** The final analysis was performed on 286 individuals (187 TMD patients and 99 controls). Poor sleep (PSQI global score > 5) was exhibited in 43.3% of the TMD group and in 28.3% of the control group ($P = .013$) (mean ± standard deviation [SD] PSQI score = 5.53 ± 2.85 for TMD patients and 4.41 ± 2.64 for controls, $P = .001$). TMD patients had significantly worse scores in the sleep quality component of the PSQI questionnaire ($P = .006$). Higher PSQI global scores and poor sleep were positively associated with whiplash history ($P = .009$ and $P = .004$, respectively), coexisting headaches ($P = .005$ and $P = .002$), body pain ($P = .001$ and $P < .001$), clenching habit ($P = .016$ and $P = .006$), reduced unassisted ($P = .014$ and $P = .042$) and assisted ($P = .005$ and $P = .006$) mouth opening, higher muscle tenderness scores, higher pain scores, and higher OHIP-14 global and dimension scores. **Conclusion:** TMD patients had poorer sleep than controls. Sleep quality was positively associated with TMD disease characteristics, comorbid pain conditions, and poorer OHRQoL. Assessing sleep quality should be a routine part of the diagnostic work-up of TMD patients. A multidisciplinary management approach is needed to address all the factors—including sleep—that modulate pain experience. *J Oral Facial Pain Headache 2017;31:313–322. doi: 10.11607/ofph.1824*

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A bidirectional relationship between pain and impaired sleep is suggested in the literature, supported by the reciprocal relationship between craniofacial pain and sleep.[1] Temporomandibular disorders (TMD), a group of disorders that affect the temporomandibular joint (TMJ), the masticatory muscles, or both, is the most common chronic orofacial pain condition,[2] affecting 5% to 12% of the population with an estimated annual cost of $4 billion.[3] TMD may negatively impact daily activities, social behavior, psychological status, and quality of life (QoL).[4,5] The public health implications of this population are clear, and exploration of sleep quality in these patients is fundamental, as sleep quality influences overall well-being.

While evidence of sleep disruption in TMD patients has been published,[6–13] many parameters that could affect sleep quality have not been investigated due to the complexity of both TMD and sleep. Surprisingly, although headaches are a common complaint in TMD patients, few studies assessing patients with TMD have compared TMD patients with and without headache,[14–17] particularly in the context of

sleep.[16] Moreover, despite the fact that many studies have confirmed that TMD has a significant impact on oral health–related quality of life (OHRQoL),[5,18] to the best of the authors' knowledge, studies are lacking that have assessed whether OHRQoL can identify differences in sleep quality (and vice versa) or that have examined the influence of muscle tenderness scores on sleep quality in the context of TMD. The muscle tenderness score is commonly used in headache practice for the assessment of pericranial muscle tenderness and adds valuable information other than the number of involved muscles.[19–25]

Furthermore, it is important to include an age- and gender-matched control group in order to include individuals with subclinical or mild TMD and to perform clinical examinations and questionnaires in both groups. However, the control group also had poor sleep in some studies,[26] and others did not include a control group at all.[8,9,27]

Therefore, the aim of the present study was to measure and compare sleep quality in TMD patients with that of control subjects and to analyze its association with disease characteristics and OHRQoL. The hypothesis was that poor sleep is associated with TMD disease characteristics, comorbid pain conditions, and poor OHRQoL. Specifically, the present study assessed the impact on sleep quality of certain types of TMD, demographics, tobacco use, pain scores, dysfunction, history of trauma, parafunctional habits, muscle tenderness to palpation scores, coexisting body pain, headaches, and OHRQoL. To minimize confounders such as aging and illnesses,[28] young individuals without comorbid mental, psychiatric, or physical disabilities were examined, which enhanced the ability to assess the effects of other demographic and clinical parameters on sleep. Therefore, the study was limited to patients who had developed TMD in early adulthood.

Materials and Methods

Study Groups

This study was part of a series of studies focusing on the demographic, clinical, and behavioral characteristics of patients with TMD.[5] A total of 200 consecutive patients who had a primary complaint of TMD and were referred to the TMD Department at the Oral and Maxillofacial Center, Tel-Hashomer Medical Center, Israel between May 1, 2011 and January 31, 2013 were enrolled in the study. This department is a secondary prosthodontics referral center that manages treatment of TMD patients referred by dentists and physicians from primary clinics throughout the country.

The control subjects were 100 age- and gender-matched, consecutive, TMD-free individuals presenting for a regular dental check-up at the same center.

Appropriate sample size was calculated by using WINPEPI software, and, based on the authors' experience of analyzing PSQI scores among patients with dental anxiety, the calculation determined that a sample size of at least 255 participants (170 in one group and 85 in the second group) distributed into two groups in a 2:1 ratio was needed to provide 90% statistical power to identify a 1.3-point difference in Pittsburgh Sleep Quality Index (PSQI) score ($\alpha = .05$) with an estimated standard deviation of 3.0.[29]

The study conformed to Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines and met the requirements of the Institutional Review Board. All patients signed an informed consent form and received free and unconditional treatment.

Inclusion Criteria

Inclusion criteria were 18 to 30 years of age and attending for new patient screenings. Exclusion criteria were mental, psychiatric, or physical disabilities; a comorbid malignancy or serious medical history; medical and/or dental emergencies; pregnancy or lactation; presence or history of alcohol or drug abuse; and current use of medication with effects on the central nervous system (eg, narcotics, antidepressants, anticonvulsants, and/or muscle relaxants), including medications with effects on sleep (eg, sleeping tablets, benzodiazepines, etc).

Data Collection

Questionnaires and clinical examinations were used. The questionnaires included questions about demographics and tobacco use, history of trauma, presence of coexisting headaches (migraine and tension-type headache [TTH]), presence of pain in other body sites, parafunctional habits (eg, clenching, cheek, and nail bite habits), and sleep quality and OHRQoL, which were measured by using the PSQI and Oral Health Impact Profile-14 (OHIP-14), respectively.

Questionnaires were given on a standard questionnaire form during a one-on-one consultation prior to treatment. The solitary interview took place between 9:00 am and 3:00 pm to reduce the potential effects of time of day.[30]

The clinical examination was performed in both TMD patients and control subjects, and all examinations were conducted by one of two senior authors (A. Zakuto, H.S.). Prior to the beginning of the study, a training and calibration session was performed for the examiners to ensure mutual agreement and correct interpretation of the measurements used in the study. All diagnoses were confirmed in the clinic and

then re-examined following data tabulation and summary by both senior authors (R.B., Y.S.).

TMD patients were diagnosed according to Axis I of the Research Diagnostic Criteria for Temporomandibular Disorders (RDC/TMD),[31] which was the most accepted diagnostic instrument at the time the study was performed. Redistribution of the study population was performed before statistical analysis of the data[5] according to Axis I of the Diagnostic Criteria for TMD (DC/TMD).[4]

TMD patients were divided into three diagnostic categories according to DC/TMD Axis I[4]:

- Masticatory muscle disorders (MMD): diagnosis of myalgia (ie, local myalgia, myofascial pain, or myofascial pain with referral)[3] only
- Isolated TMJ disorders (TMJ): DC/TMD diagnoses of arthralgia and the following joint disorders: disc displacement with reduction, disc displacement with reduction with intermittent locking, disc displacement without reduction with limited opening, and disc displacement without reduction without limited opening.[3]
- TMP: Both MMD and TMJ disorders

The tenderness to palpation of the masticatory (masseter, temporalis) and cervical (suboccipital group [as one], sternocleidomastoid, and trapezius) muscles was examined. Bilateral examination was always performed in the same order. Muscle palpation was performed with about 2 to 3 pounds of palpation pressure (previous examiner calibration).[4] Tenderness to palpation was graded on an ordinal scale where 0 = no pain; 1 = mild; 2 = moderate; and 3 = severe.[3] A masticatory muscle tenderness score (MTS) and a cervical muscle tenderness score (CTS) were calculated individually and combined to give the total muscle tenderness score (TTS) for each patient.

Pittsburgh Sleep Quality Index

The study included the validated Hebrew version of the PSQI to assess sleep quality.[32] The PSQI[33] has been found to be reliable, valid, and time effective for measuring sleep dysfunction in patients with TMD and/or orofacial pain.[12,27] Exploration of the dimensionality and psychometric properties of the PSQI in TMD has demonstrated that sleep quality in TMD patients is a unidimensional construct and can therefore be represented by one summary score.[27] A global PSQI score > 5 indicates poor sleep, with high sensitivity (98.7) and specificity (84.4).[34]

Pain Evaluation

Patients were asked to approximate the duration and frequency of pain episodes. Pain severity was assessed on a 0 to 10 verbal pain scale (VPS), where 0 represented no pain and 10 represented the strongest pain possible.

Oral Health Impact Profile-14

The validated Hebrew version of the OHIP-14[35] was employed to assess OHRQoL.[36] The OHIP-14 includes 14 questions, and summing the response scores for each pair of corresponding questions generates 7 conceptual dimensions of the OHRQoL. For each OHIP-14 question, subjects were asked how frequently they had experienced the impact in the last 6 months. OHRQoL impairment was characterized by the OHIP-14 global score, with a range of 0 (no adverse impacts within the last 6 months) to 56 (all 14 impacts experienced very often within the last 6 months).

Statistical Analyses

The data were analyzed by using SPSS software version 21.0. Two-tailed level of statistical significance (α) was set at .05. Continuous variables are presented as means and standard deviations (SD), and categorical variables are presented as frequencies and percentages. Differences between groups were examined by using chi-square test for categorical variables and independent *t* test and analysis of variance (ANOVA) for numeric variables. Chi-square test for categorical parameters and independent *t* test for numeric variables were also used to test for significance between poor sleep and the independent variables. For significance tests between PSQI global score and the independent variables, ANOVA was used for categorical parameters and Pearson correlation and *t* test for numeric variables. Based on the univariate results, significant parameters were selected for multivariate backward stepwise linear regression analysis. Pearson correlation was used to assess the correlation between PSQI global score and OHIP-14 dimensions, as well as between the OHIP-14 global score and PSQI components.

Results

General Description

The final analysis was performed on 286 individuals (187 TMD patients and 99 controls). Incomplete records from 13 patients in the TMD group and 1 patient in the control group resulted in their exclusion from the final analysis.

Table 1 presents age, gender, tobacco use, and VPS scores of TMD patients compared to controls. TMP was the most frequent diagnosis (n = 103; 54.78%), followed by TMJ (n = 47; 25%) and MMD (n = 38; 20.21%). The demographic data were similar for all types of TMD (*P* > .05). TMD patients exhibited higher VPS scores compared to control subjects, but no differences were found between the TMD patients and controls for age, gender, or tobacco use.

Table 1 Demographic Characteristics, Tobacco Use, and Verbal Pain Scale (VPS) Scores of TMD Patients Compared to Controls

	TMD group			Control group			
Parameter	n (%)	Mean	SD	n (%)	Mean	SD	*P* value
Gender							
Male	77 (41.0)			52 (52.5)			.061[a]
Female	111 (59.0)			47 (47.5)			
Tobacco use							
Yes	49 (26.2)			16 (16.2)			.054[a]
No	138 (73.8)			83 (83.8)			
Age		21.21	4.01		20.81	1.49	.34[b]
VPS		3.06	2.53		0.51	1.74	< .001[b]

SD = standard deviation. [a]Chi square test. [b]Independent *t* test.

Table 2 Pittsburgh Sleep Quality Index (PSQI) Component Scores Among the Study Groups

PSQI Component	TMD group (mean score ± SD)	Control group (mean score ± SD)	*P* value[a]
Sleep duration	0.83 ± 0.97	0.74 ± 0.82	.424
Sleep disturbances	1.09 ± 0.58	0.98 ± 0.51	.113
Sleep latency	1.10 ± 1.03	0.92 ± 0.88	.149
Daytime dysfunction	0.81 ± 0.97	0.90 ± 0.87	.468
Habitual sleep efficiency	0.22 ± 0.59	0.20 ± 0.51	.763
Sleep quality	0.98 ± 0.77	0.72 ± 0.71	.006
Sleeping medication	0.06 ± 0.36	0.12 ± 0.71	.371
Global PSQI score	5.53 ± 2.85	4.41 ± 2.64	.001

[a]Analysis of variance.

Pittsburgh Sleep Quality Index

TMD patients exhibited higher mean PSQI global and higher scores in the PSQI sleep quality component compared to controls (Table 2). There were no significant differences in the mean PSQI global and component scores between the TMD subgroups ($P > .05$).

Poor sleep and PSQI global scores were examined in relation to demographics, tobacco use, and clinical parameters among the whole study population (Tables 3 and 4). No significant associations were found with age ($P = .999$ and $P = .442$, respectively), gender ($P = .206$ and $P = .154$), or tobacco use ($P = .690$ and $P = .322$). Poor sleep and higher mean PSQI global scores were positively associated with whiplash history ($P = .004$ and $P = .009$, respectively), coexisting migraine compared to TTH or no headache ($P = .002$ and $P = .005$), presence of body pains ($P \leq .001$ and $P = .001$), clenching habit ($P = .006$ and $P = .016$), pain on lateral movement ($P = .007$ and $P = .003$), reduced unassisted ($P = .042$ and $P = .014$) and assisted ($P = .006$ and $P = .005$) mouth opening, higher VPS scores ($P = .001$ and $P < .001$), and higher MTS ($P = .001$) in all areas analyzed (Tables 3 and 4).

Clinical parameters that had a statistically significant positive association only with poor sleep were presence of tooth wear and cheek-biting habit (Table 3).

Clinical parameters that had a statistically positive association only with the PSQI global score were presence of TMJ sounds, deviation in lateral movement, and frequency and duration of pain (Table 4).

Table 5 presents a multivariate backward stepwise linear regression analysis of all parameters reaching statistical significance with both mean global PSQI score and poor sleep in the univariate analysis. The mean global PSQI score retained a significant positive association with the VPS and with TTS, and VPS and body pain maintained their significant association with poor sleep.

Association Between OHIP-14 and PSQI in TMD Patients

There were no statistically significant differences between the TMD subgroups for demographics, tobacco use, or PSQI global or component scores. Since all these parameters matched in the TMD group, the correlation of OHIP-14 scores with the PSQI scores was assessed only in the TMD group. Tables 6 to 9 present the associations between PSQI global and component scores and OHIP-14 global and dimension scores among TMD patients.

PSQI global scores were positively associated with each OHIP-14 domain (Table 6). The physical pain, social disability, and handicap dimensions of the OHIP-14 retained a significant association with the PSQI global scores after backward regression (Table 7).

OHIP-14 global score as the dependent variable (Tables 8 and 9) was positively associated with sleep disturbances, sleep latency, daytime dysfunction, and sleep quality PSQI components, as well as with the PSQI global score (Table 8). The sleep disturbances, sleep latency, and daytime dysfunction PSQI components retained a significant association with the OHIP-14 global scores after backward regression analysis (Table 9).

Figure 1 summarizes the main findings of the present study.

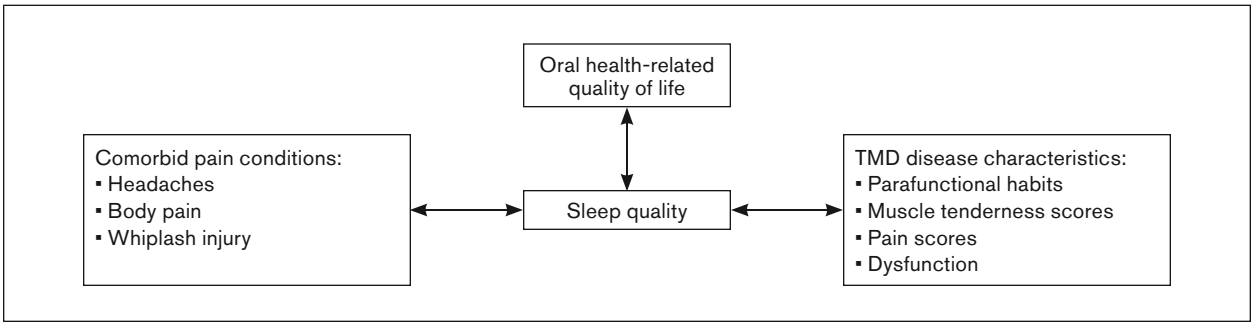

Fig 1 Factors associated with subjective sleep quality in temporomandibular disorder (TMD) patients.

Table 3 Comparison Between Good (PSQI ≤ 5; n = 177) and Poor (PSQI > 5; n = 109) Sleep Based on Clinical Parameters Among the Study Population (n = 286)

	Good sleep		Poor sleep		
Parameter	n (%)	Mean ± SD	n (%)	Mean ± SD	*P* value
Study group					
TMD	106 (56.7)		81 (43.3)		.013[a]
Control	71 (71.7)		28 (28.3)		
History of whiplash injury					
Yes	0 (0)		5 (100)		.004[a]
No	177 (63.0)		104 (37.0)		
Presence of coexisting headache					
Migraine	8 (30.8)		18 (69.2)		.002[a]
TTH	7 (53.8)		6 (46.2)		
No	162 (65.6)		85 (34.4)		
Presence of pain in other body sites					
Yes	69 (50.7)		67 (49.3)		< .001[a]
No	108 (72.5)		41 (27.5)		
Presence of tooth wear in clinical examination					
Yes	59 (54.6)		49 (45.4)		.049[a]
No	118 (66.3)		60 (33.7)		
Clenching habit					
Yes	54 (51.4)		51 (48.6)		.006[a]
No	123 (68.0)		58 (32.0)		
Cheek bite habit					
Yes	49 (53.3)		43 (46.7)		.039[a]
No	128 (66.0)		66 (34.0)		
Pain in lateral movement					
Yes	52 (29.4)		49 (45.0)		.007[a]
No	125 (70.6)		60 (55.0)		
Unassisted mouth opening		48.5 ± 8.5		46.3 ± 9.9	.042[b]
Assisted mouth opening		50.5 ± 8.0		47.5 ± 10.1	.006[b]
VPS		1.6 ± 2.3		3.1 ± 2.7	.001[b]
MTS		1.2 ± 1.7		2.3 ± 2.3	.001[b]
CTS		0.4 ± 1.3		1.2 ± 2.2	< .001[b]
TTS		1.6 ± 2.6		3.5 ± 3.9	< .001[b]
No. of tender muscles		1.9 ± 2.6		3.6 ± 3.2	< .001[b]

TTH = tension-type headache; VPS = verbal pain score; MTS = masticatory muscle tenderness score; CTS = cervical muscle tenderness score; TTS = total tenderness score. [a]Chi square test. [b]Independent *t* test.

Discussion

To the best of the authors' knowledge, this is the first study in the English literature to measure sleep quality in young patients with TMD and compare it to control subjects, adjusting for many important confounding factors (ie, demographics, tobacco use, pain scores, dysfunction, history of trauma, coexisting body pain

Table 4 Associations and Correlations of Clinical Parameters with Mean PSQI Global Scores Among the Study Population (n = 286)

	PSQI global score			
Parameters	n	Mean ± SD	*R*	*P* value
History of whiplash injury				
Yes	5	8.40 ± 1.81		.009[a]
No	281	5.09 ± 2.81		
Presence of coexisting headache				
Migraine	26	6.85 ± 3.02		.005[a]
TTH	13	5.31 ± 2.46		
None	247	4.96 ± 2.77		
Presence of pain in other body sites				
Yes	149	5.67 ± 2.75		.001[a]
No	136	4.61 ± 2.72		
Presence of TMJ sounds (according to the patient)				
Yes	147	5.54 ± 2.85		.016[a]
No	139	4.73 ± 2.74		
Clenching habit				
Yes	105	5.68 ± 2.50		.016[a]
No	181	4.84 ± 2.96		
Pain in lateral movement				
Yes	101	5.82 ± 2.90		.003[a]
No	185	4.78 ± 2.72		
Deviation in lateral movement				
Yes	199	5.44 ± 2.81		.007[a]
No	87	4.47 ± 2.74		
Age			−0.046[b]	.442
Unassisted mouth opening			−0.146[b]	.014
Assisted mouth opening			−0.166[b]	.005
Current VPS			0.300[b]	< .001
Frequency of pain			0.244[b]	< .001
Duration of pain			0.197[b]	.001
Masseter (right + left)			0.287[b]	< .001
Temporalis (right + left)			0.217[b]	< .001
MTS			0.305[b]	< .001
CTS			0.291[b]	< .001
TTS			0.344[b]	< .001
No. of tender muscles			0.319[b]	< .001

TMJ = temporomandibular joint; VPS = verbal pain scale; MTS = masticatory muscle tenderness score; CTS = cervical muscle tenderness score; TTS = total tenderness score.
[a]Analysis of variance. [b]Pearson correlation.

Table 5 Multivariate Linear Regression Analysis of Factors Influencing PSQI Global Score and Poor Sleep (PSQI > 5) Among the Study Population

Parameter	B (95% CI)	SE	*P* value
Factors influencing PSQI global score			
Constant	4.01–6.32	.586	< .001
Current VPS	0.049–0.335	.072	.009
TTS	0.049–0.203	.039	.001
Factors influencing poor sleep			
Constant	.219	.234	< .001
Current VPS	1.147 (1.021–1.290)	.060	.021
Presence of pain in other body sites	1.712 (1.004–2.921)	.273	.048

CI = confidence interval; SE = standard error; VPS = verbal pain scores; TTS = total tenderness score.

and headaches, parafunctional habits, muscle tenderness to palpation scores, and OHRQoL). The findings of the present study indicate that TMD patients had poorer sleep than controls. Consistent with the study hypothesis, poor sleep was associated with TMD disease characteristics, comorbid pain conditions, and poorer OHRQoL. This may reflect alterations of systems beyond the masticatory tissues in line with the biopsychosocial model of illness, blending biologic, social, and psychological centrally mediated factors.[37]

Differences in Global PSQI Scores Between TMD Patients and Control Subjects

The proportion of individuals with poor sleep in the control group (28.3%) is similar to reports that sleep difficulties are experienced by about one-third of the general population.[38] The proportion of TMD patients with poor sleep (43.3%) is in line with the rate reported among adolescents[13] and adults[6] with TMD (38.3% and 50%, respectively), but lower than those in other studies involving older TMD patients (between 78% and 83.3%).[9,10,39] The PSQI scores of TMD patients (5.53 ± 2.85) are similar to those reported for adolescent TMD patients (5.91 ± 2.59).[13] Differences may be due to inclusion of young individuals without mental, psychiatric, or physical disabilities or due to the use of different measures, such as community samples vs tertiary care samples, different sample sizes, and lack of uniform diagnostic standards.

Differences in PSQI Components Between TMD and Control Patients

In line with the present findings—that the sleep quality PSQI component had the strongest relationship with TMD compared to controls—a systematic literature review found that poor sleep quality and excessive daytime sleepiness were the most frequent complaints of TMD patients.[12]

Differences in Global PSQI Scores Between TMD Subgroups

There were no statistically significant differences in PSQI global or component scores between TMD subgroups. Other studies have reported that myofascial pain patients had poorer sleep than patients with TMJ pain and controls.[8,40,41] It is difficult to compare the results of this study with these studies, as they did not include cases of combined myofascial pain and TMJ pain. The rationale of ignoring combined cases is unclear, especially considering that combined cases affect about half of TMD patients[42] and are therefore more representative of the clinical scenario.

The Associations of Demographics and Tobacco Use with PSQI Global Scores

Interestingly, neither demographics nor tobacco use had a significant association with PSQI global score. Since the TMD group matched the control group in these parameters, the differences between these groups in PSQI scores cannot be attributed to these parameters.

Previous studies have demonstrated that smokers with TMD reported significantly more sleep disturbances than nonsmokers.[43] However, additional data are needed due to the limited number of tobacco users in this sample. Additionally, tobacco users were not categorized according to the frequency and/or duration of tobacco use.

Associations of Clinical Parameters with PSQI Global Scores

Whiplash Injury

A positive association between whiplash history and worse PSQI scores was found in this study. This finding coincides with the finding that, among whiplash patients, a high prevalence of sleep problems was identified in the initial (76%) and late phase of whiplash injury (85%), which is similar to other chronic pain patients who had suffered different bodily trauma.[44] However, due to the very few whiplash patients in the study (five), additional data are needed.

Table 6 Pearson Correlation of PSQI Global Score and OHIP-14 Dimensions Among TMD Patients (n = 187)

	PSQI global score	
OHIP-14 domain	*R*	*P* value
Functional limitation (1 + 2)	0.152	.035
Physical pain (3 + 4)	0.231	.001
Psychological discomfort (5 + 6)	0.225	.002
Physical disability (7 + 8)	0.236	.001
Psychological disability (9 + 10)	0.223	.002
Social disability (11 + 12)	0.270	< .001
Handicap (13 + 14)	0.287	< .001
OHIP-14 global score	0.379	< .001

Table 7 Backward Regression of PSQI Global Scores and OHIP-14 Dimensions Among TMD Patients (n = 187)

					95% confidence interval for β	
Parameter	B	SE	β	*P* value	Lower bound	Upper bound
(Constant)	3.22	0.48		< .001	2.28	4.18
Physical pain (OHIP 3 + 4)	0.19	0.07	0.19	.005	0.06	0.32
Social disability (OHIP 11 + 12)	0.26	0.10	0.19	.015	0.05	0.46
Handicap (OHIP 13 + 14)	0.25	0.11	0.17	.029	0.03	0.47

Table 8 Pearson Correlation of OHIP-14 Global Score and PSQI Components Among TMD Patients (n = 187)

	OHIP-14 global score	
PSQI	*R*	*P* value
Sleep duration	0.088	.233
Sleep disturbances	0.329	< .001
Sleep latency	0.256	< .001
Daytime dysfunction	0.284	< .001
Habitual sleep efficiency	0.067	.362
Sleep quality	0.237	.001
Sleeping medication	0.006	.931
Global PSQI score	0.379	< .001

Table 9 Backward Regression Analysis of OHIP-14 Global Scores and PSQI Components Among TMD Patients (n = 187)

					95% confidence interval	
Parameter	B	SE	β	*P* value	Lower bound	Upper bound
(Constant)	5.11	1.37		< .001	2.40	7.82
Sleep disturbances	2.83	1.11	0.190	.012	0.62	5.04
Sleep latency	1.64	0.58	0.200	.006	0.49	2.80
Daytime dysfunction	1.83	0.55	0.23	.001	0.74	2.92

Pain

The observation that TMD patients with pain had worse PSQI scores was evident in several findings, such as pain severity, frequency, and duration; pain in function; coexisting body pain and headaches; and the physical pain domain of the OHIP-14. Of those, the most sensitive tool was the VPS, which retained its significant association with PSQI global scores in the multivariate analysis. These findings are consistent with substantial evidence showing that chronic pain patients exhibit poorer sleep than controls.[1] Pain may lead to sleep difficulties that in turn exacerbate pain, thus creating a vicious cycle.[45] Poor sleep quality was predicted by higher pain severity in TMD patients,[9] and vice versa, sleep disturbance was a predictor of TMD pain.[8,10]

Coexisting Headache

The finding that TMD patients with coexisting headaches—in particular, migraine—exhibited worse sleep scores was expected. Sleep disturbances and headaches are closely related. This is especially true for primary headaches, such as migraine and TTH.[46]

Coexisting Body Pain

The observation that TMD patients with coexisting body pain exhibited worse PSQI scores is in line with findings that predictors of first-onset TMD are presence of headache and low back pain conditions reported at baseline.[15] TMD share many features with other chronic pain conditions (such as headaches and back pain) that are characterized by neuroendocrine abnormalities, frequent biopsychosocial distress, and complaints that include sleep disturbances.[12]

Parafunctional Habits

Clenching, cheek biting habits, and tooth wear were associated with worse PSQI scores. This combination of parafunctions may reflect underlying central dysregulation.[47] Indeed, greater prevalence of sleep bruxism has been reported among TMD patients compared to controls,[48] and first-onset TMD incidence has also been reported to be associated with oral parafunctions.[47] It should be noted, however, that self-reported habits are not a particularly valid measure of parafunctional habits.

Muscle Tenderness Scores

Patients with higher muscle tenderness scores exhibited poorer sleep. These findings are congruent with the findings that predictors for TMD incidence included not only body muscle pain, but also pain on palpation of masticatory and neck muscles.[49] However, it is unclear whether poor sleep is the cause of higher sensitivity to palpation, higher muscle tenderness is a cause for impaired sleep, or both.

Oral Health–Related Quality of Life

PSQI and OHIP-14 scores were reciprocally related. Indeed, one of the OHIP-14 dimensions is psychological disability, a dimension that contains disturbed sleep as one of its criteria.[36] Sleep disturbances are known to impair QoL in chronic pain patients.[12]

The large study population (286 patients), together with the uniform protocol using the standardized, validated, internationally accepted PSQI and OHIP-14 questionnaires, VPS scores, and the DC/TMD criteria, are among the strengths of the present study.

Limitations of this study include the case-control study design, which cannot address a causal direction of effects and suggests only associations/correlations between the variables. There is also the possibility of selection bias in the convenience sample; however, patients were referred from multiple clinics serving different populations. Only the influence of physical conditions (ie, Axis 1) was assessed, and the influences of somatization and depression (ie, Axis 2) were not evaluated. However, the correlation between these conditions and OHRQoL is well known, implying that OHRQoL may be able to capture some of the impact of these conditions in a single measure.[18] Indeed, two of the OHIP-14 dimensions are psychological discomfort (5 and 6) and psychological disability (9 and 10), which were positively related with the PSQI score in the present study.

The present study did not use polysomnography and instead used self-assessment measures of sleep due to feasibility and convenience, especially because of the large sample size. However, polysomnography is an objective measure of biophysiologic sleep parameters, while sleep quality is usually assessed using self-report instruments, since subjective sleep complaints often do not match the objective measurements, particularly for pain patients.[11] Moreover, the PSQI measures sleep quality over a 1-month period, while polysomnography produces a one-time measurement.

Conclusions

TMD patients suffered more from impaired sleep than control subjects, and poor sleep was associated with multiple comorbid symptoms. Assessing sleep quality should be a routine part of the diagnostic work-up of TMD patients. A multidisciplinary management approach is needed to address all the factors in addition to sleep that modulate pain experience.

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