Biopsychosocial Factors Associated with the Subcategories of Acute Temporomandibular Joint Disorders

Angela Liegey Dougall, PhD
Assistant Professor
Department of Psychology
The University of Texas at Arlington
Arlington, Texas

Carmen A. Jimenez, MS
Research Assistant
Department of Psychology
The University of Texas at Arlington
Arlington, Texas

Robbie A. Haggard, MS
Project Coordinator
Department of Psychology
The University of Texas at Arlington
Arlington, Texas

Anna W. Stowell, PhD
Adjunct Faculty
Department of Psychology
The University of Texas at Arlington
Arlington, Texas

Richard R. Riggs, DDS
Private practice
Richardson, Texas

Robert J. Gatchel, PhD, ABPP
Distinguished Professor and Chairman
Department of Psychology
The University of Texas at Arlington
Arlington, Texas

Correspondence to:
Dr Robert J. Gatchel
Department of Psychology
College of Science
The University of Texas at Arlington
501 South Nedderman Drive
PO Box 19528
Arlington, TX 76019
Fax: (817) 272-2364
Email: gatchel@uta.edu

Aims: *To assess the biopsychosocial factors associated with acute temporomandibular disorders (TMD) based on the Research Diagnostic Criteria for Temporomandibular Disorders (RDC/TMD).* ***Methods:*** *Participants were assessed in community-based dental clinics and evaluated by trained clinicians using physical and psychosocial measures. A total of 207 subjects were evaluated. Patients' high-risk versus low-risk status for potentially developing chronic TMD was also determined. Analyses of variance and chi-square analyses were applied to these data.* ***Results:*** *Participants' characteristic pain intensity differed among RDC/TMD Axis I diagnoses. They also significantly varied in their self-reported graded chronic pain, depression, somatization (pain inclusive), somatization (pain excluded), and physical well-being. In addition, participants with differing RDC/TMD Axis I diagnoses varied in self-reported pain during their chewing performance. Finally, there were also significant differences in chewing performance between high-risk versus low-risk (for developing chronic TMD) patients.* ***Conclusion:*** *Participants with multiple diagnoses reported higher pain, as well as other symptoms, relative to participants without a TMD diagnosis. For chewing performance, participants with mutual diagnoses reported more pain compared to other participants. Finally, the risk-status of patients significantly affected chewing performance.*
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Temporomandibular disorders, commonly referred to as TMD, is a collection of disorders characterized by orofacial pain, chewing dysfunction, or a combination of the two.[1] Common symptoms include pain, headache, joint discomfort or dysfunction, earaches, ringing in the ear, dizziness, pain in the upper and lower back, or neck aches.[2–5] Patients may also experience clicking, popping, or grating noises when opening or closing the mouth.[2,3] Pain may also be accompanied by dental changes, such as tooth wear and excessive overbite.[4] Hoffmann and colleagues[5] have noted many other associated clinical comorbidities associated with TMD. The severity of TMD symptoms can range from noticeable, but otherwise insignificant problems to seriously debilitating pain and dysfunction.[1] Moreover, TMD ranks as one of the highest commonly

occurring musculoskeletal conditions resulting in pain and disability, second only to chronic low back pain. In the United States alone, the prevalence of TMD is estimated to be between 5% to 15%.[1] The US National Institute of Dental and Craniofacial Research[6] estimated that TMD cost an average of $4 billion annually.[6]

Presently, a dual-axis system developed by Dworkin and LeResche is accepted as the best and most widely used classification scheme for TMD.[7] It is referred to as the Research Diagnostic Criteria for Temporomandibular Disorders (RDC/TMD), and was developed in order to define the subtypes of TMD and to standardize the diagnosis of them. The RDC/TMD are comprised of two parts: the history questionnaire and self-report measures completed by the patient and a physical examination conducted by a trained clinician. The RDC/TMD have two particular strengths: clinical researchers have the capability to accurately diagnose TMD in a standardized format, and the RDC/TMD reflect a comprehensive conceptualization of the disorders.[8] It should also be noted that a new revised version of the RDC/TMD is being considered, based on the RDC/TMD Validation Project as reviewed previously in this journal.[9]

Axis I of the RDC/TMD assesses the clinical characteristics of TMD by means of palpation and physical measures of oral and facial tasks.[8] Diagnoses are split into three categories: masticatory muscle disorders, disc displacements, or other degenerative joint conditions. Group I (muscle pain disorder or MPD) includes two subgroups, which are defined based on jaw-opening limitations. Disc displacements (DD) constitute Group II of the clinical conditions, and include three subcategories, which are also defined based on the restrictions of the mandible opening. Group III includes degenerative joint diseases (DJD), namely arthralgia, arthritis, and arthrosis. The RDC/TMD diagnoses within the three groups are not mutually exclusive, allowing a patient to be diagnosed with anywhere from zero up to five diagnoses (one muscle diagnosis, one disc displacement, and one diagnosis from Group III for each joint). Axis II provides a reliable, valid assessment of psychosocial factors, including pain intensity, pain-related disability, depression, and nonspecific physical symptoms (ie, somatization[8,10]). It blends three reliable clinical questionnaires in order to assess for these psychosocial factors. Finally, a brief jaw disability checklist is incorporated to assess the amount of interference TMD have on patients as it relates to mandibular function, such as talking or chewing. Thus, the RDC/TMD represent a system that provides several pieces of reliable information, including demographics, patient characteristics, Axis I diagnoses, and an Axis II profile. With this array of variables, it is not surprising that the treatment of TMD varies greatly. The most common forms of treatment include biopsychosocial interventions, self-care interventions, physical therapy, pharmacologic therapies, and surgery, albeit not necessarily in this order.[1,5,11]

Patients with chronic MPD (Group I on the RDC/TMD) report higher pain levels, as well as more distress, relative to patients with arthritic conditions.[12] Kino et al[13] also found that chronic TMD patients with a diagnosis of MPD reported higher disability scores in activities of daily living compared to other diagnostic categories. The current body of literature, though, has not extensively investigated biopsychosocial factors of RDC/TMD Axis I diagnoses in acute TMD patients. However, Epker et al[14] were able to predict accurately whether an acute patient was at "high risk" for developing chronic TMD by combining two variables: measurements of self-reported pain and the presence of myofascial pain. A series of studies have further demonstrated the predictive validity of this high risk-low risk dichotomy in acute TMD patients.[15–20] Thus, MPD patients could have a more dysfunctional biopsychosocial profile compared to patients with either DD or DJD.

The purpose of the present study was to assess the biopsychosocial factors associated with acute TMD based on the RDC/TMD. This is the first study of its type examining this acute TMD population. While most of the literature on TMD has focused on chronic facial pain, fewer studies have focused specifically on the area of acute jaw pain. Relatedly, a second goal was to further evaluate the construct validity of the "high-risk versus low-risk" model for the development of chronic TMD.

Materials and Methods

Participants

A consecutive cohort of 207 first-time diagnosed acute TMD patients, who met criteria for the study, were recruited and evaluated in community-based dental clinics in the Dallas/Fort Worth metroplex. These participants completed a preintervention biopsychosocial evaluation and were eligible for treatment. They were considered eligible for participation if they were over 18 years of age and had acute TMD pain or discomfort for 6 months or less at the time of their entry into the study. Potential participants with a comorbid pain-exacerbating physical condition (such as other musculoskeletal

pain conditions or cancer) or a history of jaw pain before the most recent episode were excluded from the current study. Collaborating dentists and clinical research associates at each clinical site determined patients' eligibility for this study. High-risk subjects (those at risk for progressing to chronic TMD) were identified at intake by using an algorithm developed in previous studies to predict risk score.[14,21] Participants were evaluated between September 2008 and August 2010. As can be seen in Table 1, the majority of the sample was female, Caucasian, and married, and had graduated from college. This demographic composition was representative of the dental clinics in the Dallas–Fort Worth metropolitan area that treat TMD patients. The study was specifically conducted in community clinics in order to ensure the generalization of results to the general population. Indeed, these demographic characteristics were similar to a large-scale study reported by Hoffmann and colleagues,[5] thus strengthening the external validity of the results found in the present study.

Table 1 Demographic Variables for Preintervention Participants

Variables	(n = 207)
Age (y): mean (SD)	43.36 (15.73)
Range (y)	18–80
Gender (%)	
Male	46 (22.2)
Female	161 (77.8)
Race (%)	
Caucasian	142 (68.6)
Latino(a)	24 (11.6)
African American	25 (12.1)
Asian	6 (2.9)
Other	10 (4.8)
Marital status (%)	
Single	77 (37.2)
Married	100 (48.3)
Divorced or separated	24 (11.6)
Widowed	1 (0.5)
Missing data	5 (2.4)
Years of education (%)	
8–15 y	88 (42.5)
16 y	80 (38.6)
≥ 17 y	39 (18.8)
Risk status (%)	
Low risk	95 (45.9)
High risk	112 (54.1)

Procedure

The participants in this study were primarily recruited and referred to the study by collaborating dental practices in the Dallas–Fort Worth area. After the collaborating dentist or clinical research associate determined a participant's eligibility, the potential participant was given a packet consisting of a consent form, HIPAA (Health Insurance Portability and Accountability Act) privacy form, patient information form, and payment voucher ($20). Participants were then scheduled for a series of preintervention biopsychosocial (BPS) evaluations. The BPS evaluations were preferably completed within 1 week. The evaluations included both physical measures and psychosocial measures. Trained clinicians administered the RDC/TMD, including the components of the "at-risk" screening algorithm. These evaluators were initially trained on the RDC/TMD administration by an experienced oral surgeon. Interrater reliability for correct completion of the TMD examination form was conducted on nonsubject volunteers prior to the beginning of the study. Quality control of evaluators was then maintained by reevaluating randomly selected cases throughout the project, as well as recalibrating evaluations. The initial guidelines delineated by Dworkin et al[22] were followed. This produced close to 100% reliability. The screening algorithm consisted of: question 3 from the RDC/TMD history questionnaire; the Characteristic Pain Intensity (CPI); and the evaluation of oral and facial pain, as assessed by muscle palpation on items 1, 8, and 10 of the Oral Facial Examination. The trained clinician also administered the Functional Evaluation of Chewing Performance, another physical measure. The psychosocial measures included in this study were as follows: Graded Chronic Pain Scale (GCPS); CPI; Perceived Stress Scale; Beck Depression Inventory-II (BDI-II); Health Care Utilization, which collects information about types of care received, both related and unrelated to jaw pain; Medication Use Information; Medical Outcomes Shortform-36 Health Status Questionnaire (SF-36); Symptom Checklist; Headache Questionnaire; Orthodontic History Questionnaire; and Treatment Cost Data. It should also be noted that clinical research associates were all educated at the Masters level and licensed in their respective disciplines (ie, social work, counseling).

Measures

RDC/TMD. As reviewed earlier, the RDC/TMD are comprised of two axes. Axis I is a physical measure

that outlines the clinical characteristics of TMD, separating them into three categories: MPD, DD, and DJD. Axis II assesses psychosocial factors commonly seen in patients with TMD.

CPI. The CPI is a self-report measure derived from the RDC/TMD History Questionnaire and appraises current pain, average pain, and worst pain in the jaw. The patient's score ranges from 0 to 100, with 100 being the most pain. The mean score of questions 7 through 9 are taken and then multiplied by 10.

GCPS. The GCPS is a measure derived from Axis II of the RDC/TMD and assesses pain intensity, interferences with usual activities, family and leisure activities, work-related activities, and disability days due to pain. A disability score gives researchers the extent to which TMD pain interferes with daily activities for a participant and the number of activity days that were lost due to pain. This score ranges from 0 to 100. The GCPS uses simple scoring rules to categorize pain severity into four hierarchical groups. Grade I is TMD pain of low intensity with little pain-related impediment. Grade II is high-intensity pain and is associated with low amounts of pain-related interference. Grade III is related to pain-related disability with a high pain intensity. Grade IV is the most debilitating, with severely limiting pain intensity and a high disability score.

SCL-90R. Two subscales of the Symptom Check List are incorporated into the RDC/TMD to assess for symptoms of depression and somatization. The complete version of the SCL-90-R is a 90-item self-report symptom inventory intended to measure psychological well-being and pathology.[23] It is considered appropriate for use within health care settings. While the complete version of the inventory assesses psychological distress across nine separate psychosocial dimensions, only the two mentioned above (depression and somatization) are incorporated into the RDC/TMD.

SF-36. This 36-item self-report inventory assesses mental and physical health-related quality of life.[24] It was developed to assess treatment outcomes in health-care settings, and is composed of eight subscales and two composite scales. The two composite scales help to provide an overall snapshot of a patient's sense of physical (Physical Component Scale [PCS]) and mental (Mental Component Scale [MCS]) well-being. The SF-36 is especially informative when used in pain management settings because normative data are already available from medical populations, as well as a reported high test-retest reliability coefficient. Cronbach's alphas have been reported above .80 for internal consistency.[24]

BDI-II. The BDI-II is a widely accepted 21-item measure that indicates the occurrence and severity of the physical and emotional symptoms associated with depression in adults and adolescents aged 13 years and older.[25] This self-report measure uses a 4-point scale (0 to 3) for each item. The sum of the 21 items is compared to scoring guidelines in order to establish an interpretive range. The suggested scoring guideline is as follows: less than 10, absence of depression; 10 to 18, mild to moderate depression; 19 to 29, moderate to severe depression; and over 29, severe depression.

Chewing Performance. The major indices used were the evaluations of median particle size and broadness of the distribution, as well as the participants' self-rating of pain during the task. Standardized tablets (5-mm thick and 20 mm in diameter) of a new, softer CutterSil (a condensation silicone impression material; Heraeus Kulzer) are formed using a plexiglass template. The tablets are cut into quarters, after hardening for at least 1 hour. Five portions, containing three-quarter tablets each, are packaged for each subject.[26] Subjects were asked to chew the tablets at their normal rate of chewing, as a measure of how they usually chew foods.[27] Once the chewed samples were obtained from subjects, they were air dried in filter papers over a stainless-steel colander. The samples were then separated, using a series of seven sieves, with mesh sizes of 5.6 mm, 4.0 mm, 2.8 mm, 2.0 mm, 0.85 mm, 0.425 mm, and 0.25 mm, stacked on a mechanical stacker, and vibrated for 2 minutes. Once the sample was separated, the contents of each sieve were weighted to the nearest 0.01 gm. Cumulative weight percentages (defined by the amount of the sample that can pass through each successive sieve) were calculated for each chewed sample. From these percentages, the median particle size and broadness of particle distribution were estimated using the Rosin-Rammler equation.[28] The reproducibility of this procedure has been demonstrated by Oltoff and colleagues[29] to be excellent. Chewing performance measures were collected for both sides of the jaw. Values were used for the side that the participant indicated as producing the most discomfort during the tasks or were averaged for participants who reported equal discomfort on both sides.

Data Analysis

The variables under investigation were examined thoroughly prior to conducting data analyses in order to ensure that the assumptions of the statistical tests were met. First, demographic differences among the TMD diagnostic groups were examined using chi-square tests of independence or analysis of variance (ANOVA) models as appropriate.

Table 2 Demographics of Participants by RDC/TMD Axis I Diagnosis

Variables	Axis I diagnostic category: None (n = 22)	MPD (n = 62)	DD or DJD (n = 32)	Combination of MPD and DD or DJD (n = 91)	F or χ^2	*df*	*P*
Age (y): mean (SD)	45.50 (14.56)	43.37 (16.97)	41.03 (15.27)	43.65 (15.44)	.376	3, 203	.770
Range (y)	24–70	19–80	18–70	19–72			
Gender (%)					15.11	3	.002*
Male	11 (50.0)	8 (12.9)	10 (31.3)	17 (18.7)			
Female	11 (50.0)	54 (87.1)	22 (68.8)	74 (81.3)			
Race (%)					13.64	12	.324
Caucasian	16 (72.7)	38 (61.3)	19 (59.4)	69 (75.8)			
Latino(a)	3 (13.6)	8 (12.9)	6 (18.8)	7 (7.7)			
African American	1 (4.5)	10 (16.1)	3 (9.4)	11 (12.1)			
Asian	2 (9.1)	2 (3.2)	1 (3.1)	1 (1.1)			
Other	0 (0.0)	4 (6.5)	3 (9.4)	3 (3.3)			
Marital status (%)					20.58	12	.057
Single	4 (18.2)	31 (50.0)	13 (40.6)	29 (31.9)			
Married	16 (72.7)	24 (38.7)	15 (46.9)	45 (49.5)			
Divorced or separated	0 (0.0)	6 (9.7)	3 (9.4)	15 (16.5)			
Widowed	0 (0.0)	0 (0.0)	0 (0.0)	1 (1.1)			
Missing data	2 (9.1)	1 (1.6)	1 (3.1)	1 (1.1)			
Years of education (%)					4.92	6	.554
8-15 y	8 (36.4)	26 (42.6)	13 (40.6)	45 (49.5)			
16 y	7 (31.8)	16 (26.2)	13 (40.6)	27 (29.7)			
≥ 17 y	7 (31.8)	19 (31.1)	6 (18.8)	19 (20.9)			
Risk status (%)					23.28	3	.000*
Low risk	18 (81.8)	32 (51.6)	18 (56.2)	27 (29.7)			
High risk	4 (18.2)	30 (48.4)	14 (43.8)	64 (70.3)			

*Significant at $P < .05$.

Differences in chewing performance measures were examined using ANOVA models, with either TMD diagnostic group or risk status as the between-subjects factor. Univariate ANOVA models were conducted to examine differences in the psychosocial variables (ie, CPI, GCPS, depression, quality of life, and somatization) among the TMD diagnostic groups, or between the risk status groups. All post-hoc analyses were conducted using Holm Bonferroni corrections to minimize the Type I error rates.[30]

Results

Demographics

Group Composition by TMD Diagnosis. From the core sample of 207 participants who completed baseline measurements, 22 (10.6%) did not meet the criteria for an RDC/TMD Axis I diagnosis, 62 (30%) had a diagnosis of MPD only, 32 (15.5%) had a diagnosis of either DD or DJD, and 91 (44%) had a diagnosis of MPD in combination with a diagnosis of DD or DJD (Table 2). Gender was associated with TMD diagnoses; specifically, women were less likely than expected, and men were more likely than expected, to not meet criteria for a TMD diagnosis. Additionally, patients who were classified as having low risk status were more likely than expected to not meet criteria for a TMD diagnoses, and less likely than expected to have a diagnosis of MPD in combination with either DD or DJD. Conversely, patients who were classified as high risk were less likely than expected to not meet TMD diagnostic criteria and were more likely than expected to have a diagnosis of MPD in combination with either DD or DJD. Race/ethnicity was not a significant factor for participants with differing RDC/TMD Axis I diagnoses.

Table 3 Results of Chewing Performance by RDC/TMD Axis I Diagnoses Versus Groups II and III Diagnoses

Chewing performance measure	RDC/TMD Axis I Diagnoses† None	MPD	DD or DJD	Combination of MPD and DD or DJD	F (*df*), *P*	η_p^2
Pain rating						
	2.26 (1.49) (n = 21)	3.17 (2.64) (n = 55)	3.15 (2.33) (n = 27)	4.65 (2.22) (n = 84)	F (3, 183) = 8.99, < .001*	0.128
Median particle size						
	3.58 (1.01) (n = 20)	3.55 (1.16) (n = 53)	3.80 (1.27) (n = 23)	3.89 (1.17) (n = 73)	F (3, 165) = 1.05, .37	0.019
Broadness						
	16.10 (13.98) (n = 20)	16.43 (15.00) (n = 53)	22.74 (15.08) (n = 23)	20.73 (15.60) (n = 73)	F (3, 165) = 1.53, .21	0.027

†Group diagnosis is based on the RDC/TMD criteria; standard deviations appear in parentheses following mean values.
*Significant at $P < .05$.
Note: there are some sample size differences because of some missing data due to technical difficulties or participants not completing the measure.

Physical Measures of RDC/TMD Axis I Diagnoses

As presented in Table 3, ANOVA models were conducted to determine whether the type of RDC/TMD Axis I diagnosis had a significant impact on a participant's self-reported pain and his or her chewing performance (ie, ability to break down materials by chewing). Diagnoses were separated as follows: no diagnoses, MPD diagnosis only; DD or DJD only; combination of MPD and DD or DJD. Participants with multiple diagnoses, including MPD, reported more pain during the chewing task than did those with no diagnoses, those with only MPD, and those with DD or DJD only. However, no differences were found among the RDC/TMD Axis I diagnoses for broadness of particle distribution or median particle size after chewing.

Psychosocial Measures of RDC/TMD Axis I Diagnoses

Overall, it was found that participants with a combination of MPD and other disorders (DD or DJD) differed significantly from participants with no diagnoses, MPD only, or DD or DJD only on many psychosocial variables (Table 4). Results of one-way ANOVAs indicated that, on average, participants with a combination of MPD and other diagnoses reported more pain relative to those without an RDC/TMD Axis I disorder and those with MPD only. Participants with DD or DJD also reported higher CPI scores than did those without an RDC/TMD diagnosis. In addition to higher CPI scores, participants with MPD combined with another TMD had significantly higher GCPS disability scores compared to participants without an RDC/TMD Axis I diagnosis and participants with DD or DJD. Participants with MPD only did not differ from the other groups.

For the questions derived from the SCL-90 portion of the RDC/TMD history questionnaire, significant differences were found among participants with regard to depression scores (Table 4). Participants with a mutual diagnosis of MPD and either DD or DJD had significantly higher levels of depression compared to participants with no TMD diagnoses, but participants with MPD only or with DD or DJD did not differ from the other groups. This finding was further reinforced when depression scores based on the BDI-II were assessed. There were also significant differences among participants with differing diagnoses of TMD for nonspecific physical symptoms (taken from the SCL-90 somatization component of the RDC/TMD), excluding or including pain. Post-hoc tests again revealed that those with a combination of diagnoses had more somatic complaints compared to those with either no RDC/TMD Axis I diagnosis, or those with a diagnosis of only DD or DJD. Participants with MPD only did not differ on their amount of somatic complaints relative to those who also had DD or DJD. This finding was reinforced by the somatic score derived from the BDI-II, for which the group with multiple diagnoses reported more

Table 4 Psychosocial Measures Examining RDC/TMD Axis I Diagnoses

Measure	RDC/TMD Axis I Diagnoses† None	MPD	DD or DJD	Combination of MPD and DD or DJD	F (*df*), *P*	η_p^2
CPI	37.42 (20.34) (n = 22)	48.44 (20.06) (n = 62)	51.67 (20.32) (n = 32)	57.84 (15.61) (n = 91)	F (3, 203) = 8.52, < .001*	0.112
GCPS	13.48 (16.57) (n = 22)	24.03 (24.04) (n = 62)	20.73 (18.72) (n = 32)	33.04 (23.71) (n = 91)	F (3, 203) = 6.14, < .001*	0.083
Depression, RDC/TMD	0.40 (0.27) (n = 22)	0.82 (0.68) (n = 62)	0.66 (0.56) (n = 32)	0.94 (0.77) (n = 91)	F (3, 203) = 4.26, .006*	0.059
Depression, BDI-II	4.90 (4.17) (n = 21)	9.16 (7.32) (n = 58)	7.93 (7.21) (n = 29)	11.03 (9.68) (n = 88)	F (3,192) = 3.57, .015*	0.053
Somatization, pain included	0.37 (0.22) (n = 22)	0.72 (0.58) (n = 62)	0.45 (0.40) (n = 32)	0.90 (0.71) (n = 89)	F (3,201) = 7.67, < .001*	0.103
Somatization, pain excluded	0.20 (0.19) (n = 22)	0.50 (0.55) (n = 62)	0.27 (0.41) (n = 32)	0.70 (0.75) (n = 90)	F (3,202) = 6.62, < .001*	0.090
Somatization, BDI-II	3.25 (2.49) (n=20)	6.71 (5.31) (n=58)	6.00 (4.80) (n=27)	7.45 (5.72) (n=84)	F (3,185)= 3.62, .014*	0.055
Physical Composite Score, SF-36	54.18 (4.39) (n=22)	48.06 (9.03) (n=53)	51.85 (7.59) (n=29)	46.61 (9.19) (n=78)	F (3,178)= 6.10, .001*	0.093

Standard deviations appear in parentheses following mean values; sample sizes reflect random missing data.
†Group diagnosis is based on the RDC/TMD criteria.
*Significant at $P < .05$.

Table 5 Results of Chewing Performance by Risk Status

Chewing performance measure	Risk status Low risk	High risk	F (*df*), *P*	η_p^2
Pain rating	2.47 (1.65) (n = 72)	4.57 (2.60) (n = 93)	F (1,163) = 35.59, < .001*	0.179
Median particle size	3.72 (1.20) (n = 66)	3.74 (1.17) (n = 85)	F (1,149) = .019, .89	0.000
Broadness	19.84 (15.62) (n = 66)	18.19 (14.94) (n = 85)	F (1,149) = .43, .51	0.003

Standard deviations appear in parentheses following mean values.
*Significant at $P < .05$.

somatic complaints than did the group with no RDC/TMD Axis I diagnosis. Furthermore, those with a combination of diagnoses reported poorer quality of life on the physical composite score of the SF-36, as compared to those with no RDC/TMD Axis I diagnosis or those with a diagnosis only of DD or DJD. Participants with MPD only reported poorer quality of life than the group with no diagnosis.

Physical Measures of High- Versus Low-Risk Participants

Differences in chewing performance based on risk status were examined using ANOVA models (Table 5). Analyses revealed that high-risk participants reported more pain while chewing, relative to low-risk participants. However, high- and low-risk

Table 6 Psychosocial Measures by Risk Status

Measure	Risk status		F (*df*), *P*	η_p^2
	Low risk	High risk		
CPI	36.00 (13.14) (n = 95)	65.39 (11.98) (n = 112)	F (1,205) = 283.02, < .001*	0.580
GCPS	16.60 (17.71) (n = 95)	34.64 (23.75) (n = 112)	F (1,205) = 37.26, < .001*	0.154
Depression, RDC/TMD	0.68 (0.63) (n = 95)	0.90 (0.72) (n = 112)	F (1,205) = 5.45, .021*	0.026
Depression, BDI-II	8.07 (7.85) (n = 90)	10.46 (8.71) (n = 106)	F (1,194) = 4.03, .046*	0.020
Somatization, pain excluded	0.55 (0.54) (n = 95)	0.87 (0.65) (n = 112)	F (1,203) = 14.83, < .001*	0.068
Somatization, pain included	0.36 (0.52) (n = 95)	0.66 (0.69) (n = 112)	F (1,204) = 12.16, .001*	0.056
Somatization, BDI-II	5.50 (4.78) (n = 86)	7.47 (5.61) (n = 103)	F (1,187) = 6.57, .011*	0.034
Physical composite score, SF-36	51.74 (7.15) (n = 83)	46.30 (9.33) (n = 99)	F (1,180)= 18.93, < .001*	0.095

Standard deviations appear in parentheses following mean values; sample sizes reflect random missing data.
*Significant at $P < .05$.

participants did not differ on median particle size or broadness of particle distribution.

Psychosocial Measures of High- Versus Low-Risk Participants

Participants' psychosocial response to TMD was also evaluated based on their risk status (Table 6). One-way ANOVAs were conducted on the same psychosocial variables, namely, CPI, GCPS, depression, quality of life, and somatization. Results indicated that high-risk participants reported more pain on the CPI relative to low-risk participants. High-risk participants also reported significantly more interference with daily activities due to TMD symptoms compared to low-risk participants. Significant differences were also found among participants with regard to depression scores, somatic complaints, and physical well-being. High-risk participants had significantly higher levels of depression as compared to low-risk participants in both the RDC/TMD and BDI-II measures of depression. High-risk participants were also more likely to have complaints of symptoms with and without including pain relative to those who were low risk on both the RDC/TMD and BDI-II measures. Additionally, high-risk participants also reported lower quality of life on the physical composite score of the SF-36.

Discussion

Results of the present investigation revealed that, among acute TMD participants, those with multiple diagnoses (including MPD) were more likely to report higher pain as well as more interference with daily activities due to pain relative to participants who did not have a TMD diagnosis. Participants diagnosed with mutual diagnoses of MPD and DD or DJD also had significantly higher symptoms of depression compared to participants with no diagnosis. Finally, participants with MPD and DD or DJD reported higher somatization relative to participants with no diagnosis and participants with a diagnosis of only DD or DJD. Such findings suggest that patients with more than one diagnosis, including MPD, may experience greater pain, thereby affecting their depressive symptoms, somatization, and ability to engage in daily activities. Other studies have found similar results for chronic TMD patients.[12,13] While having only one diagnosis does not significantly differ from a healthy control, participants with multiple diagnoses, including MPD, were found to experience many more biopsychosocial symptoms. This appears to be related to the fact that the presence of MPD is one major predictor of acute TMD developing into chronic TMD without proper intervention.[14]

Thus, the results clearly demonstrate that multiple biopsychosocial factors differentiated among the

TMD diagnostic groups, as well as the low- versus high-risk groups. For the RDC diagnostic groups, there were differences found for self-reported pain during chewing performance, CPI pain and GCPS disability scores, measures of depression (both on the BDI-II and the depression score component of the SCL-90), as well as for measures of somatization (on the somatic component of the BDI-II, the somatization score component of the SCL-90, and the physical component score of the SF-36). In terms of the low- versus high-risk group categorization, there were again significant differences on the aforementioned measures. It should be noted that because the CPI is used in the algorithm to differentiate between low–high risk, it should not be viewed as a valid measure of pain used to further validate this dichotomy. However, there were other independent measures of pain to differentiate the low- versus high-risk groups, such as pain during chewing performance and the GCPS.

These findings have significant implications for clinical research using the RDC/TMD. For example, Truelove and colleagues[31] have concluded that this diagnostic system has acceptable validity for detecting myofascial TMD pain. However, the validity for the diagnosis of disc displacements and some DJD disorders such as arthrosis was found to be poor. This may explain why MPD was the most consistent diagnostic entity involved in the results found in the present study. In addition, these results further highlight the fact that masticatory muscle pain needs to be more extensively investigated in predicting orofacial pain, as recently suggested by Davis et al[32] and Fricton.[33] The fact that the present study evaluated only first-time diagnosed acute TMD patients made the resultant findings even more valuable to the scientific clinical research literature.

With regard to chewing performance, participants with a combination of MPD and DD or DJD significantly differed in the amount of reported pain during the test relative to participants with either no diagnoses, only MPD, or DD or DJD diagnoses at the preintervention stage. Measures of median particle size and broadness of particles, though, were not found to be significant. However, for those patients who were classified as high risk, there was a significant difference in self-reported pain during chewing performance and RDC/TMD functioning, as compared to low-risk patients. These high-risk patients also differed from the low-risk patients on a number of psychosocial measures evaluated. Combined with earlier studies that have demonstrated the predictive utility of this high- versus low-risk model,[16,18,34,35] these results further document the construct validity of the high–low risk dichotomy for acute TMD patients. Moreover, they correspond closely with the findings by Ohrbach and coworkers[36] that these RDC/TMD Axis II measures not only have good psychometric properties, but also good clinical utility. This clinical utility now appears especially true in the case of acute high-risk TMD patients.

Conclusions

The results of this study indicate that participants who are at a high risk of developing chronic TMD symptoms suffer from more self-reported pain, interference with daily activities, depression, and somatization. Additionally, high-risk participants experience more pain while chewing relative to low-risk participants. Overall, the general findings clearly reinforce the need for a new revised RDC/TMD, as noted by Sessle.[9] The MPD category of Axis I was the only consistently predictive measure found in the present study. In addition, the demonstration of biopsychosocial differences (chewing performance and Axis II psychosocial measures) between high-risk versus low-risk patients further illustrate the validity of this "at-risk" dichotomy algorithm.

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