

# Temporomandibular Disorder Pain Is Related to the General Disposition to be Anxious

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**Aims:** To assess whether trait anxiety as a person's general disposition to be anxious is a risk factor for temporomandibular disorder (TMD) pain. **Methods:** A total of 320 adult TMD patients with at least one pain-related TMD diagnosis according to the Research Diagnostic Criteria for Temporomandibular Disorders (RDC/TMD) were included in the study. Subjects from the general population without pain-related TMD were used as controls ( $n = 888$ ). All study participants completed the State-Trait Anxiety Inventory (STAI). The association between the level of trait anxiety (STAI-Trait scores) and case-control status (patients diagnosed with pain-related TMD and controls) was analyzed using logistic regression analysis. Odds ratios (OR) with 95% confidence intervals (CI) were computed. **Results:** The level of trait anxiety was associated with the subject status (case vs control). A one-point increase in STAI-Trait sum scores (range: 20 to 80) was related to an increase of the odds for pain-related TMD by the factor 1.04 (CI: 1.02–1.05;  $P < .001$ ). Severe trait anxiety (above the 90th percentile of general-population subjects) doubled the odds (OR: 2.05; CI: 1.42–2.98;  $P < .001$ ). Analyses adjusted for age, gender, and level of education did not change the results. **Conclusion:** Trait anxiety is significantly associated with diagnoses of TMD pain. *J Oral Facial Pain Headache* 2014;28:322–330. doi: 10.11607/ofph.1277

**Key words:** pain, risk factor, temporomandibular disorders, trait anxiety

Up to 18% of the adult population in the US and in Germany meet the criteria for anxiety disorders in a 12-month period.<sup>1,2</sup> Anxiety is a response to stimuli that are perceived as uncontrollable or unavoidable.<sup>3</sup> It can result in physical symptoms, such as elevated blood pressure and tremor, or in psychological reactions, such as panic attacks. Anxiety can be classified as either transitory state anxiety or stable trait anxiety.<sup>4</sup> State anxiety represents a dynamic condition of short duration and often of high intensity. It reflects a fluctuating and intensity-varying transitory emotional state in a particular situation.<sup>5</sup> In contrast, trait anxiety reflects a general tendency to respond with anxiety to perceived threats in the environment (cross-situational) and is therefore considered an enduring personality attribute of an individual.<sup>5</sup> While state anxiety is a normal reaction to stress, trait anxiety is often described as a disorder that is characterized by an individual's increased attention to threat-related stimuli.<sup>6</sup>

While state anxiety increases the attention to perceived threats, it also elevates blood pressure, heart rate, and general muscle tension. Patients with generalized anxiety disorders also report increased muscle tension; additionally, they report sleep disturbances, restlessness, and impairment of concentration, and they suffer more often from chronic pain.<sup>7,8</sup> In contrast, it was recently determined that trait anxiety may impair the prefrontal cerebral cortical control of attention, in particular when ongoing task-related demands on attention are low. This might explain difficulties in concentration that are associated with anxiety disorders.<sup>9</sup> In any case, trait anxiety is placing an enormous

emotional burden on the affected individual. It is associated with a wide variety of diseases and symptoms of disorders from coronary heart disease<sup>10</sup> to diabetes.<sup>11</sup> Furthermore, trait anxiety is associated with chronic pain conditions.<sup>12</sup>

In dentistry, temporomandibular disorders (TMD)—a collective term for heterogeneous findings and complaints associated with the temporomandibular joints (TMJs) and the masticatory muscles—are considered the most frequent causes of chronic facial pain.<sup>13</sup> It has been reported that patients with chronic facial pain disorders or facial myofascial pain have a higher level of anxiety than patients with an intracapsular disorder of the TMJs.<sup>14,15</sup> Although evidence is still controversial whether or not TMD is associated with anxiety,<sup>14–17</sup> most studies have found increased levels of anxiety in TMD patients and, therefore, favor an association.<sup>18–25</sup> Unfortunately, most studies did not discriminate between state and trait anxiety. Assuming that anxiety could be the result as well as the cause of TMD, it might be essential to draw a distinction, whereas state anxiety is a transitory emotional state in a particular situation and trait anxiety is an enduring personality attribute of an individual.<sup>4,5,26</sup>

Given the fact that the impact of anxiety on TMD patients is still controversial yet essential for the diagnosis and treatment of TMD, the aim of this study was to assess whether trait anxiety as a person's general disposition to be anxious is a risk factor for TMD pain.

## Materials and Methods

### Subjects, Study Design, and Setting

In this case-control study, cases were selected from 761 consecutively recruited adult patients seeking treatment for masticatory muscle and TMJ problems at the Department of Prosthodontics and Materials Science, University of Leipzig (Leipzig, Germany), or at the Department of Prosthodontics, Martin Luther University Halle-Wittenberg (Halle/Saale, Germany), between 1997 and 2004. All clinical examinations and TMD diagnoses were performed by trained examiners using the German version of the Research Diagnostic Criteria for Temporomandibular Disorders (RDC/TMD).<sup>27,28</sup> The RDC/TMD is a well-established and internationally accepted diagnostic system that applies a dual-axis approach. Axis I involves physical assessment according to a standardized protocol, while Axis II assesses psychosocial aspects of TMD. All clinical examiners had advanced training in diagnosing TMD. For standardization, all examiners used the manual of the German RDC/TMD, which contains explicit explanations of each step of the clinical examination, and an ongoing calibration of the examiners was performed. Reliability of

the RDC/TMD clinical examination was found to be sufficient.<sup>29–31</sup> All patients aged 18 years or more who were determined to have at least one pain-related physical diagnosis (Axis I) according to the German version of the RDC/TMD and who had a sufficient command of the German language were included in this study. No further exclusion criteria were applied. This resulted in a final sample of 320 cases. A formal sample-size calculation could not be performed due to the lack of available data in the target population before the study started.

Unmatched controls were selected from already existing data of 894 adult subjects from a probability sample of the general population in the metropolitan area of Halle/Saale and surrounding areas in Germany. Subjects 20 to 60 years of age and with a sufficient command of the German language were recruited and examined between 1997 and 1999. No further exclusion criteria were applied. For details of the recruitment procedure, see Hirsch et al.<sup>32</sup> Only general-population subjects without any pain-related TMD diagnosis were included in the present analysis. There were 888 control subjects in the final sample.

Cases and controls completed the RDC/TMD Axis II measures to assess psychosocial aspects of TMD. The German version of Axis II of the RDC/TMD is essentially identical to the English original and includes measures to assess dysfunctional chronic pain, jaw disability, depression, and non-specific physical symptoms.<sup>33</sup> Dysfunctional chronic pain was assessed using the 7-item Graded Chronic Pain Scale (GCPS).<sup>34</sup> Jaw disability was measured with the 12-item Jaw Disability List (JDL, range: 0 to 12).<sup>28</sup> Depression was assessed using the 6 items of Giessen-Test (GT, range: 6 to 42),<sup>35</sup> and non-specific physical symptoms were evaluated by the "Beschwerdenliste" (Complaint List),<sup>36</sup> a well-validated 24-item instrument (range: 0 to 72) widely used in Germany. Population-based normative data are available for measures of depression and nonspecific physical symptoms, which allow the classification of "normal," "moderate," and "severe."<sup>35–37</sup> Internal consistency, a measure for the scale's reliability assessed by calculating Cronbach alpha, was 0.87 for GCPS and JDL, 0.90 for Complaint List, and 0.66 for GT. Additionally, level of education as an indicator for the socioeconomic status of the study participants was assessed (Table 1).

This research was conducted in accordance with accepted ethical standards for research practice, undergoing review and approval by the Institutional Review Board at the University of Leipzig and at the Martin Luther University Halle-Wittenberg. Written informed consent was obtained from all participants prior to their enrollment.

**Table 1 Sociodemographic Characteristics of Cases (TMD Patients) and Controls (General-Population Subjects)**

| Sociodemographic characteristics  | Cases (n = 320) | Controls (n = 888) | Significance (P) |
|-----------------------------------|-----------------|--------------------|------------------|
| <b>Demography</b>                 |                 |                    |                  |
| Gender, no. of women (%)          | 269 (84.1)      | 503 (56.6)         | < .001           |
| Age, mean y (±SD)                 | 39.4 (±15.4)    | 40.4 (±11.8)       | .216             |
| <b>Level of education, n (%)*</b> |                 |                    | .037             |
| 6 y of school                     | 2 (0.6)         | 3 (0.3)            |                  |
| 8 y of school                     | 48 (15.0)       | 110 (12.4)         |                  |
| 10 y of school                    | 107 (33.4)      | 308 (34.7)         |                  |
| 12 y of school                    | 39 (12.2)       | 82 (9.2)           |                  |
| College of higher education       | 65 (20.3)       | 205 (23.1)         |                  |
| University                        | 45 (14.1)       | 174 (19.6)         |                  |

\*n = 14 cases and n = 6 controls with missing values for level of education.

### Assessment of State and Trait Anxiety

Anxiety was assessed using the German version of the Spielberg State-Trait Anxiety Inventory (STAI).<sup>5,38</sup> The STAI consists of two parts, one for the assessment of state anxiety (STAI-State) and one for trait anxiety (STAI-Trait). All cases (TMD patients) and controls (general-population subjects) completed the STAI-State and STAI-Trait assessments, administered as a self-completed questionnaire, both with 20 items and a 4-point Likert-type scale, ranging from 1 (not at all) to 4 (very much). Thus, summary scores for both the STAI-State and the STAI-Trait can range from 20 to 80, with higher scores indicating higher levels of anxiety. Participants' state anxiety was classified as "normal," "moderate," or "severe" based on the 70th percentile (score: 39) of STAI-State scores in the initial sample of 894 general-population subjects as the threshold for "moderate" and the 90th percentile (score: 49) as the threshold for "severe" state anxiety. STAI-Trait scores also were accordingly categorized based on the 70th percentile (score: 42) and the 90th percentile (score: 52).

As a measure of internal consistency, Cronbach alpha was 0.95 for the complete instrument, 0.91 for the subset of items representing state anxiety (STAI-State), and 0.92 for the subset representing trait anxiety (STAI-Trait).

Since this study focused on a person's general disposition to be anxious, referred to as trait anxiety, only the scores of the STAI-Trait were utilized in data analyses as the predictor variable. State anxiety is presented together with the other RDC/TMD Axis II measures (dysfunctional chronic pain, jaw disability, depression, and nonspecific physical symptoms) for describing the current psychosocial status of cases and controls (Table 2).

### Data Analyses

The analytic approach involved several steps. First, cases (TMD patients) and controls (general-population subjects) were compared with respect to sociodemographic and psychosocial characteristics by using a two-sample *t* test for continuous data (age, and means of JDL, GT, Complaint List, STAI-State), chi-square test for dichotomous data (sex), and Wilcoxon rank-sum test (Mann-Whitney *U* Test) for ordinal data (categories of

GCPS, JDL, GT, Complaint List, STAI-State), respectively (Tables 1 and 2).

Second, means with a corresponding 95% confidence interval (CI) of STAI-Trait scores were computed, and differences in these means were tested with respect to case-control status by using a two-sample *t* test. Effect size was calculated for the group comparison. According to Cohen,<sup>39</sup> an effect size above 0.2 indicates a small effect, above 0.5 a medium effect, and above 0.8 a large effect. Additionally, differences in classifications between cases and controls were tested for statistical significance using the Wilcoxon rank-sum test.

Third, a possible exposure-response relationship between the level of trait anxiety and the probability of TMD pain was tested, ie, whether more anxiety increased the probability of TMD pain. The correlation between the STAI-Trait scores and corresponding proportion of case-control status was determined by calculating a point-biserial correlation coefficient,<sup>40</sup> including the 95% CI.<sup>41</sup>

Fourth, the strength of the relationship between trait anxiety and the presence of TMD pain was computed using logistic regression analyses adjusted for possible confounders (sociodemographic variables). Case-control status was considered as the criterion variable, whereas STAI-Trait summary score and category were treated as the predictor variables, and sociodemographic variables (age, gender, level of education) as covariates. The first models only included the STAI-Trait summary score or category, respectively. The second models additionally included the variables of age, gender, and level of education as possible confounders for the relationship between trait anxiety and the case-control status. The odds ratio (OR) with 95% CI was computed for predictor variables and covariates in the models.

Finally, a sensitivity analysis was performed to test if the level of trait anxiety is related not only to the presence of TMD pain, but also to the type and location of the pain. Therefore, STAI-Trait mean scores with 95% CI were computed for diagnostic TMD subgroups, and means were compared using analysis of variance (ANOVA). Three subgroups were defined based on the physical TMD diagnosis (Axis I): patients with myogenous pain only (n = 126), patients with arthrogenous pain only (n = 93), and patients with myogenous and arthrogenous pain diagnoses

( $n = 101$ ). The relationship between trait anxiety and the presence of TMD pain was computed using multinomial logistic regression analyses, and relative-risk ratio (RRR) values with 95% CI were reported. This regression model included the diagnostic subgroups as criterion variables simultaneously and was adjusted for possible confounders (sociodemographic variables).

All 20 items of the STAI-Trait were complete in 310 (96.7%) cases and in 880 (99.1%) controls. Only 34 missing answers were observed among the remaining 18 participants. Regression imputation for missing data on all single items was performed within the STAI-Trait in participants with up to two (10%) missing answers (17 participants). One TMD patient (case) had 16 missing answers and was therefore excluded from analyses of the STAI-Trait.

All analyses were performed using the statistical software package STATA (Stata Statistical Software, Release 12, StataCorp LP), with the probability of a type I error set at the .05 level.

## Results

### Characteristics of Cases and Controls

The final sample consisted of 320 cases and 888 controls (Table 1). Both groups did not substantially differ in mean age ( $t$  test:  $P = .216$ ). As expected, women were found considerably more within the TMD patient population than in the general-population subjects ( $t$  test:  $P < .001$ ). Furthermore, general-population subjects were slightly higher educated compared to TMD patients (rank-sum test:  $P = .037$ ).

Arthralgia was the most prevalent TMD diagnosis (55.6%) among TMD patients, followed by the diagnoses of myofascial pain without limited mouth opening (38.8%) and then with limited mouth opening (32.8%; Table 2). According to the predefined exclusion criteria, none of the general-population subjects had a pain-related TMD diagnosis. Disc displacement with reduction was the most common TMD diagnosis (13.9%) among controls. However, this diagnosis was more than twice as common (29.1%) in TMD patients.

TMD patients were more psychosocially impaired compared to controls, as indicated by the RDC/TMD Axis II measures (Table 2). The patients reported higher levels of de-

**Table 2 Physical TMD Diagnoses (Axis I) and Psychosocial Status (Axis II) of Cases (TMD Patients) and Controls (General-Population Subjects)**

|                                                             | Cases<br>( $n = 320$ ) | Controls<br>( $n = 888$ ) | Significance<br>( $P$ ) |
|-------------------------------------------------------------|------------------------|---------------------------|-------------------------|
| <b>TMD Axis I</b>                                           |                        |                           |                         |
| TMD diagnoses, $n$ (%)                                      |                        |                           | N/A                     |
| Myofascial pain without limited opening                     | 124 (38.8)             | –                         |                         |
| Myofascial pain with limited opening                        | 103 (32.2)             | –                         |                         |
| Disc displacement with reduction                            | 93 (29.1)              | 123 (13.9)                |                         |
| Disc displacement without reduction with limited opening    | 15 (4.7)               | –                         |                         |
| Disc displacement without reduction without limited opening | 8 (2.5)                | 4 (0.5)                   |                         |
| Arthralgia                                                  | 178 (55.6)             | –                         |                         |
| Osteoarthritis                                              | 16 (5.0)               | –                         |                         |
| Osteoarthritis                                              | 8 (2.5)                | 20 (2.3)                  |                         |
| <b>TMD Axis II</b>                                          |                        |                           |                         |
| <b>Depression*</b>                                          |                        |                           |                         |
| Summary score, mean ( $\pm$ SD)                             | 25.4 ( $\pm$ 6.1)      | 24.4 ( $\pm$ 5.6)         | .007                    |
| Categories, $n$ (%)                                         |                        |                           | .003                    |
| Normal                                                      | 153 (47.8)             | 539 (60.7)                |                         |
| Moderate                                                    | 66 (20.6)              | 150 (16.9)                |                         |
| Severe                                                      | 81 (25.3)              | 192 (21.6)                |                         |
| <b>Nonspecific physical symptoms†</b>                       |                        |                           |                         |
| Summary score, mean ( $\pm$ SD)                             | 22.7 ( $\pm$ 12.1)     | 16.6 ( $\pm$ 10.3)        | < .001                  |
| Categories, $n$ (%)                                         |                        |                           | < .001                  |
| Normal                                                      | 130 (40.6)             | 535 (60.3)                |                         |
| Moderate                                                    | 92 (28.8)              | 238 (26.8)                |                         |
| Severe                                                      | 90 (28.1)              | 111 (12.5)                |                         |
| <b>Jaw disability‡</b>                                      |                        |                           |                         |
| Summary score, mean ( $\pm$ SD)                             | 4.2 ( $\pm$ 2.4)       | 0.4 ( $\pm$ 1.3)          | < .001                  |
| Categories, $n$ (%)                                         |                        |                           | < .001                  |
| 0–3                                                         | 112 (35.0)             | 845 (95.2)                |                         |
| 4–7                                                         | 135 (42.2)             | 26 (2.9)                  |                         |
| 8–12                                                        | 48 (15.0)              | 11 (1.2)                  |                         |
| <b>Graded chronic pain§</b>                                 |                        |                           |                         |
| Categories, $n$ (%)                                         |                        |                           | < .001                  |
| Grade 1                                                     | 86 (26.9)              | 57 (6.4)                  |                         |
| Grade 2                                                     | 145 (45.3)             | 13 (1.5)                  |                         |
| Grade 3                                                     | 28 (8.8)               | 5 (0.6)                   |                         |
| Grade 4                                                     | 17 (5.3)               | 4 (0.5)                   |                         |
| <b>State anxiety¶</b>                                       |                        |                           |                         |
| Summary score, mean ( $\pm$ SD)                             | 42.4 ( $\pm$ 11.5)     | 36.4 ( $\pm$ 8.7)         | < .001                  |
| Categories, $n$ (%)                                         |                        |                           | < .001                  |
| Normal                                                      | 136 (42.5)             | 601 (67.7)                |                         |
| Moderate                                                    | 81 (25.3)              | 197 (22.2)                |                         |
| Severe                                                      | 100 (31.3)             | 89 (10.0)                 |                         |

\* $n = 20$  cases and  $n = 7$  controls with missing values for depression.

† $n = 8$  cases and  $n = 4$  controls with missing values for nonspecific physical symptoms.

‡ $n = 25$  cases and  $n = 6$  controls with missing values for jaw disability.

§ $n = 276$  cases and  $n = 79$  controls with values for graded chronic pain.

¶ $n = 3$  cases and  $n = 1$  control with missing values for state anxiety.

N/A = statistical testing not applicable (TMD diagnoses were inclusion and exclusion criteria, respectively).

pression (rank-sum test:  $P = .003$ ), nonspecific physical symptoms (rank-sum test:  $P < .001$ ), jaw disability (rank-sum test:  $P < .001$ ), graded chronic pain (rank-sum test:  $P < .001$ ), and state anxiety (rank-sum test:  $P < .001$ ).



**Table 3 STAI-Trait Summary Scores and Categories for Level of Trait Anxiety in Cases (TMD Patients) and Controls (General-Population Subjects)**

|                              | Cases (n = 320)  | Controls (n = 888) | Significance (P) | Effect size (Cohen <sup>39</sup> ) |
|------------------------------|------------------|--------------------|------------------|------------------------------------|
| <b>Trait anxiety*</b>        |                  |                    |                  |                                    |
| Summary score, mean (95% CI) | 41.7 (40.5–42.8) | 38.4 (37.8–39.0)   | < .001           | 0.33                               |
| Categories, n (%)            |                  |                    | < .001           | –                                  |
| Normal                       | 168 (52.5)       | 598 (67.3)         |                  |                                    |
| Moderate                     | 95 (29.7)        | 193 (21.7)         |                  |                                    |
| Severe                       | 56 (17.5)        | 97 (10.9)          |                  |                                    |

\*n = 1 case with missing values for trait anxiety.

**Table 4 Logistic Regression Analysis Models Characterizing the Relationship Between Case-Control Status and Trait Anxiety in Unadjusted and Adjusted (Sociodemographic Variables) Analyses**

| Model                            | Variable           | OR   | 95% CI    | P      |
|----------------------------------|--------------------|------|-----------|--------|
| <b>STAI-Trait summary scores</b> |                    |      |           |        |
| # 1                              | Trait anxiety      | 1.04 | 1.02–1.05 | < .001 |
| # 2                              | Trait anxiety      | 1.03 | 1.02–1.05 | < .001 |
|                                  | Gender             | 3.91 | 2.79–5.46 | < .001 |
|                                  | Age                | 0.99 | 0.98–1.00 | .251   |
|                                  | Level of education | 0.88 | 0.80–0.97 | .014   |
| <b>STAI-Trait categories</b>     |                    |      |           |        |
| # 3                              | Trait anxiety      |      |           |        |
|                                  | Normal*            | 1    | –         | –      |
|                                  | Moderate           | 1.75 | 1.30–2.36 | < .001 |
|                                  | Severe             | 2.05 | 1.42–2.98 | < .001 |
| # 4                              | Trait anxiety      |      |           |        |
|                                  | Normal*            | 1    | –         | –      |
|                                  | Moderate           | 1.75 | 1.28–2.41 | < .001 |
|                                  | Severe             | 1.95 | 1.32–2.88 | .001   |
|                                  | Gender             | 3.96 | 2.83–5.53 | < .001 |
|                                  | Age                | 0.99 | 0.98–1.00 | .244   |
|                                  | Level of education | 0.88 | 0.80–0.97 | .014   |

\*Reference category.

OR = odds ratio.

### Trait Anxiety and TMD

Trait anxiety was more pronounced in TMD patients than in controls ( $t$  test:  $P < .001$ ; Table 3). The effect size of 0.33 was considered small.<sup>39</sup> The patients' trait anxiety was more often classified as moderate or severe (Table 3) compared to that of the controls (rank-sum test:  $P < .001$ ). The STAI-Trait scores correlated significantly to the case-control status, indicated by a correlation coefficient of 0.18 ( $P < .001$ ; 95% CI: 0.10–0.25).

In the logistic regression analysis, a one-point increase in STAI-Trait summary scores resulted in 1.04-fold higher odds of having pain-related TMD ( $P < .001$ ) compared to controls (Table 4). Moderate trait anxiety increased the odds for having TMD pain ( $P < .001$ ), and severe trait anxiety doubled the odds ( $P < .001$ ). Analyses adjusted for age, gender, and level of education did not change results substantially. While age had no significant effect on the risk of TMD pain in the adjusted analyses, women had an almost four times higher

risk than men, and higher education slightly decreased the risk for TMD pain.

The sensitivity analysis did not reveal a relationship between the level of trait anxiety and the type and location of TMD pain. STAI-Trait summary scores did not differ substantially between patients with myogenous pain only (41.3; 95% CI: 39.7–42.9), patients with arthrogenous pain only (41.6; 95% CI: 39.4–43.9), and patients with myogenous and arthrogenous pain diagnoses (42.2; 95% CI: 39.9–44.6), respectively (ANOVA:  $P = .794$ ). In the multinomial regression analysis controlled for possible confounders (age, gender, level of education), the STAI-Trait summary score was related to an increase in the risk of having a myogenous pain diagnosis (RRR = 1.03; 95% CI: 1.01–1.05;  $P = .002$ ), an arthrogenous pain diagnosis (RRR = 1.03; 95% CI: 1.01–1.06;  $P = .006$ ), and having both myogenous and arthrogenous pain diagnoses (RRR = 1.03; 95% CI: 1.01–1.06;  $P = .002$ ), to an almost identical extent.

## Discussion

The findings in this case-control study indicate that higher levels of a person's general disposition to be anxious (trait anxiety) increase the risk of having pain-related TMD, irrespective of the type and location of TMD pain. Increased levels of trait anxiety were related to a higher probability of having TMD pain with a moderate size of the effect. However, TMD is of multifactorial origin.<sup>42</sup> Therefore, it would have been surprising if larger effects had been observed. A one-point increase in the level of trait anxiety on the STAI-Trait scale was related to an additional risk of TMD pain by about 4%. Considering the large range of the trait anxiety score from 20 to 80, this effect becomes meaningful. When categorized as having "severe" trait anxiety (above 90th percentile of the general population), risk for TMD pain was about doubled compared to "normal" trait anxiety (up to the 70th percentile), which can be considered clinically relevant in naming the enduring personality attribute trait anxiety as a risk factor for TMD pain.

A theoretic conceptualization of anxiety includes the distinction between transitory state anxiety and stable trait anxiety.<sup>4</sup> In the present study, trait anxiety was investigated as a potential risk factor for TMD. The presence of TMD signs and symptoms, especially pain, was considered to be a threatening stimulus in TMD patients. Higher scores for state anxiety could be the result of having TMD. In contrast to state anxiety, trait anxiety is reasonably stable over time. A study investigated the longitudinal stability of both anxiety components over a period of 24 months and found higher test-retest reliability for trait anxiety, indicated by a higher correlation coefficient than for state anxiety ( $r = 0.90$  and  $r = 0.66$ , respectively).<sup>26</sup> Others found similar results for a 10-month interval (trait anxiety:  $r = 0.68$ – $0.70$ ; state anxiety:  $r = 0.28$ – $0.37$ ).<sup>4</sup> These studies support the assumption that trait anxiety is an enduring personality disposition. It is therefore reasonable that higher levels of trait anxiety were a contributing factor in the occurrence of TMD and not the result of it.

At present, the underlying pathophysiology of a relationship between trait anxiety (as a personality disposition) and TMD pain is not well understood. Both share some neurochemical pathways,<sup>43–47</sup> but a solid model of how and to what degree these two concepts interact is not known yet. Further research on this topic is warranted.

When comparing the present results to the literature, a distinction between state and trait anxiety is necessary. However, in most studies, the applied instruments for the assessment of anxiety do not make this distinction, limiting the comparability between studies. Several studies reported an association be-

tween anxiety and TMD pain<sup>18–22</sup> or between anxiety and pain disorders in general.<sup>7,12,48</sup> Strong support for the association between anxiety disorders and chronic pain comes also from a study conducted in a representative sample of the general US population.<sup>8</sup> Furthermore, anxiety level is related to perceived pain intensity<sup>49</sup> and to muscle tenderness,<sup>50,51</sup> and notably, there is a high prevalence of anxiety in patients with myofascial pain,<sup>25</sup> acute TMD,<sup>24</sup> and chronic TMD.<sup>23</sup> Anxiety and fear are predictors for care-seeking behavior for TMD by increasing treatment demand.<sup>52</sup> In contrast, another study found that pain characteristics are a stronger predictor than psychological distress for health care-seeking behavior in patients with orofacial pain.<sup>53</sup> However, given the association between the level of anxiety and the perceived pain intensity,<sup>49</sup> pain characteristics might be modulated by anxiety. Anxiety levels in patients with TMD are comparable to those of psychiatric patients.<sup>22</sup> The authors are aware of only one study using the trait component of the STAI. In this prospective study, trait anxiety was a predictor for TMD pain.<sup>54</sup> Summarizing the findings of the studies mentioned above, anxiety plays an important role in TMD, and a person's general disposition to be anxious can be considered a risk factor for TMD pain.

In contrast, other studies have found no association between anxiety and TMD,<sup>16,17</sup> which is contradictory to the present findings. Patients with chronic TMD pain did not differ significantly from the pain-free controls in their levels of anxiety.<sup>17</sup> However, controls used were also treatment-seeking TMD patients, so higher anxiety levels in controls would not be surprising. Furthermore, the above-mentioned study excluded patients with acute TMD and with diagnoses of both muscular and articular disorders, and anxiety was assessed using the Hospitality Anxiety and Depression Scale (HADS), which evaluates state anxiety rather than trait anxiety. The controls in the present study came from a probability sample of the general population without TMD pain, and level of anxiety was achieved via the trait component of the STAI. These methodological differences might explain the conflicting results.

No effect of trait anxiety was found on the location of the TMD pain indicated by TMD diagnoses. This is in line with previous studies that investigated anxiety levels or compared psychosocial profiles in TMD patients.<sup>55–57</sup> However, other studies reported that anxiety is more prevalent in patients with myofascial pain than in patients with disc displacement or other joint disorders.<sup>15,50</sup> In one study,<sup>15</sup> anxiety was derived from a self-reported questionnaire for panic-agoraphobic spectrum. Differences in the conceptualization of anxiety in this study compared to the present study might explain the conflicting results.

In another study,<sup>50</sup> patients with joint disorders were defined as having signs of internal derangements in the TMJ. TMD diagnoses were not derived according to the RDC/TMD as in the present study, and it is not clear from the methods and results provided in the publication if all these patients actually had TMJ pain.<sup>50</sup> Comparability with the present study is therefore limited.

A major strength of the present study was the use of a standardized and internationally recognized instrument (the RDC/TMD) for the clinical examination of patients and the consequent allocation of TMD diagnoses. Furthermore, the study applied the STAI, which allows for the distinction between trait and state anxiety, and included a sufficient number of TMD patients (cases) and general-population subjects (unmatched controls). The large number of cases allowed subgroup analyses to be performed, ie, to investigate whether anxiety is related not only to TMD as a collective term embracing different pain diagnoses, but also to type and location of pain. The cases represented a typical TMD patient population and were comparable to other studies with TMD patients in terms of TMD diagnoses, mean age, and proportion of women,<sup>58,59</sup> but did differ substantially from the controls in gender and level of education. This was anticipated because of the known deviation of TMD patients from general-population subjects regarding socioeconomic characteristics. Age, gender, and level of education were included as covariates in the adjusted analyses. However, the OR for trait anxiety did not differ substantially between the adjusted and the unadjusted analyses. While age had no significant effect on the risk of TMD pain in the adjusted analyses, gender did, thus emphasizing that clinical TMD patient populations consist mainly of women. Higher levels of education slightly decreased the risk for TMD pain. The cases differed also significantly from controls in measures of depression, nonspecific physical symptoms, jaw disability, graded chronic pain, and state anxiety. However, these measures were not included in the regression analyses, since the measures were considered a description of the current psychosocial status and an important prognostic factor for treatment success rather than a risk factor. Higher scores could be the result of having TMD. Therefore, inclusion of these measures in the regression analyses was deemed not justified.

This study had some limitations. It was a case-control study, and such a design usually prevents the ability to make inferences from associations to causal relationships. Furthermore, there is some uncertainty as to whether there was a bias in responding. Trait anxiety scores might have been affected by current levels of state anxiety, which were higher in patients with TMD pain. However, since trait anxiety has been

shown to be an enduring personality attribute,<sup>4,26</sup> it can be assumed to be a predisposition for both state anxiety and TMD pain. Therefore, a risk-outcome relationship could be established between a person's general disposition to be anxious and TMD pain by using the trait component of the STAI, but this inference should be made with caution. A proportion of study participants with possible facial pain with no TMD diagnosis is assumed to be small and insufficient to substantially affect study findings. Finally, even though ongoing calibrations of the examiners were performed, no formal data on the reliability of all study examiners is available; however, several reliability studies were performed on the examiners.<sup>29–31</sup>

Therefore, it can be concluded from the present study that a person's general disposition to be anxious seems to be a significant risk factor for TMD.

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