Received: 29 August 2022 | Accepted: 20 January 2023

DOI: 10.1111/eos.12919

European Journal of Oral Sciences NOF Nordisk Odontologisk Förening Scandinavian Division IADR WILEY

ORIGINAL ARTICLE

Psychosocial factors associated with pain outcomes in patients with painful temporomandibular disorders and headaches

Hedwig A van der Meer[1,2,3,4] | Cornel H. M Tol[1] | Caroline M Speksnijder[2] | Maurits K. A van Selms[1] | Frank Lobbezoo[1] | Corine M Visscher[1]

[1]Department of Orofacial Pain and Dysfunction, Academic Centre for Dentistry Amsterdam (ACTA), University of Amsterdam and Vrije Universiteit Amsterdam, Amsterdam, The Netherlands

[2]Department of Oral and Maxillofacial Surgery and Special Dental Care, University Medical Center Utrecht, Utrecht University, Utrecht, The Netherlands

[3]Department of Rehabilitation, Amsterdam Movement Sciences, Academic Medical Center, University of Amsterdam, Amsterdam, The Netherlands

[4]Faculty of Health, Amsterdam University of Applied Sciences, Amsterdam, The Netherlands

Correspondence
Hedwig A. van der Meer, Academic Center for Dentistry Amsterdam, Gustav Mahlerlaan 3004, 1081 LA Amsterdam, The Netherlands.
Email: h.a.vander.meer@acta.nl

Hedwig A. van der Meer and Cornel H.M. Tol these authors contributed to this manuscript equally.

Abstract

The objective of this study was to assess the association between psychosocial factors (in terms of anxiety, somatization, depression, and optimism) and pain (in terms of headache pain intensity and pain-related disability), in patients with a painful temporomandibular disorder (TMD) and one of the following headache types: migraine, tension-type headache (TTH), or headache attributed to TMD, corrected for the influence of bruxism. A retrospective study was conducted at an orofacial pain and dysfunction (OPD) clinic. Inclusion criteria were painful TMD, with migraine, TTH, and/or headache attributed to TMD. Linear regressions were performed to assess the influence of psychosocial variables on pain intensity and on pain-related disability, stratified per headache type. The regression models were corrected for bruxism and the presence of multiple headache types. A total of 323 patients (61% female; mean age 42.9, SD 14.4 years) were included. Headache pain intensity only had significant associations in TMD-pain patients with headache attributed to TMD, and anxiety showed the strongest relation ($\beta = 0.353$) with pain intensity. Pain-related disability was most strongly associated with depression in TMD-pain patients with TTH ($\beta = 0.444$), and with somatization in patients with headache attributed to TMD ($\beta = 0.399$). In conclusion, the influence of psychosocial factors on headache pain intensity and pain-related disability depends on the headache type presenting.

KEYWORDS

headache, migraine, orofacial pain, temporomandibular disorders

INTRODUCTION

Temporomandibular disorders (TMD) are complaints related to muscular and joint problems in the masticatory system, which occur in 5%–12% of the general population [1–4]. Patients with a painful TMD according to the Diagnostic Criteria for TMD (DC/TMD) [2] experience headaches more frequently than the general population, with a prevalence of 76%–82% [5, 6] as compared to 50% in the general population [7]. The most common headache types in patients with a painful TMD are migraine (17%–55%) and tension-type headache (TTH; 22%–30%) [5, 6, 8, 9]. A headache which is of specific interest in TMD patients is the secondary headache attributed to TMD. Within the subgroup of TMD-pain patients who experience headache complaints, this type of headache is prevalent in about one in five patients [2, 6, 9, 10].

Migraine and TTH are primary headaches, which means that the headache is not a sign or symptom of an underlying causative disorder but rather a disorder itself [9]. Even though the etiology of migraine and TTH is not fully understood, in both cases sensitization may play a role [11–13]. Headache attributed to a TMD is a secondary headache, indicating that the headache is a symptom of, in this case, a painful TMD [14]. In patients with (chronic) painful TMD, sensitization also plays a role in the etiology [15, 16]. Therefore, central sensitization is considered to be one of the processes that could be responsible for the co-occurrence of TMD and different headache types [17]. Another hypothesis for the co-occurrence of TMD and headache is the presence of shared risk or prognostic factors, such as "bruxism." This is a repetitive jaw-muscle activity characterized by clenching or grinding of the teeth and/or by bracing or thrusting of the mandible [18]. Bruxism is associated with TMD, migraine, and headache attributed to TMD, though it is not correlated with TTH [5, 6]. In the case of migraine, bruxism is suggested to be a risk factor or trigger for migraine attacks [19]. Psychosocial factors, such as depression, anxiety, and ‘somatic complaints, are also reported as prognostic factors for painful TMD as well as headache [20–22]. These psychosocial factors can play an important role in the chronification of both TMD and headache complaints, and are reported to influence the perceived pain intensity and pain-related disability in patients with various types of pain [23–25]. Individuals with TMD pain, with and without headache, who also experience depression or anxiety, usually report higher TMD pain intensity and more TMD pain-related disability than those who do not experience depression or anxiety [26, 27]. A similar association between psychosocial factors and headache pain intensity is found in studies focusing on patients with headache [28, 29]. Furthermore, studies focusing on patients who report bruxism have described strong associations between bruxism and several psychosocial factors, especially in those with orofacial pain or TMD [30].

Although previous research demonstrated that pain intensity and pain-related disability in individuals with a painful TMD or headache are associated with psychosocial factors, and that bruxism may influence these associations, no study has yet been performed in which all three headache conditions are taken into account. We hypothesize that psychosocial factors are differently associated with the various types of headaches within the TMD population. To study these associations, correction for bruxism is necessary to account for a possible confounding effect [6]. Therefore, the objective of this study was to assess the association between psychosocial factors (in terms of anxiety, somatization, depression, and optimism) and pain (in terms of headache pain intensity and pain-related disability), in patients with a painful TMD and one of the following headache types: migraine, TTH, or headache attributed to TMD, corrected for the influence of bruxism.

MATERIAL AND METHODS

This manuscript is written according to the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement [31].

Study design and patients

This retrospective medical file study was conducted at the specialized clinic for orofacial pain and dysfunction (OPD) of the Academic Centre for Dentistry Amsterdam (ACTA). Reasons for referral to this clinic are orofacial pain complaints (including TMD and headache), bruxism, tooth wear, and/or obstructive sleep apnea. Prior to the first visit to the clinic, all patients complete a digital questionnaire, including questions on TMD complaints, headache, pain-intensity, pain-related disability, bruxism, and psychosocial factors. During the intake, a standardized examination is performed by a trained dentist following the Diagnostic Criteria for TMD (DC/TMD) protocol [2]. During the timespan from January 2014 to January 2019, a total 2493 patients visited the OPD clinic. The medical records of adult patients (at least 18 years of age) who had complete information regarding the psychosocial part of the questionnaire were retrieved from the medical database for this study (N = 1745). All data in these files were retrieved as part of the usual care diagnostic procedure of the OPD clinic. One of the researchers (CT) checked whether the patient fulfilled the following additional criteria: i) a TMD-pain diagnosis according to the criteria of the DC/TMD (i.e., myalgia or arthralgia), and ii) one of the following headache types: migraine, TTH, or headache attributed to TMD. In case of missing data relevant for this study, patients were excluded (see results). The information from the included patients was anonymized and transferred into a separate data file for the analyses of the current study.

This study was considered by the Medical Ethics Committee of the ACTA not to fall under the provisions of the Medical Research Involving Human Subjects Act, and to comply with the ethical research code of conduct of the ACTA (reference number 2,018,038). Data was collected only from patients who had given consent to the anonymous use of their information for research purposes as part of the initial intake questionnaire.

Headache diagnosis

To screen for the presence of migraine or TTH, the Headache Screening Questionnaire Dutch Version (HSQ-DV) was used. The HSQ-DV is a validated self-report questionnaire consisting of 11 questions, and based on the criteria of the International Classification of Headache Disorders

(ICHD-3) [32]. The HSQ provides two summary scores which may range from 0 to 8 points for migraine (equal to 0 to 100% of the ICHD-3 criteria), and from 0 to 8 points for TTH (equal to 0 to 100% of the ICHD-3 criteria) [32]. Based on these scores, the following tentative diagnoses are made: no migraine or TTH, probable migraine or TTH ($\geq$ 6 points, which equals $\geq$ 75% of the criteria of the ICHD-3), or definite migraine or TTH (8 points, which equals all of the criteria of the ICHD-3). In the current study, the cut-off of $\geq$ 6 points was applied to classify the presence of headache. In other words, all who fulfilled at least 75% of the ICHD-3 criteria for migraine or TTH were classified as patients with a probable migraine or TTH, respectively. Double classifications were allowed. For probable migraine, the sensitivity and specificity are 0.89 and 0.54, respectively [32]. For the recognition of probable TTH the sensitivity is 0.92 and the specificity 0.48 [32]. No differentiation was made between episodic or chronic headaches diagnoses, all were included under the same classification.

Headache attributed to TMD was classified by means of the DC/TMD, which is a validated classification system to diagnose the various subtypes of TMD [2, 14]. The DC/TMD criteria for headache attributed to TMD have a sensitivity of 0.89 and specificity of 0.87 [14].

When a patient fulfilled the criteria for more than one headache type (e.g., both migraine and headache attributed to TMD), the recommendations of the International Headache Society were followed: As all headaches have the diagnostic criterium ‘headache is not better accounted for by another ICHD-3 diagnosis’, we classified patients with a primary headache combined with headache attributed to TMD as ‘secondary headache with a concomitant primary headache’. This is because the secondary headache can be provoked during clinical examination. In case a patient scores positive on both the migraine and TTH criteria, the following recommendation of the ICHD-3 was applied; ’when the migraine or TTH was already pre-existent both diagnoses should be given‘ [9]. Based on these recommendations, the subsequent hierarchy in classification was applied to assign patients to one of the headache groups: headache attributed to TMD, migraine, TTH, probable migraine and then probable TTH [9]. For example, if a patient scored positive on 100% of the criteria for TTH and on 75% of migraine, this patient was classified as a patient with a TTH. The concurrent (lower hierarchy) headache types were noted in the data file.

Headache pain intensity

Headache pain intensity was assessed using a Numeric Pain Rating Scale based on the following question: “*On a scale of 0 to 10, where 0 means no pain and 10 means the worst pain imaginable, on average, how severe is your headache?”* [33]. Convergent validity of the Numeric Pain Rating Scale is considered good with a correlation of 0.79 to 0.95 with the Visual Analog Scale [34].

Pain-related disability

Pain-related disability was assessed with the Graded Chronic Pain Scale, which is a multidimensional measure that consists of eight questions on the possibility to perform normal daily tasks in the past 30 days (three questions regarding pain-intensity, one question regarding the number of days with pain, three questions regarding pain-related disability, and one question regarding the number of days on which a person is limited by the complaints) [35]. In the current study, the three pain-related disability questions were used to assess pain-related disability as related to orofacial pain complaints, including both the headache and TMD complaints, with scores that can range from 0 (no pain-related disability) to 10 (pain-related disability as bad as it could be). The outcome was the average score of the three questions. Internal consistency values of the Graded Chronic Pain Scale are considered good with a Cronbach’s α of 0.67 for headache and a Cronbach’s α of 0.71 for painful TMD [35]. The validity and reliability of the subscale is yet to be determined.

TMD pain intensity

TMD pain intensity was assessed by the Characteristic Pain Intensity score of the Graded Chronic Pain Scale. The Characteristic Pain Intensity score is the average score of three questions in which patients were asked about their jaw pain complaints right now, worst pain, and average pain of the last month. The average score is the pain intensity on a scale of 0 to 100 [35].

Anxiety

The General Anxiety Disorder screener is a seven-item self-report questionnaire and is used to assess anxious mood and behavior over the past 2 weeks. Anxiety is classified into four categories: no anxiety (score 0 to 4), mild anxiety (score 5 to 9), moderate anxiety (score 10 to 14), and severe anxiety (score 15 to 21) [36]. The psychometric values of the General Anxiety Disorder screener are considered good, with a convergent validity showing a correlation coefficient of 0.72 to 0.75 by correlating the General Anxiety Disorder screener with the Beck Anxiety Inventory and the anxiety subscale of the Symptom Checklist-90, respectively. The internal

European Journal of Oral Sciences NOF Scandinavian Division IADR

consistency of the General Anxiety Disorder screener is 0.92 as measured with Cronbach's α [36].

Somatic complaints

The Patient Health Questionnaire-15 is a 15-item self-report questionnaire and is used to assess the severity of somatic complaints. High scores on the Patient Health Questionnaire-15 are strongly associated with functional impairment, disability, and health care use [37]. The Patient Health Questionnaire-15 classifies somatic complaints in four categories: minimal somatization (score 1 to 4), low somatization (score 5 to 9), medium somatization (score 10 to 14), and high somatization (score 15 to 30). Internal consistency values of the PHQ-15 are considered excellent, with a Cronbach's α of 0.8 [37].

Depression

The Patient Health Questionnaire-9 is a nine-item self-report questionnaire and is used to assess depression. Classification of depression consists of five categories: no depression (score 1 to 4), mild depression (score 5 to 9), moderate depression (score 10 to 14), moderately severe depression (score 15 to 19), and severe depression (score 20 to 27) [38]. Psychometric values of the Patient Health Questionnaire-9 are considered good, with a construct validity correlation coefficient of 0.33 to 0.73 by correlating the Patient Health Questionnaire-9 with the Short Form-20. Internal consistency is 0.89 (Cronbach's alpha) [38].

Optimism

The Life Orientation Test-Revised is a 10-item questionnaire and is used to assess the patient's optimism in general [39]. Six of these items measure optimism, the other four questions are fillers and do not influence the outcome. The score ranges from 0 to 24 points. Higher scores indicate higher levels of optimism. Convergent validity assessed using the Pearson correlation coefficient is −0.22 when correlated with the Generalized Anxiety Disorder assessment, and −0.31 when correlated with the PHQ-9 for depression [40]. The Cronbach's alpha coefficient of internal consistency is 0.70 for optimism [40].

Bruxism

For measuring bruxism, the Dutch version of the Oral Behaviors Checklist was used [40]. The Oral Behaviors Checklist is a 21-item scale for quantifying the frequency of jaw-overuse behaviors, and is implemented in the DC/TMD Axis II instruments [2]. In the current study, the first four bruxism items were used to determine a bruxism score. A distinction is made between activities during sleep and activities during waking hours. Activities during sleep (two items) are scored on a five-point scale ranging from (0) 'none of the time' to (4) '4 to 7 nights a week'. Activities during waking hours (two items) are scored on a five-point scale ranging from (0) 'none of the time' to (4) 'all of the time' [41]. The bruxism score used in the current study is the average of the four bruxism items and ranges from 0 (no bruxism) to 4 (severe bruxism). Validity of the full Oral Behaviors Checklist questionnaire is good with a Spearman's correlation of 0.75, and test-retest reliability is excellent with an intra-class correlation coefficient (ICC) of 0.86 [41]. The validity and reliability of the four-item subscale is yet to be determined.

Statistical analyses

The patients' characteristics were presented using frequencies or as mean values, standard deviations (SD), and 95% confidence intervals. The assumptions for linear regression models were tested as part of the regression analyses. The assumptions tested were linearity between the dependent and independent variables, homoscedasticity, independence of observations, and normally distributed errors of the standardized residuals with methods as described by Field [42]. When all assumptions were met, two regression models were built; one for the outcome measure pain intensity, and one for pain-related disability. For the multiple regression models, multicollinearity between the independent variables (including headache type and bruxism) was checked. Multicollinearity was considered present when variables would show a correlation higher than 0.8. All assumptions for linear regression were met and there was no multicollinearity [42].

Both regression models were stratified by headache type. Single linear regressions (step 1) were performed to detect which psychosocial variables were associated with the outcome measures headache pain intensity and pain-related disability. Each single regression was corrected for the presence of concurrent headaches (step 2), as this may influence the association between pain outcomes and the psychosocial factors. Then, in the next step (step 3), the regressions were corrected for the severity of bruxism as bruxism may have a confounding effect on the association between the outcome measures and the psychosocial variables [6]. Variables that changed the regression coefficient of the previous step by more than 10% were considered to confound that association [43]. To be included in the multiple regression analyses (step 4), a statistically significant association ($p < 0.011$, see below) with the outcome measure in the corrected single linear regression model (step 3) needed to be present. For the multiple linear regression analyses, the step-by-step forward procedure was used, starting with the strongest variable in the model, and subsequently adding additional variables in order of their strength as based on the single-regression standardized coefficient β. For each step, it was assessed whether there was a significant change in model fit using the F-test [42].

To account for an increased type-I error rate associated with multiple comparisons, the online software simple interactive statistical analysis (http://www.quantitativeskills.com/sisa/calculations/bonfer.htm) was used to calculate an adjusted alpha (significance level) for each headache subgroup. This adjusted Bonferroni correction is based on the mean correlation between the dependent variables, which was calculated using R STATISTICAL SOFTWARE (https://www.r-project.org/). These correlations and the adjusted alpha values were $r = 0.071$ and $p < 0.011$ for TMD-pain patients with migraine, $r = 0.081$ and $p < 0.011$ for patients with TTH and $r = 0.059$ and $p < 0.011$ for patients with headache attributed to TMD. Further statistical analyses were performed using the IBM SPSS STATISTICS 26 software package (IBM).

RESULTS

From the 1745 medical records available for assessment, 323 were eligible for inclusion in the present study. Reasons for exclusion (in order of drop-out criterion) were: 'no TMD pain diagnosis' ($n = 1262$), 'no headache diagnosis' ($n = 139$), and 'missing information regarding headache pain intensity' ($n = 21$). The mean age of the patients was 42.9 (SD 14.4) years and 61.0% was female. Myalgia was present in 122 (37.8%) of the patients, arthralgia in 40 (12.4%) patients, and the combination of myalgia and arthralgia was present in 161 (49.8%) patients (Table 1). Ninety-nine patients were classified with headache attributed to TMD, of which 49 were also classified as having a migraine and 68 with a TTH (Table 2). Of those not having a headache attributed to TMD, 79 patients were classified with a migraine and 145 with a TTH. Approximately half of the TMD-pain patients with migraine ($n = 39$) also experienced TTH, and 21 TMD-pain patients with TTH had a concurrent probable migraine.

Headache pain intensity

For patients with headache attributed to TMD, headache pain intensity was significantly associated with all psychosocial variables in the single regression models ($\beta = -0.269 - 0.378$; $p < 0.000 - 0.007$). Optimism lost its significance ($p > 0.011$) and had a > 10% change in the regression coefficient after correction for the presence of concurrent headaches. In the multiple regression analysis, only anxiety was retained in the regression model ($\beta = 0.353$; $p < 0.001$). All outcomes are presented in Table 3.

For the group of TMD-pain patients with migraine, no significant associations between headache pain intensity and any of the psychosocial variables were present in the single regression analyses. After correcting for bruxism and the presence of concurrent headaches (in this case: TTH, $n = 39$), no significant associations were found with the adjusted p-value of $p < 0.011$. Hence, no multiple regression analysis was performed.

In patients with TMD-pain and TTH, no multiple regression analysis was performed as the single regression models were not significant ($p > 0.011$).

Pain-related disability

In patients with headache attributed to TMD, pain-related disability was associated with all psychosocial factors, except for optimism, in the single regression analyses ($\beta = 0.332 - 0.397$; $p \leq 0.001$), as well as the corrected single regression analyses ($\beta = 0.341 - 0.400$; $p \leq 0.001$). Somatization came out as the strongest variable in the multiple regression analysis ($\beta = 0.399$; $p < 0.001$). All outcomes are presented in Table 4.

In TMD-pain patients with migraine, there was no statistically significant association with any of the psychosocial factors and pain-related disability ($p > 0.011$) in the single regression analysis. Therefore, no adjusted regression analysis was performed (Table 4).

In TMD-pain patients with TTH there was an association between pain-related disability and all psychosocial factors in both the single regression and corrected single regression analyses ($\beta = -0.277 - 0.439$; $p \leq 0.001$). Depression was the strongest variable based on the multiple regression analysis ($\beta = 0.444$; $p < 0.001$).

DISCUSSION

The key findings of the current study were that in TMD-pain patients with primary headaches the psychosocial factors were not associated with headache pain intensity. In those with headache attributed to TMD, anxiety, depression, and somatic complaints were significantly associated with headache pain intensity, even after correction for concurrent headaches and bruxism. Pain-related disability was associated with psychosocial factors in TMD-pain patients with TTH and in TMD patients with headache attributed to TMD, but not in those with migraine.

The current study shows that, in patients with migraine and in patients with TTH, only some associations with pain-related disability were found and no associations were found with headache pain intensity. This is in contrast to TMD patients with a secondary headache attributed to TMD,

European Journal of Oral Sciences NOF Scandinavian Division IADR

TABLE 1 Characteristics of the study population, presented as mean values (SD), or as frequencies by number and percentage.

	Total study population ($N = 323$)	Migraine ($N = 79$)	TTH ($N = 145$)	Headache attributed to TMD ($N = 99$)
Patient characteristics				
Gender (female); *N* (%)	197 (61.0%)	46 (58.2%)	85 (58.6%)	66 (66.7%)
Age in years; mean ± SD	42.9 ± 14.4	41.4 ± 13.1	43.8 ± 15.6	42.7 ± 13.7
Myalgia; *N* (%)	122 (37.8%)	31 (39.2%)	59 (40.7%)	32 (32.3%)
Arthralgia; *N* (%)	40 (12.4%)	8 (10.1%)	26 (17.9%)	6 (6.1%)
Combined myalgia and arthralgia); *N* (%)	161 (49.8%)	40 (50.6%)	60 (41.4%)	61 (61.6%)
TMD pain intensity; mean ± SD	54.0 ± 26.7	53.1 ± 26.2	48.8 ± 27.0	62.6 ± 24.8
Headache pain-intensity; mean ± SD	6.2 ± 2.0	6.7 ± 1.7	5.4 ± 2.0	6.8 ± 2.0
Pain-related disability; mean ± SD	39.3 ± 30.4	40.4 ± 28.0	31.9 ± 29.4	49.2 ± 31.1
Psychosocial variables (range of instrument)				
Anxiety (0–21)	5.5 ± 5.1	5.9 ± 4.7	4.4 ± 4.5	7.0 ± 5.8
Somatization (1–30)	10.5 ± 5.0	10.9 ± 4.1	9.0 ± 4.3	12.3 ± 5.8
Depression (1–27)	6.9 ± 5.5	6.9 ± 5.0	6.0 ± 5.0	8.4 ± 6.3
Optimism (0–24)	15.6 ± 4.7	15.3 ± 4.7	15.8 ± 4.7	15.7 ± 4.8
Bruxism (0–4)	1.2 ± 1.0	1.2 ± 1.0	1.1 ± 0.9	1.2 ± 1.0

Abbreviations: *N*, number of patients; TMD, temporomandibular disorder; TTH, tension-type headache.

TABLE 2 Distribution of headache diagnoses in the study population.

	Single headache	Co-morbid migraine	Co-morbid TTH	Co-morbid migraine + TTH
TMD-pain and headache attributed to TMD ($N = 99$)	10	21	40	28
TMD-pain and migraine ($N = 79$)	40	n/a	39	n/a
TMD-pain and TTH ($N = 145$)	124	21	n/a	n/a

Note: Number of participants is depicted in each column.
Abbreviations: *N*, number of participants; TMD, temporomandibular disorder; TTH, tension-type headache.

where both headache pain intensity and pain-related disability are associated with all of the measured psychosocial variables, except for optimism. Higher scores on the presence of multiple somatic complaints were associated with a higher headache pain intensity in the patients with headache attributed to TMD. Somatic complaints are multiple persistent physical complaints such as pain, fatigue or dizziness, which are all common in patients with widespread pain [37, 44, 45]. Widespread pain is also common in individuals with TMD, and is considered an expression of central sensitization [15]. One of the symptoms of central sensitization is hypersensitivity for pain, explaining the higher headache pain intensity scores in patients with higher levels of somatization [46].

Additionally, the current study shows higher β values in TMD-pain patients with migraine after correcting for bruxism, than before correction, for all psychosocial factors except optimism in relation to pain intensity. For anxiety and somatization, bruxism impacted the associations with headache pain intensity. In TMD-pain patients with TTH or headache attributed to TMD, bruxism did not act as a confounder in any of the associations, which is in line with previous research showing bruxism to be a confounder in the association between TMD-pain and migraine [6]. Bruxism may act like a trigger for migraine by overloading the trigeminal system [19, 47], especially if there is peripheral sensitization. With a sensitized system, pain intensity may be perceived at higher levels particularly when other psychosocial factors are at play [48]. Future research should study the influence on bruxism in TMD-pain patients with migraine further.

Furthermore, evidence states that psychological factors can influence headache pain through central nervous system pathways [22], and could be mediated by the presence of central

TABLE 3 Single variable and multivariable linear regression for headache pain intensity in TMD-pain patients with headache, stratified by headache type.

	Step 1: Single variable regression		Step 2: Single variable regression (corrected for concurrent headache types[a])		Step 3: Single variable regression (corrected for concurrent headache types and bruxism)		Step 4: Multiple regression (corrected for bruxism and concurrent headache types[a])		
Pain intensity	***β***	**b (95% CI)**	***β***	**b (95% CI)**	***β***	**b (95% CI)**	***β***	**b (95% CI)**	**p (change in model)**
Migraine ($n = 79$)									
Depression	−0.16	−0.06 (−0.13, 0.02)	−0.17	−0.06 (−0.14, 0.02)	−0.20	−0.07 (−0.14, 0.01)	–	–	–
Anxiety	−0.15	−0.06 (−0.14, 0.03)	−0.15	−0.06 (−0.14, 0.03)	−0.18	**−0.07 (−0.15, 0.01)**	–	–	–
Somatization	0.08	0.03 (−0.06, 0.13)	0.05	**0.02 (−0.08, 0.12)**	0.08	**0.03 (−0.06, 0.13)**	–	–	–
Optimism	0.23	0.09 (0.00, 0.17)	0.24	0.09 (0.01, 0.17)	0.23	0.09 (0.01, 0.17)	–	–	–
Tension-type headache (n = 145)									
Depression	0.14	0.05 (−0.01, 0.12)	0.15[b]	**0.06**[c] **(−0.00, 0.12)**	0.152	0.06[c] (−0.00, 0.12)	–	–	–
Anxiety	0.11	0.05 (−0.03, 0.12)	0.11[b]	0.05[c] (−0.02, 0.12)	0.108	0.05[c] (−0.02, 0.12)	–	–	–
Somatization	0.17	0.08 (0.00, 0.15)	0.20[b]	**0.09**[c] **(0.02, 0.17)**	0.207	0.10[c] (0.02, 0.17)	–	–	–
Optimism	−0.03	−0.01 (−0.08, 0.06)	−0.04[b]	**−0.02**[c] **(−0.09, 0.05)**	−0.043	−0.02[c] (−0.09, 0.05)	–	–	–
Headache attributed to TMD ($n = 99$)									
Depression	0.38	0.12 (0.06, 0.18)	0.34	0.11[c] (0.05, 0.17)	0.34	0.12 (0.5, 0.17)	–	–	–
Anxiety	0.37	0.13 (0.06, 0.19)	0.35[b]	0.12[c] (0.06, 0.18)	0.35	0.12[c] (0.06, 0.19)	0.35	0.12[c] (0.06, 0.19)	<0.001
Somatization	0.38	0.13 (0.07, 0.19)	0.34	0.12 (0.06, 0.18)	0.34	0.12 (0.05, 0.18)	–	–	–
Optimism	−0.27	−0.11 (−0.19, −0.03)	−0.22	**−0.09 (−0.17, −0.01)**	−0.22	−0.09 (−0.17, −0.01)	–	–	–

Note: *β*: standardized coefficient; b: beta regression coefficient; CI: confidence interval; TMD: temporomandibular disorders; TTH: tension-type headache.

[a]Patients may have more than one headache diagnosis. When more than one headache is present, patients were classified according to pre-defined hierarchy criteria. In this step of the analysis, the single regression outcomes are corrected for the presence of the other concurrent headaches.

[b]Change in model is statistically significant (Alpha-value [corrected for multiple comparisons] = 0.011).

[c]The variable "concurrent migraine" is significant within the model.

Bold-faced regression coefficients depict estimates demonstrating > 10% change from previous step in the model.

sensitization [48]. In the current study, the psychosocial factors did not seem to influence perceived pain intensity in a population of TMD-pain patients with primary headache. Central sensitization and the chronicity of the complaints were not taken into account, which could have influenced these outcomes. Therefore, this should be studied more extensively in the future. Additionally, future research should consider prospective studies with a longitudinal design, to predict the influence of psychosocial factors on the development of pain intensity and pain-related disability in TMD-pain patients with headache.

The association between pain-related disability and the different psychosocial factors was stronger in TMD-pain patients with TTH or secondary headache attributed to TMD, compared to patients with TMD-pain and migraine in the current study. This indicates that migraine is quite a disabling type of headache, regardless of the presence of psychosocial factors, while suffering from TTH or headache attributed to TMD is more influenced by the presence of psychosocial factors. Depression was associated in all headache groups except for TMD-pain patients with migraine. In those with TTH, depression was the strongest factor in the model. Depression often comes with a lack of interest or pleasure in doing things, which could explain the higher disability scores. Other studies have shown that depression is associated with pain-related disability in patients with chronic pain [25, 49]. Overall, somatization, depression, and anxiety influence a person's mood, which can directly affect the impact of the pain complaints and increase the perceived disability. This is more strongly the case in women compared to men [50], and the current study consists of more women (61%) than men. Therefore, the findings of this study in relation to pain-related disability in TMD-pain patients with TTH or headache attributed to TMD are not surprising, but it is interesting that in those with migraine the psychosocial factors do not seem to influence the pain-related disability. Migraine itself is a very disabling disorder, especially in those with chronic migraine [51]. Unfortunately, the current study did not allow for further subclassification between episodic or chronic migraine, due to the relatively small sample size. It is recommended for future studies to analyze if there is a difference in influence of the psychosocial factors on pain-related disability depending on the level of chronicity of the migraine complaints.

TABLE 4 Single variable and multivariable linear regression for pain-related disability in TMD-pain patients with headache, stratified by headache type.

	Step 1: Single variable regression		Step 2: Single variable regression (corrected for concurrent headache types[a])		Step 3: Single variable regression (corrected for concurrent headache types and bruxism)		Step 4: Multivariable regression (corrected for bruxism and concurrent headache types[a])		
Pain-related disability	β	b (95% CI)	β	b (95% CI)	β	b (95% CI)	β	b (95% CI)	*p*-Value for *F* change
Migraine ($n = 79$)									
Depression	0.26	1.44 (0.21, 2.67)	0.24	1.36 (0.15, 2.58)	0.24	1.37 (0.14, 2.59)	–	–	–
Anxiety	0.21	1.26 (−0.09, 2.60)	0.20	1.21 (−0.11, 2.54)	0.20	1.22 (−0.12, 2.56)	–	–	–
Somatization	0.23	1.57 (0.05, 3.08)	0.19	**1.33 (−0.21, 2.86)**	0.20	1.35 (−0.21, 2.90)	–	–	–
Optimism	0.04	0.22 (−1.15, 1.58)	0.05	0.28 (−1.07, 1.63)	0.05	0.28 (−1.08, 1.64)	–	–	–
Tension-type headache ($n = 145$)									
Depression	0.44	2.57 (1.69, 3.45)	0.44	2.60 (1.71, 3.48)	0.44	2.63 (1.74, 3.51)	0.44	2.63 (1.74, 3.51)	<0.001
Anxiety	0.35	2.25 (1.24, 3.27)	0.35	2.25 (1.24, 3.27)	0.35	2.29 (1.27, 3.30)	–	–	–
Somatization	0.29	1.94 (0.87, 3.02)	0.30	2.01 (0.93, 3.20)	0.31	2.08 (0.99, 3.16)	–	–	–
Optimism	−0.27	−1.72 (−2.71, −0.72)	−0.28	−1.73 (−2.73, −0.74)	−0.28	−1.74 (−2.74, −0.74)	–	–	–
Headache attributed to TMD ($n = 99$)									
Depression	0.39	1.90 (0.99, 2.82)	0.40	1.97 (1.04, 2.91)	0.40	1.96 (1.03, 2.90)	–	–	–
Anxiety	0.339	1.77 (0.76, 2.79)	0.34	1.82 (0.79, 2.85)	0.34	1.83 (0.80, 2.86)	–	–	–
Somatization	0.40	2.12 (1.13, 3.10)	0.40	2.14 (1.13, 3.14)	0.40	2.13 (1.12, 3.14)	0.40	2.13 (1.12, 3.14)	0.002
Optimism	−0.21	−1.38 (−2.65, −0.11)	−0.22	−1.41 (−2.72, −0.10)	−0.22	−1.41 (−2.72, −0.09)	–	–	–

B: standardized coefficient; b: beta regression CI: confidence interval; TMD: temporomandibular disorders; TTH: tension-type headache. Corrected *p*-value suggesting statistical significance for all headache groups is $p < 0.011$.

[a]Patients may have more than one headache diagnosis. When more than one headache is present, patients were classified according to pre-defined hierarchy criteria. In this step of the analysis, the single regression outcomes are corrected for the presence of the other concurrent headaches.

Bold-faced regression coefficients depict estimates with > 10% change from previous step in the model.

The results of this study confirm that assessment of psychosocial factors like somatization and depression in the clinical setting is important information to collect. This is because certain psychosocial factors in TMD-pain patients with headache are found to influence the patient's pain-intensity and pain-related disability. The influence of psychosocial factors on headache pain intensity and pain-related disability in TMD patients should then be taken into consideration when tailoring treatment to the individual patient needs. Especially in patients with a headache attributed to TMD, counselling [52] and cognitive behavioral therapy [53] could be part of the treatment strategy, to acknowledge the associations with these psychosocial factors.

The current study was conducted at a specialized clinic for OPD. In this clinic, all practitioners work according to the DC/TMD protocol, which enhances the reliability of the data. However, not all eligible patients could be included in the study due to missing data from their medical records. This led to 21 patients with headache attributed to TMD not being included in the study due to missing information regarding their headache pain intensity. As this missing information was not missing at random, this may have some implications for the results. However, comparison of age and pain-related disability showed no significant differences with the study population (data not shown). Therefore, besides providing a bigger sample for the headache attributed to TMD group, we do not believe it would have changed the results in another way. Another limitation of the current study is the use of self-administered questionnaires to gather information on many of the variables used in this study. Patients may have provided answers which they feel will help to receive the treatment they preferred. Another common disadvantage of self-reported data relates to unreliable answers due to recall bias. However, the questionnaires used to assess psychosocial factors, headache pain-intensity, and pain-related disability do have good psychometric properties. The presence of migraine and TTH was based on the headache screening questionnaire, which has a high sensitivity (89% and 93%, respectively), but low specificity (54% and 48%, respectively). This means there is an enhanced chance of false-positive outcomes (patients incorrectly being classified as having a migraine or TTH), which could have influenced the outcomes. To have a better understanding of the influence of psychosocial factors on pain outcomes in various headache patients, replication of the study results while using a clinical confirmation of the headache diagnosis is recommended. Bruxism was also assessed by using a questionnaire, which would be considered as possible bruxism. Possible bruxism yields less certainty of a diagnosis than definite bruxism, where the gold standard of a polysomnography is used [18]. However, in order to be able to compare the results of the current study to the previous study which described bruxism as a confounder in the association between migraine and painful TMD, the same assessment tool was used. That is why in the current study, no differentiation was made between awake and sleep bruxism, which should be done in future research as awake and sleep bruxism have different associations with TMD and psychosocial factors [54].

A strength of the current study is that the multiple regression models that were used were built including a correction for the influence of bruxism on the studied associations. Hence, previous research has shown that bruxism does confound the association between painful TMD and headache [6]. Moreover, awake bruxism is associated with myofascial TMD as well as with psychosocial factors like anxiety and depression [30, 54]. By correcting for bruxism, the influence of the different psychosocial factors on pain intensity and pain-related disability can be better identified [55]. Previous studies have shown various associations between painful TMD and psychosocial factors [25, 56, 57]. In a TMD population from an orofacial pain clinic, a positive association was found between TMD pain intensity and anxiety, somatization, and depression [26]. In the current study, similar associations as reported in the literature for TMD pain intensity were found in patients with headache attributed to TMD [26].

In conclusion, in patients with TMD and a primary headache (migraine and/or TTH), no associations were found between the psychosocial factors (depression, anxiety, somatic complaints, and optimism) and headache pain intensity. For pain-related disability, only in TMD-pain patients with TTH were significant associations with the psychosocial factors found; not in those with migraine. In TMD patients with a secondary headache attributed to TMD, both headache pain intensity and pain-related disability were associated with all of the measured psychosocial variables, except for optimism. It is of importance for health care providers to screen for these factors and to optimize treatment.

AUTHOR CONTRIBUTIONS

Conceptualization: Hedwig van der Meer, Cornel Tol, Corine Visscher; **Methodology**: Hedwig van der Meer, Cornel Tol, Caroline Speksnijder, Maurits van Selms, Frank Lobbezoo, Corine Visscher; **Validation**: Hedwig van der Meer, Cornel Tol, Caroline Speksnijder, Maurits van Selms, Frank Lobbezoo, Corine Visscher; **Formal analysis**: Hedwig van der Meer, Cornel Tol, Caroline Speksnijder, Corine Visscher; **Investigation**: Hedwig van der Meer, Cornel Tol; **Resources**: Maurits van Selms, Frank Lobbezoo, Corine Visscher; **Data curation**: Maurits van Selms; **Writing—original draft preparation**: Hedwig van der Meer, Cornel Tol; **Writing - review and editing**: Caroline Speksnijder, Maurits van Selms, Frank Lobbezoo, Corine Visscher; **Visualization**: Hedwig van der Meer; **Supervision**: Caroline Speksnijder, Maurits van Selms, Frank Lobbezoo, Corine Visscher; **Project administration**: Hedwig van der Meer, Frank Lobbezoo, Corine Visscher; **Funding acquisition**: Hedwig van der Meer, Caroline Speksnijder, Corine Visscher.

ACKNOWLEDGMENTS

This study was funded by the Dutch Organization for Scientific Research (Nederlandse Organisatie voor Wetenschappelijk Onderzoek—NWO) [grant number 023.006.004].

CONFLICTS OF INTEREST STATEMENT

None of the authors declared a conflict of interest.

ORCID

Hedwig A van der Meer https://orcid.org/0000-0002-6848-9629
Cornel H. M Tol https://orcid.org/0000-0002-4327-1762
Caroline M Speksnijder https://orcid.org/0000-0003-0540-3741
Maurits K. A van Selms https://orcid.org/0000-0002-0792-4930
Corine M Visscher https://orcid.org/0000-0002-4448-6781

REFERENCES

1. Anastassaki Köhler A, Hugoson A, Magnusson T. Prevalence of symptoms indicative of temporomandibular disorders in adults: cross-sectional epidemiological investigations covering two decades. Acta Odontol Scand. 2012;70:213–23.
2. Schiffman E, Ohrbach R, Truelove E, Look J, Anderson G, Goulet J.-P., et al. Diagnostic criteria for temporomandibular disorders (DC/TMD) for clinical and research applications: recommendations of the International RDC/TMD consortium network and orofacial pain special interest group. J Oral Facial Pain Headache. 2014;28:6–27.
3. Slade GD, Bair E, Greenspan JD, Dubner R, Fillingim RB, Diatchenko L, et al. Signs and symptoms of first-onset TMD and sociodemographic predictors of its development: the OPPERA prospective cohort study. J Pain. 2013;14(Suppl):T20-T32.E3.
4. National Institute of Dental and Craniofacial Research. Facial Pain Statistics. 2018. [cited 2020 Jan 15]. Available from: https://www.nidcr.nih.gov/research/data-statistics/facial-pain
5. Fernandes G, Franco AL, Goncalves DAG, Speciali JG, Bigal ME, Camparis CM. Temporomandibular disorders, sleep bruxism, and Primary Headaches are mutually associated. J Orofac Pain. 2013;27:14–20.
6. van der Meer HA, Speksnijder CM, Engelbert RHH, Lobbezoo F. Nijhuis-van der Sanden WGM, Visscher CM. The association between headaches and temporomandibular disorders is confounded by bruxism and somatic complaints. Clin J Pain. 2017;33:835–43.
7. Stovner LJ, Andree C. Prevalence of headache in Europe: a review for the Eurolight project. J Headache Pain. 2010;11:289–99.

8. Goncalves DAG, Camparis CM, Speciali JG, Franco AL, Castanharo SM, Bigal ME. Temporomandibular disorders are differentially associated with headache diagnoses; a controlled study. Clin J Pain. 2011;27:611–15.
9. Headache Classification Committee of the International Headache Society I. The International Classification of Headache Disorders, 3rd edition. Cephalalgia. 2018;38:1–211.
10. Speciali JG, Dach F. Temporomandibular dysfunction and headache disorder. Headache J Head Face Pain. 2015;55: 72–83.
11. Olesen J, Burstein R, Ashina M, Tfelt-Hansen P. Origin of pain in migraine: evidence for peripheral sensitisation. Lancet Neurol. 2009;8:679–90.
12. Noseda R, Burstein R. Migraine pathophysiology: anatomy of the trigeminovascular pathway and associated neurological symptoms, cortical spreading depression, sensitization, and modulation of pain. Pain. 2013;154(Suppl 1). https://doi.org/10.1016/j.pain.2013.07.021
13. Bendtsen L. Central sensitization in tension-type headache–possible pathophysiological mechanisms. Cephalalgia. 2000;20: 486–508.
14. Schiffman E, Ohrbach R, List T, Anderson G, Jensen R, John MT, et al. Diagnostic criteria for headache attributed to temporomandibular disorders. Cephalalgia. 2012;32:683–92.
15. Campi L, Visscher C, Ongaro P, Guilherme B, Giovana F, Goncalves D. Widespread pain and central sensitization in adolescents with signs of painful temporomandibular disorders. J Oral Facial Pain Headache. 2020;34:83-91.
16. La Touche R, Paris-Alemany A, Hidalgo-Pérez A, López-deUralde-Villanueva I, Angulo-Diaz-Parreño S, Muñoz-García D. Evidence for central sensitization in patients with temporomandibular disorders: a systematic review and meta-analysis of observational studies. Pain Pract. 2018;18:388–409.
17. Costa YM, Conti PCR, de Faria FAC, Bonjardim LG. Temporomandibular disorders and painful comorbidities: clinical association and underlying mechanisms. Oral Surg Oral Med Oral Pathol Oral Radiol. 2017;123:288-97.
18. Lobbezoo F, Ahlberg J, Glaros AG, Kato T, Koyano K, Lavigne GJ, et al. Bruxism defined and graded: an international consensus. J Oral Rehabil. 2013;40:2–4.
19. Zaproudina N, Lipponen JA, Tarvainen MP, Vierola A, Rissanen SM, Karjalainen PA, et al. Autonomic responses to tooth clenching in migraineurs-augmented trigeminocardiac reflex? J Oral Rehabil. 2018;45:764–9.
20. Harper DE, Schrepf A, Clauw DJ. Pain mechanisms and centralized pain in temporomandibular disorders. J Dent Res. 2016;9:1102–8.
21. Peñacoba-Puente C, Fernández-de-Las-Peñas C, González-Gutierrez JL, Miangolarra-Page JC, Pareja JA. Interaction between anxiety, depression, quality of life and clinical parameters in chronic tension-type headache. Eur J Pain. 2008;12:886–94.
22. Nicholson RA, Houle TT, Rhudy JL, Norton PJ. Psychological risk factors in Headache. Headache. 2007;47:413-26.
23. Vranceanu AM, Bachoura A, Weening A, Vrahas M, Smith RM, Ring D. Psychological factors predict disability and pain intensity after skeletal trauma. J Bone Jt Surg - Ser A. 2014;96:e20.
24. Turner JA, Jensen MP, Warms CA, Cardenas DD. Catastrophizing is associated with pain intensity, psychological distress, and pain-related disability among individuals with chronic pain after spinal cord injury. Pain. 2002;98:127–34.
25. Lerman SF, Rudich Z, Brill S, Shalev H, Shahar G. Longitudinal associations between depression, anxiety, pain, and pain-related disability in chronic pain patients. Psychosom Med. 2015;77:333–41.
26. Su N, Lobbezoo F, van Wijk A, van der Heijden GJMG, Visscher CM. Associations of pain intensity and pain-related disability with psychological and socio-demographic factors in patients with temporomandibular disorders: a cross-sectional study at a specialised dental clinic. J Oral Rehabil. 2017;44:187–96.
27. Manfredini D, Marini M, Pavan C, Pavan L, Guarda-Nardini L. Psychosocial profiles of painful TMD patients. J Oral Rehabil. 2009;36:193–8.
28. Song TJ, Cho SJ, Kim WJ, Yang KI, Yun CH, Chu MK. Anxiety and depression in tension-type headache: a population-based study. PLoS One. 2016;11:e0165316.
29. Lampl C, Thomas H, Tassorelli C, Katsarava Z, Laínez JM, Lantéri-Minet M, et al. Headache, depression and anxiety: associations in the Eurolight project. J Headache Pain. 2016;17:59.
30. Manfredini D, Lobbezoo F. Role of psychosocial factors in the etiology of bruxism. J Orofac Pain. 2009;23:153–66.
31. von Elm E, Altman DG, Egger M, Pocock SJ, Gøtzsche PC, Vandenbroucke JP. The strengthening the reporting of observational studies in epidemiology (STROBE) statement: guidelines for reporting observational studies. PLoS Med. 2007;4:e296.
32. van der Meer HA, Visscher CM, Engelbert RHH, Mulleners WM, Nijhuis-van der Sanden WGM, Speksnijder CM. Development and psychometric validation of the headache screening questionnaire—Dutch Version. Musculoskelet Sci Pract. 2017;31:52–61.
33. Williamson A, Hoggart B. Pain: a review of three commonly used pain rating scales. J Clin Nurs. 2005;14:798–04.
34. Kahl C, Cleland JA. Visual analogue scale, numeric pain rating scale and the McGill pain Questionnaire: an overview of psychometric properties. Phys Ther Rev. 2005;10:123–8.
35. Von Korff M, Ormel J, Keefe FJ, Dworkin SF. Grading the severity of chronic pain. Pain. 1992;50:133–49.
36. Spitzer RL, Kroenke K, Williams JBW, Löwe B. A brief measure for assessing generalized anxiety disorder: the GAD-7. Arch Intern Med. 2006;166:1092–7.
37. Kroenke K, Spitzer RL, Williams JBW. The PHQ-15: validity of a new measure for evaluating the severity of somatic symptoms. Psychosom Med. 2002;64:258–66.
38. Kroenke K, Spitzer RL, Williams JBW. The PHQ-9: validity of a brief depression severity measure. J Gen Intern Med. 2001;16:606–13.
39. Scheier MF, Carver CS, Bridges MW. Distinguishing optimism from neuroticism (and trait anxiety, self-mastery, and self-esteem): a reevaluation of the Life Orientation Test. J Pers Soc Psychol. 1994;67:1063–78.
40. Glaesmer H, Rief W, Martin A, Mewes R, Brähler E, Zenger M, et al. Psychometric properties and population-based norms of the Life Orientation Test Revised (LOT-R). Br J Health Psychol. 2012;17:432–45.
41. van der Meulen M, Lobbezoo F, Aartman I, Naeije M. Validity of the Oral Behaviours Checklist: Correlations between OBC scores and intensity of facial pain. J Oral Rehabil. 2014;41:115–21.
42. Field AP. Discovering statistics using IBM SPSS statistics (4th ed.). SAGE Publications; 2013.
43. Kamangar F. Confounding variables in epidemiologic studies: basics and beyond. Arch Iran Med. 2012;15:508–16.

44. Mansfield KE, Sim J, Croft P, Jordan KP. Identifying patients with chronic widespread pain in primary care. Pain. 2017;158:110–9.
45. Kroenke K. Patients presenting with somatic complaints: epidemiology, psychiatric co-morbidity and management. Int J Methods Psychiatr Res. 2003;12:34–43.
46. Woolf CJ. Central sensitization: implications for the diagnosis and treatment of pain. Pain. 2011;152(Suppl 3):S2-15.
47. Zaproudina N, Rissanen APE, Lipponen JA, Vierola A, Rissanen SM, Karjalainen PA, et al. Tooth clenching induces abnormal cerebrovascular responses in migraineurs. Front Neurol. 2018;9. https://doi.org/10.3389/fneur.2018.01112
48. Shigetoh H, Tanaka Y, Koga M, Osumi M, Morioka S. The mediating effect of central sensitization on the relation between pain intensity and psychological factors: a cross-sectional study with mediation analysis. Pain Res Manag. 2019:3916135.
49. Arnow BA, Blasey CM, Constantino MJ, Robinson R, Hunkeler E, Lee J, et al. Catastrophizing, depression and pain-related disability. Gen Hosp Psychiatry. 2011;33:150–6.
50. Hirsh AT, Waxenberg LB, Atchison JW, Gremillion HA, Robinson ME. Evidence for sex differences in the relationships of pain, mood, and disability. J Pain. 2006;7:592–01.
51. Emadi F, Sharif F, Shaygan M, Shaygan M, Shariffi N, Ashiazadeh N. Comparison of pain-related and psychological variables between acute and chronic migraine patients, and factors affecting headache chronicity. Int J Community Based Nurs Midwifery. 2019;7:192–200.
52. De Freitas RFCP, F MÂF, Barbosa GAS, Calderon PS. Counselling and self-management therapies for temporomandibular disorders: a systematic review. J Oral Rehabil. 2013;40:864–74.
53. Turner JA, Mancl L, Aaron LA. Short- and long-term efficacy of brief cognitive-behavioral therapy for patients with chronic temporomandibular disorder pain: a randomized, controlled trial. Pain. 2006;121:181–94.
54. Baad-Hansen L, Thymi M, Lobbezoo F, Svensson P. To what extent is bruxism associated with musculoskeletal signs and symptoms? A systematic review. J Oral Rehabil. 2019;46:845–61.
55. Pourhoseingholi MA, Baghestani AR, Vahedi M. How to control confounding effects by statistical analysis. Gastroenterol Hepatol Bed Bench. 2012;5:79–83.
56. Canales GDLT, Guarda-Nardini L, Rizzatti-Barbosa CM, Conti PCR, Manfredini D. Distribution of depression, somatization and pain-related impairment in patients with chronic temporomandibular disorders. J Appl Oral Sci. 2019;27:e20180210.
57. Kothari S, Baad-Hansen L, Svensson P. Psychosocial profiles of temporomandibular disorder pain patients: proposal of a new approach to present complex data. J Oral Facial Pain Headache. 2017;31:199–209.

How to cite this article: van der Meer HA, Tol CHM, Speksnijder CM, van Selms MKA, Lobbezoo F, Visscher CM. Psychosocial factors associated with pain outcomes in patients with painful temporomandibular disorders and headaches. Eur J Oral Sci. 2023;131:e12919. https://doi.org/10.1111/eos.12919