



# Quantitative and Qualitative Gradient of Pain Experience, Sleep Quality and Psychological Distress in Patients with Different Phenotypes of Temporomandibular Disorders

Hee Hun Choi<sup>1</sup>, Hye-Kyoung Kim<sup>2</sup>, Mee-Eun Kim<sup>2</sup>

<sup>1</sup>Ipyeonhan Dental Clinic, Suwon, Korea

<sup>2</sup>Department of Oral Medicine, Collage of Dentistry, Dankook University, Cheonan, Korea

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**Purpose:** Temporomandibular disorders (TMD) is a mosaic of clinical signs and symptoms that can be regarded as a set of phenotypes that are affected by various factors including pain sensitivity, pain disability, sleep and psychological functioning. The aims of this study were to evaluate association of pain experience, sleep quality and psychological distress with different phenotypes of TMD patients.

**Methods:** This retrospective study included a cohort (n=1,858; 63.8% for female, mean age=34.9±15.9 years) of patients with TMD. A set of self-administered questionnaires concerning pain interference (Brief Pain Inventory), pain disability (Graded Chronic Pain Scale), sleep quality (Pittsburg Sleep Questionnaire Index), psychological distress (Symptom Checklist-90 revised), and pain catastrophizing (Pain Catastrophizing Scale) were administered to all participants at the first consultation. All TMD patients were classified into four groups including TMD with internal derangement without pain (TMD\_ID, n=370), TMD with joint pain (TMD\_J, n=571), TMD with muscle pain (TMD\_M, n=541) and TMD with muscle-joint combined pain (TMD\_MJ, n=376).

**Results:** The female ratio was particularly high in the group with TMD\_MJ (p=0.001). The patients with muscle pain and both muscle and joint pain had longer symptom duration (p=0.004) and presented significantly higher scores in pain experience (p<0.001), subjective sleep quality (p<0.001), pain catastrophizing (p<0.001) and psychological distress (p<0.05) except for paranoid-ideation than the groups with only joint problems.

**Conclusions:** The results of this study highlight the importance of multi-dimensional approach that consider pain disability, sleep quality, and psychological functioning in the management of TMD with muscle component. This study would contribute to a better understanding of interaction between heterogeneous TMD and multiple risk factors in order to build tailored treatment based on different phenotypes.

**Key Words:** Catastrophization; Pain; Phenotype; Psychological distress; Sleep; Temporomandibular disorder

## Correspondence to:

Mee-Eun Kim  
Department of Oral Medicine, Collage of Dentistry, Dankook University, 119 Dandae-ro, Dongnam-gu, Cheonan 31116, Korea  
Tel: +82-41-550-1915  
Fax: +82-505-434-7951  
E-mail: meunkim@dankook.ac.kr  
<https://orcid.org/0000-0001-9332-532X>

## INTRODUCTION

Pain is an unpleasant sensory and emotional experience. Unlike protective aspect of acute pain, persistent pain interferes with daily life and may cause psychological distress

such as anxiety and fear. Most orofacial pain commonly encountered by dentists originates from the teeth and the cause and treatment of toothache are usually clear, so that there is no great difficulty in diagnosis and treatment [1,2]. However, temporomandibular disorders (TMD), known as

the most common non-dental origin of orofacial pain and the second most common musculoskeletal condition [3-5], presents complex and multidimensional etiology and heterogeneous nature in its symptoms [5,6]. This is mainly caused by characteristics of TMD which embraces various painful and non-painful of clinical conditions that involve the masticatory musculature, the temporomandibular joint (TMJ) and associated structures and often results in some difficulties for diagnosis and management of TMD [7].

There are a variety of factors associated with development and persistence of TMD including age, sex, occlusion, trauma, parafunctional habits, orthodontic treatment and etc [5,8-10]. Besides to these systemic and local factors, psychological factors such as anxiety, depression, somatization and catastrophizing have been recently emphasized [11-19]. A relation of sleep and TMD has been also studied [10,14,20-23]. In recent studies, these factors that influence TMD have been analyzed in accordance with TMD subgroups such as muscle disorder and joint disorders [4,18,19]. As in the case with other parts of the body, factors such as pain experience, sleep, and psychological distress are known to affect muscle pain rather than joint pain in TMD [15,24,25].

TMD is a mosaic of clinical signs and symptoms that can be regarded as a set of phenotypes that are affected by various factors including pain sensitivity, pain disability, sleep and psychological functioning. Understanding of different phenotypes of TMD is an essential prerequisite of successful management. However, comparative studies on effects of influential factors between TMD subgroups were scarce in a large sample. The aims of this study were to evaluate association of pain experience, sleep quality and psychological distress with different phenotypes of TMD patients.

## MATERIALS AND METHODS

### 1. Subjects

The included subjects in this study were a total of 1,858 TMD patients (1,186 females, 672 males; mean age=34.9±15.9 years; range 10-95 years) who visited first at the Orofacial Pain Clinic of Dankook University Dental Hospital (Cheonan, Korea) over a period of two years from 2016 to 2017 for the management of TMD. All participants were asked to complete the questionnaires before the diagnosis, and filled them out in the waiting room. The questionnaires included Brief Pain Inventory (BPI); Graded Chronic Pain Scale (GCPS), Pain Catastrophizing Scale (PCS); Symptom Checklist-90-Revision (SCL-90R); Pittsburgh Sleep Quality Index (PSQI).

Exclusion criteria were as follows: (1) Patients who refused to fill out questionnaires or refused to use their survey data for research purposes, (2) Patients who did not fully complete the questionnaire, (3) Patients who couldn't be given a definite diagnosis about their orofacial pain, (4) Patients diagnosed with mental illness by medical history, (5) Patients who are on chemotherapy or have a history of cancer diagnosis, and (6) Patients diagnosed with other neuro-pathic or central diseases such as stroke, Parkinson disease and etc.

All patients were assessed by experienced orofacial pain specialists who were trained in accordance with the Diagnostic Criteria for Temporomandibular Disorders (DC/TMD) [3]. Then, all the TMD patients were classified into four groups as follow (Fig. 1) (1) group 1: TMD with internal derangement without pain (TMD\_ID, n=370), (2) group 2: TMD with joint pain (TMD\_J, n=571), (3) group 3: TMD with muscle pain (TMD\_M, n=541) and (4) group 4: TMD with muscle-joint combined pain (TMD\_MJ, n=376).

The study plan was reviewed and approved by Institutional

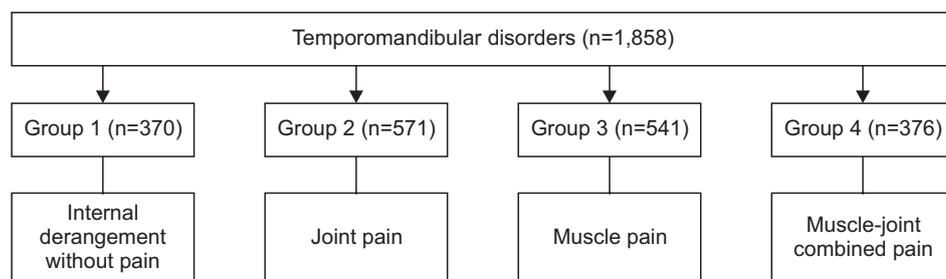


Fig. 1. Flow chart of included patients.

Review Board (IRB) committee of Dankook University Dental Hospital (IRB no. 2018-03-003) and informed consent was obtained from all the subjects.

## 2. Self-Reported Questionnaires

### 1) Brief Pain Inventory

The BPI is a short, simple questionnaire and one of the most widely used measurement tools for assessing clinical pain [26,27]. It was presented with 0-10 scales to assess the pain severity and pain interference. The BPI pain severity is composed the four pain items: 'worst', 'least', 'average' and 'now'. The BPI pain interference includes seven items to measure how much pain has interfered with daily activities, walking, work, mood, enjoyment of life, relations with others, and sleep. The Korean version of BPI was used, and the item related to walking ability was replaced by the question of 'chewing ability' related to orofacial pain [14]. Responses were based on the week before the completion of the BPI.

### 2) Graded Chronic Pain Scale

The GCPS assesses the severity of chronic pain and pain disability and consists of seven questions that reflect pain intensity, disability days (loss of work days) due to pain, and interference in daily activities [28]. The pain intensity is calculated as the average of the pain at the time of the interview, the average pain, and the worst pain for the last 6 months (0-100 score). The number of disability days also refers to the days with pain during the past 6 months. GCPS are graded as a 0-IV score, and the meaning of each grade is as follows: (1) 0, no pain, (2) I, low intensity-low disability, (3) II, high intensity-low disability, (4) III, high disability-moderately limiting, (5) IV, high disability-severely limiting. Subjects with Grade I and II are classified as low disability group and are considered psychosocially functional with minimal interference or disability associated with their daily living, while subjects with Grade III and IV are classified as high disability group and are considered psychosocially dysfunctional with greater impact on activities of daily living.

### 3) Pain Catastrophizing Scale

The PCS developed by Sullivan et al. [29,30] in 1995 is

used, and the items relate to the frequency of thoughts and feelings experienced when participants are in pain. It contains 13 items on a 5-point scale with the end points (0) not at all and (4) all the time. The PCS yields a total score and three subscale scores assessing rumination, magnification and helplessness.

### 4) Symptom Checklist-90-Revision

SCL-90R has been used to evaluate the respondent's level of psychological well-being using 90 items [31]. This 90-items has a Likert-type scale with 5 point scale (not at all, 0; extremely, 4) for how much each problem had distressed or bothered them during the past 7 days. It evaluates nine symptom dimensions: somatization, obsessive-compulsive, interpersonal sensitivity, depression, anxiety, hostility, phobic anxiety, paranoid ideation, and psychoticism.

### 5) Pittsburgh Sleep Quality Index

The PSQI contains 19 self-rated questions which assess a wide variety of factors relating to sleep quality [32]. These 19 items are grouped into seven component scores, which consisted on a scale of 0-3. The seven components are subjective sleep quality, sleep latency, sleep duration, habitual sleep efficiency, sleep disturbances, use of sleeping medications, and daytime dysfunction. These seven component scores were summed to yield a global PSQI score, which ranged from 0 to 21; higher scores indicate worse sleep quality.

## 3. Statistical Analysis

One-way ANOVA with Tukey post-hoc analysis was used to analyze the possible influence of sex, pain duration, BPI pain severity and interference, sleep quality, catastrophizing and psychological distress on 4 different phenotypes of TMD. Difference in levels of GCPS disability among 4 TMD groups was compared by Pearson's chi-square test. The significance level for all analyses was set at 0.05. All analyses were done in the PASW Statistics for Windows, Version 18.0 (SPSS Inc., Chicago, IL, USA).

## RESULTS

### 1. Demographic Characteristics of four TMD groups

A total of 1,858 subjects were included in this study. The demographic data of four groups was shown in the Table 1. The number of patients corresponding to was the highest in the group 2 (n=571), and higher in the order of group 3 (n=541), group 4 (n=376) and group 1 (n=370). The female ratio was the highest in the group 4 (73.4%) (p=0.001), and

there was no sex difference between the other groups. The mean age of group 4 (38.5 years old) was the highest, followed by that of group 2 (36.4 years old), 3 (35.3 years old), and group 1 (28.3 years old) showed the lowest mean age (p<0.001).

### 2. Pain Experience and Sleep Quality of Four TMD Groups

Pain experience and sleep quality of four different TMD groups was analyzed in the Table 2. Group 1 showed the

**Table 1.** Demographic data of patients with temporomandibular disorders classified into four groups

Demographics	Group 1	Group 2	Group 3	Group 4
Patients	370 (19.9)	571 (30.7)	541 (29.1)	376 (20.2)
Female (%)	62.3	61.5	62.7	73.4
Pearson chi-square ( $\chi^2$ )		5.612 (p=0.001)		
Age (y)	28.3±12.2	36.4±17.0	35.3±14.9	38.5±16.6
One-way ANOVA (F-value)		30.858 (p<0.001)		

Values are presented as number (%) or mean±standard deviation.

Total number of included patients=1,858. Group 1, 2, 3, and 4 indicate internal derangement without pain, joint pain, muscle pain and muscle-joint combined pain, respectively.

A p-values were determined by Pearson chi-square for sex and One-way ANOVA for age. Results of Tukey post-hoc analysis: Sex: Group 1, 2, 3 <Group 4. Age: Group 1 <Group 2, 3 <Group 4.

**Table 2.** Clinical data and sleep quality of patients with temporomandibular disorders classified into four groups

Clinical data and PSQI score	Group 1	Group 2	Group 3	Group 4	F-value	p-value
Symptom duration	23.3±38.6	14.3±32.5	18.4±39.4	18.9±38.9	4.488	0.004
Pain severity	1.6±2.0	3.4±2.3	3.6±2.4	4.0±2.1	84.284	<0.001
Pain interference	1.8±2.0	3.1±2.5	3.6±2.5	4.3±2.7	73.065	<0.001
PSQI score	7.4±2.8	8.1±3.3	8.4±3.4	9.1±3.7	17.974	<0.001

PSQI, Pittsburgh Sleep Quality Index.

Values are presented as mean±standard deviation.

Group 1, 2, 3, and 4 indicate internal derangement without pain, joint pain, muscle pain and muscle-joint combined pain, respectively.

A p-values were determined by One-way ANOVA. Results of Tukey post-hoc analysis: Symptom duration: Group 2 <Group 3, 4 <Group 1. Pain severity: Group 1 <Group 2, 3 <Group 4. Pain interference: Group 1 <Group 2 <Group 3 <Group 4. PSQI score: Group 1 <Group 2, 3 <Group 4.

**Table 3.** Comparison of pain disability between four groups with temporomandibular disorder

GCPS grade	Group 1	Group 2	Group 3	Group 4	$\chi^2$	p-value
Low disability					155.2	<0.001
Grade I	289 (78.1)	268 (46.9)	240 (44.3)	154 (40.9)		
Grade II	31 (8.3)	136 (23.8)	99 (18.2)	73 (19.4)		
Total	320 (86.4)	404 (70.7)	339 (62.5)	227 (60.3)		
High disability						
Grade III	32 (8.6)	123 (21.5)	131 (24.2)	95 (25.2)		
Grade IV	18 (4.9)	44 (7.7)	71 (13.1)	54 (14.3)		
Total	50 (13.5)	167 (29.2)	202 (37.3)	149 (39.5)		

GCPS, Graded Chronic Pain Scale.

Values are presented as number (%).

Group 1, 2, 3, and 4 indicate internal derangement without pain, joint pain, muscle pain and muscle-joint combined pain, respectively. Low disability indicates the sum of Grade I and II and the sum score of Grade III and IV represents the high disability.

A p-value was determined by Pearson chi-square test.

longest symptom duration (28.3 months), and followed by group 3 (18.4 months) and 4 (18.9 months), and group 2 had the shortest duration of symptom (14.3 months) ( $p=0.004$ ). Among the four groups, group 4 presented the highest scores of PSQI score as well as pain severity and pain interference while the least scores for group 1 ( $p<0.001$ ). Unlike pain severity and PSQI score, pain interference was higher in the group 3 than in the group 2. Table 3 showed pain disability of four TMD groups. The percentage of high disability group (Grade III and IV) was higher in the order of group 4 (39.5%), group 3 (37.3%), group 2 (29.2%) and group 1 (19.6%) and the percentage of low disability group (Grade I and II) was higher in the opposite order (Table 3,  $p<0.001$ ).

### 3. Psychological Distress of Four TMD Groups

Psychological distress including pain catastrophizing scale and SCL-90R was compared in four TMD groups (Table 4). All three dimensions of pain catastrophizing including magnification, rumination and helplessness were the highest in group 4, and followed by group 2 and group 3. Group 1 showed the least pain catastrophizing score ( $p<0.001$ ). Among the nine subcategories of SCL-90R, all dimensions except paranoid ideation showed group difference.

Somatization scores of group 3 and group 4 was higher than those of group 1 and group 2. Depression was higher in the order of group 3, group 4, group 2 and group 1. Group 3 exhibited the highest score in the obsessive-compulsive, phobic-anxiety, anxiety, interpersonal sensitivity, psychoticism and hostility.

## DISCUSSION

This study investigated the various factors that could affect or be the result of TMD. TMD were classified into 4 subgroups which can be largely divided into muscle pain and joint pain/disorder. Among them, the patients with muscle pain and both muscle and joint pain presented significantly higher scores in pain experience, sleep quality and psychological distress than the groups with only joint problems. The outcomes of this study with large cohort clearly support the concept that masticatory muscle pain is clinically distinct from internal derangement and painful TMJ disorders.

### 1. Demographic Characteristics of Four TMD Groups

The demographic data of TMD patients showed that in all TMD groups (TMD with internal derangement without pain,

**Table 4.** Pain catastrophizing and psychological distress of patients with temporomandibular disorder classified into four groups

Catastrophizing and psychological distress	Group 1	Group 2	Group 3	Group 4	F-value	p-value
PCS						
Magnification	2.8±2.6	3.5±2.8	4.0±3.0	4.4±3.1	20.776	<0.001
Rumination	3.1±3.9	4.4±4.3	5.1±6.4	5.6±4.7	18.084	<0.001
Helplessness	4.0±3.7	5.8±5.0	6.5±5.0	7.3±6.2	30.738	<0.001
SCL-90R						
Somatization	44.4±7.1	45.6±8.4	48.0±8.9	48.0±9.1	19.081	<0.001
Obsessive-compulsive	40.9±8.5	42.2±9.4	43.6±10.1	42.8±9.9	6.223	<0.001
Interpersonal sensitivity	40.9±8.1	41.8±8.3	43.9±15.1	42.7±9.4	6.404	<0.001
Depression	40.6±7.7	41.6±8.7	43.5±10.2	42.8±9.8	8.684	<0.001
Anxiety	41.9±7.0	43.2±15.0	45.1±23.7	43.8±9.1	3.061	0.027
Hostility	43.3±6.7	44.0±7.8	45.1±7.9	44.9±8.2	5.185	0.001
Phobic-anxiety	43.8±6.7	44.2±7.7	45.4±8.8	44.9±8.6	3.365	0.018
Paranoid ideation	41.9±16.7	41.7±7.2	42.8±8.1	43.2±17.2	1.617	0.183
Psychoticism	41.5±5.6	42.4±6.8	43.8±8.2	42.6±7.4	8.020	<0.001

PCS, pain catastrophizing scale; SCL-90R, Symptom Check List-90Revised.

Values are presented as mean±standard deviation.

Group 1, 2, 3, and 4 indicate internal derangement without pain, joint pain, muscle pain and muscle-joint combined pain, respectively. A p-values were determined by One-way ANOVA. Results of Tukey post-hoc analysis: Magnification/Rumination/Helplessness: Group 1<Group 2, 3<Group 4. Somatization: Group 1, 2<Group 3, 4. Obsessive-compulsive; Phobic-anxiety; Anxiety: Group 1<Group 2, 4<Group 3. Interpersonal sensitivity; Psychoticism: Group 1, 2<Group 4<Group 3. Depression: Group 1<Group 2<Group 4<Group 3. Hostility: Group 1<Group 2<Group 3, 4.

joint pain, muscle pain, muscle-joint combined pain), 60%-70% of the subjects were female. This strong female preponderance in TMD population is consistent with the findings of previous studies [11,12,33]. Although there is still no clear consensus for this sex difference, it can be inferred that this strong female representation is affected by behavioral, psychosocial, hormonal and constitutional differences [9]. The effects of the hormone estrogen, as potential contributing factor on the etiology of TMD were most extensively studied in the previous literature [8,34,35]. Among the groups, the proportion of female in muscle-joint combined pain group was significantly higher than that in the other groups (Table 1,  $p=0.001$ ). This might be attributable to the fact that female tend to present more multiple pain sites than male in chronic pain [36,37].

The mean age of the muscle-joint combined pain group (38.5 years old) was the highest, followed by the mean age of the joint pain group (36.4 years old), the muscle pain group (35.3 years old) and the group of internal derangement without pain (28.3 years old) showed the lowest mean age ( $p<0.001$ ). From the previous review on TMJ disorders, internal derangement tends to occur before pain-related TMD [38]. Manfredini et al. [39] reported that when TMD patients were divided into patients with internal derangement (with or without muscle and/or arthralgia) and those with arthritis/arthrosis, there was a significant difference in the mean age of these patients. In addition, Guarda-Nardini et al. [40] suggested that there is a change in the pattern of clinical diagnosis according to the age. They reported that the number of patients with internal derangement decreased with age and the number of patients with arthrosis/arthritis increased with age [40]. Although categorization of TMD subgroup in both studies are not consistent with that of the current study, their results were comparable with the finding of this study that the mean ages of joint pain and muscle-joint combined pain group were higher than that of internal derangement patients.

## 2. Pain Experience and Sleep Quality of Four TMD Groups

Symptom duration was longer in TMD with internal derangement without pain than the other TMD groups with pain (joint pain, muscle pain, muscle-joint combined pain) (Table 2,  $p=0.004$ ). This may be partly explained by the fact

that internal derangement patients without pain tend not to visit a hospital because it does not greatly affect the quality of life compared to painful conditions. In addition, muscle pain and muscle-joint combined pain group had significantly longer symptom duration than joint pain group. This result indicates that masticatory muscle pain lasts longer than TMJ pain. Huang et al. [24] reported that the presence of muscle pain (with or without arthralgia) was significantly associated with various risk factors (i.e. clenching, female sex, somatization etc.) but no significant associations were found in the arthralgia-only group. Therefore, multiple risk factors of muscle pain might contribute to the persistence of pain if these factors are not adequately managed.

Group with muscle-joint combined pain showed the highest pain severity and interference, followed by muscle pain group. Not surprisingly, group without pain presented the least pain severity and interference (Table 2,  $p<0.001$ ). This finding is consistent with a previous study comparing pain severity and pain-related interference by subdividing TMD into muscle problem, joint problem, and muscle-joint combined problem [19]. The presence of multiple pain sites can be interpreted as an increase and/or spreading of pain. Previous studies reported that the more pain areas, the greater the pain intensity [37,41]. Also, it is not surprising to infer that the more pain at multiple areas, the greater the pain interference in daily jaw function.

Like pain severity and interference, the PSQI score was the highest in the muscle-joint combined pain group among the four groups, while it was the lowest in the group of internal derangement without pain. Up to 77% of orofacial pain patients report poor sleep quality including reduced quantity and quality of sleep [22]. There are several studies that involve psychological distress such as depression and anxiety and clinical pain experience including pain intensity and pain chronicity in the interaction process of sleep and pain [22,42,43]. Particularly, it is reported that anxiety and depression are closely related to sleep quality [22,43]. Although the effect of pain intensity on sleep is currently controversial, pain perception alone may directly disrupt sleep [22]. Therefore, poor sleep quality, increased pain and psychological distress can affect each other and this vicious cycle might aggravate pain experience of TMD patients. Based on this fact, it can be inferred that the PSQI score of

the group of internal derangement without pain is low because the pain intensity and psychological distress are the lowest. In this context, sleep quality should be mainly considered in the management of muscle-joint combined pain group for successful treatment.

On the other hand, pain disability, limitation of the ability to work within normal range due to pain, is associated with important risk factors for pain including depression, somatization, pain duration and widespread pain [44]. In Dworkin's study [45], patients were classified according to their grade of pain disability, regardless of physical diagnosis in order to confirm the importance of pain disability evaluation in the treatment of TMD. In this study, the prognosis of conservative treatment in patients with TMD depends on the disability level rather than physical diagnosis. In the current study, low pain disability (Grade I and II) was observed mainly in group 1 (internal derangement without pain) and group 2 (joint pain) while high disability (Grade III and IV) was mainly found in TMD with muscle pain and TMD with muscle-joint combined pain (Table 3,  $p < 0.001$ ). These findings are consistent with the previous studies that TMD patients with joint disorder and joint pain show lower disability compared with TMD patients with muscle pain [44,46]. Therefore, assessment of pain disability level is considered to be an indispensable component in the treatment of TMD patients with muscle pain.

### 3. Psychological Distress of Four TMD Groups

In chronic pain patients, pain catastrophizing, as a precursor of pain problems rather than a consequence, has been reported to play an important role in the chronic pain experience, contribute to pain intensity, pain-related disability and psychological distress [47]. In this study, pain catastrophizing was the highest in the patients with muscle-joint combined pain who also presented the highest pain severity and interference (Table 4,  $p < 0.001$ ). Therefore, it can be interpreted that there is a close relationship between pain catastrophizing and pain severity and interference. Park et al. [18] suggested that pain catastrophizing of TMD patients had a positive correlation with pain severity and pain interference which is consistent with the findings of this study.

Recent studies divided TMD into two groups of muscle pain and joint pain to assess their association with

psychological distress [24,48-51]. However, they focused on the particular dimension including somatization, depression and anxiety [24,48-51]. In addition, a study of 96 TMD patients reported that the mean scores of the SCL-90R were higher in the group with muscle pain than in the group with joint pain but failed to reach statistically significant difference [51]. This statistical result might be attributable to the small sample size of the study. The current study has the strength that all dimensions of psychological distress using the SCL-90R were investigated in a large sample of 1,858 TMD patients. According to this study, psychological distress (Somatization, Obsessive-Compulsive, Interpersonal sensitivity, Depression, Anxiety, Hostility, Phobic-anxiety, Paranoid ideation, Psychoticism) was generally lower in TMD with internal derangement without pain and higher in TMD with muscle pain, and all of the dimensions except the paranoid ideation were statistically significant ( $p < 0.05$ ). This study highly suggests that psychological distress is a prominent risk factor for TMD patients with muscle component.

In conclusion, in this cross-sectional study, quantitative and qualitative gradient of pain experience, sleep quality and psychological distress in patients with different phenotypes of temporomandibular disorders was clearly seen. Among TMD patients, patients with internal derangement without pain showed the least pain profile. In painful TMD, muscle pain rather than joint pain was significantly associated with pain experience, sleep quality, and psychological distress. The more pain sites, the higher pain experience and psychological distress, the lower the sleep quality.

The results of this study highlight the importance of multi-dimensional approach that consider pain disability, sleep quality, and psychological functioning in the management of TMD with muscle component. This study would contribute to a better understanding of interaction between heterogeneous TMD and multiple risk factors in order to build tailored treatment based on different phenotypes.

### CONFLICT OF INTEREST

No potential conflict of interest relevant to this article was reported.

## ORCID

Hee Hun Choi

<https://orcid.org/0000-0002-8224-8231>

Hye-Kyoung Kim

<https://orcid.org/0000-0002-0734-5533>

Mee-Eun Kim

<https://orcid.org/0000-0001-9332-532X>

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