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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

N. SU*[†‡], F. LOBBEZOO[§], A. VAN WIJK[‡], G. J. M. G. VAN DER HEIJDEN[‡] & C. M. VISSCHER[§] *State Key Laboratory of Oral Disease, West China Hospital of Stomatology, Sichuan University, Chengdu, , [†]Department of Prosthodontics, West China Hospital of Stomatology, Sichuan University, Chengdu, China, [‡]Department of Social Dentistry, Academic Center for Dentistry Amsterdam (ACTA), University of Amsterdam and VU University Amsterdam, Amsterdam, and [§]Department of Oral Kinesiology, Academic Center for Dentistry Amsterdam (ACTA), University of Amsterdam and VU University Amsterdam, MOVE Research Institute Amsterdam, Amsterdam, The Netherlands

SUMMARY **The study assessed whether psychological and socio-demographic factors, including somatisation, depression, stress, anxiety, daytime sleepiness, optimism, gender and age, are associated with pain intensity and pain-related disability in patients with temporomandibular disorders (TMDs). In total, 320 TMD patients were involved in the study. The psychological status of each patient was assessed with questionnaires, including the Symptom Checklist-90 (SCL-90), Epworth Sleeping Scale (ESS), stress questionnaire and Life Orientation Test-Revised (LOT-R). TMD pain, including pain intensity and pain-related disability, was assessed with characteristic pain intensity (CPI) and disability points scales. The associations of psychological and socio-demographic factors with pain intensity and pain-related disability were assessed through logistic regression analyses. Higher pain intensity was significantly associated with more severe anxiety ($P = 0{\cdot}004$), more severe somatisation ($P < 0{\cdot}001$), more severe depression ($P < 0{\cdot}001$), more severe stress ($P = 0{\cdot}001$) and lower optimism ($P = 0{\cdot}025$) in univariate regression analyses. However, multiple regression analysis showed that only somatisation was significantly associated with pain intensity ($P < 0{\cdot}001$). Higher pain-related disability was significantly associated with more severe anxiety ($P < 0{\cdot}001$), more severe somatisation ($P < 0{\cdot}001$), more severe depression ($P < 0{\cdot}001$), more severe stress ($P < 0{\cdot}001$) and lower optimism ($P = 0{\cdot}003$) in univariate regression analyses. However, multiple regression analysis showed that only depression was significantly associated with pain-related disability ($P = 0{\cdot}003$). Among the psychological and socio-demographic factors in this study, somatisation was the best predictor of pain intensity, while depression was the best predictor of pain-related disability.**

KEYWORDS: **temporomandibular joint disorders, chronic pain, mental disorders, somatoform disorders, depression, association**

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Introduction

Temporomandibular joint disorders (TMDs), which consists of a group of disorders that are related to temporomandibular joint (TMJ), masticatory muscles or both (1), are considered as the most common non-odontogenic chronic oro-facial pain condition that is seen by dentists (2). It has been shown that 50–70% of the population worldwide has signs and symptoms of TMD at some stage of their life, including pain,

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limited range of jaw movement and TMJ noises (3). For most TMDs, pain is the main symptom and also the main reason for patients to seek treatment (4). In case of persistent or recurrent pain, TMD may follow a chronic course (3). It is reported that the prevalence of TMD pain in the general population ranges from 4·0% to 15·0% in countries around the world (5–8).

Nowadays, it is recognised that pain is influenced by a dynamic interaction between physical, psychological and social factors (9). Each individual has the unique experience of pain. Also, several psychological and social factors can interact with physical pathology to affect a patient's self-report of symptoms and subsequent disability (9). Several psychological factors, such as somatisation, depression, anxiety and psychological stress, are understood to be important in the assessment and management of TMD (10). Besides, chronic pain is disabling and can impair cognitive functions such as concentration and memory, disrupt the sleep cycle, produce changes in personality, lead to a decrease in activities of daily living and stop people to participate in social and other activities (11). Therefore, it has been suggested that the primary goal of treatment for chronic pain should focus on prevention or reduction of prolonged pain-related disability (11). Several previous studies have shown that TMD patients with high levels of pain-related disability or Graded Chronic Pain Scale (GCPS) showed the highest level of depression, somatisation, sleep dysfunction, worry and catastrophising thoughts (12–14). Another study (15), however, showed that GCPS was not significantly associated with depression in TMD patients and the author attributed the controversy of the association between depression and GCPS to the small sample size.

Until now, although studies generally have found positive associations between pain-related disability and psychological factors, the available information on the associations between pain intensity and psychological factors, on the association between pain-related disability and optimism and sleep, or on the association of both pain intensity and pain-related disability with socio-demographic factors in TMD patients is scarce. Insight into the relationship between pain intensity or pain-related disability and these psychological factors is important to provide dentists with underlying diagnostic inferences and deepen our insight into the complex interaction between patients' physical pain intensity or pain-related disability and psychosocial impairment. Besides, the Diagnostic Criteria for TMDs (DC/TMD) were newly introduced in 2014. The axis II of the DC/TMD for psychosocial assessment is suggested to be useful in the clinical setting (16). However, no previous study concerning the association of pain intensity or pain-related disability with psychological factors has been carried out using the data gathered by the use of the axis II of the DC/TMD before. It is nonetheless important to have the DC/TMD data collected to test whether different components of the axis II assessments of the DC/TMD are related to each other, and to compare them with findings from the previous investigations using different psychosocial questionnaires in the Research Diagnostic Criteria for Temporomandibular Disorders (RDC/TMD).

So, for this study, the purpose was to evaluate whether psychological factors, including somatisation, depression, anxiety, sleep disturbance at night, daytime sleepiness, stress and optimism, are associated with pain intensity or pain-related disability in TMD patients.

Methods

Patient sample

The data collection followed a cross-sectional design and included 320 patients who were referred from September 2014 through February 2016 for TMDs to the Department of Oral Kinesiology of the Academic Centre for Dentistry Amsterdam. Included patients were at least 18 years of age, diagnosed with TMD according to the Axis I of the Diagnostic Criteria for TMDs (DC/TMD) (16), provided written informed consent and had no missing data for any variable and outcome. At intake, the procedure follows the DC/TMD protocol, which consists of several questions, a standardised oral history and a clinical examination.

Collection of data

Pain intensity. Oro-facial pain intensity was measured with the characteristic pain intensity (CPI) scale (17). This scale ranges from 0 (no pain) to 100 (pain as bad as it could be) and is the mean of pain intensities reported for 'current pain' status, and the 'worst pain' and 'average pain' in the past 6 months. Pain intensity was classified into two categories: low intensity (CPI $<$ 50) and high intensity (CPI $\geq$ 50) (17).

Pain-related disability. Oro-facial pain-related disability was assessed with the so-called disability points (17). Disability points range from 0 to 6 and are based on the disability score (the mean ratings of how much the pain has interfered in performing activities of daily living, work and social activities in the last 6 months) and disability days (the number of days that the respondent was away from usual activities in the last 6 months due to facial pain) (17). Pain-related disability was classified into two groups: no disability (disability points <3) and moderate-to-severe disability (disability points ≥3) (17).

Anxiety. The 7-item Generalized Anxiety Disorder (GAD-7) was used to assess patients' anxious mood and behaviour over the past 2 weeks. Higher scores indicate more severe anxiety disorder. The sum score of GAD-7 can be classified into four categories: no anxiety, mild anxiety, moderate anxiety and severe anxiety (18).

Somatisation. The 15-item Patient Health Questionnaire (PHQ-15) was used to assess patients' non-specific physical symptoms, also referred to as functional symptoms or medically unexplained symptoms, over the past 4 weeks. Higher sum scores indicate more severe somatisation. The sum score of PHQ-15 can be classified into four categories: no somatisation, low somatisation, medium somatisation and high somatisation (19).

Depression. The 9-item Patient Health Questionnaire (PHQ-9) was used to assess patients' depressed mood over the past 2 weeks. Higher sum scores indicate more severe depression. The sum score of PHQ-9 can be classified into five categories: no depression, mild depression, moderate depression, moderate-to-severe depression and severe depression (20).

Stress. Psychological stress during daily life was measured using a 7-item questionnaire developed by Van der Meulen *et al.* (21), covering the stress on the following six domains: home or family, work or school, financial, social or personal relationships, health and other worries in the last 6 months. Another question asked directly for the overall amount of stress experienced during the past month. Higher sum scores indicate more stress in daily life. The mean of the sum score of stress questionnaire can be classified into five categories: no stress (0), a little bit stress (1), somewhat stress (2), much stress (3) and very much stress (4).

Daytime sleepiness. The Epworth Sleeping Scale (ESS) (22) was used to evaluate patients' average chronic daytime sleepiness in recent times and consists of eight questions. Patients report on how likely it is that they would doze off in eight different situations. Higher scores indicate more severe chronic daytime sleepiness in daily life. The sum score of ESS can be classified into three categories: normal, sleepy and very sleepy.

Optimism. Patients' optimism was assessed using the Life Orientation Test-Revised (LOT-R) (23), which consists of 10 questions: six items to measure optimism and four filler items. Among the six actual items, three are worded positively for optimism and the other three are worded negatively for pessimism. The total score ranges from 0 to 24, with higher scores indicating higher level of optimism.

Statistical analysis

For the category variables (anxiety, somatisation, depression, stress and daytime sleepiness), the distributions of data for low/high pain intensity and no/moderate-to-severe pain-related disability were expressed as absolute numbers of patients for each category of variables. For the continuous variable (optimism), the distribution of data was expressed as mean (standard deviation). Mann–Whitney *U*-tests were used to compare the mean ranking of different categories of category (ordinal) variables between low and high pain intensity and between no and moderate-to-severe pain-related disability. Independent-sample *t*-tests were used to compare the means between low and high pain intensity and between no and moderate-to-severe pain-related disability for continuous variable. Colinearity tests of the variables were performed with Spearman's rank correlation tests. If the correlation coefficients between variables were smaller than 0·9, the variables were thought to have no colinearity and can be included in the regression analyses. Binary logistic regression analysis was then used to evaluate the associations between pain intensity or pain-related disability and psychological factors. Firstly, univariate regression analyses were

used to detect which independent variables were significantly associated with pain intensity or pain-related disability. Variables with a P value equal to or below 0·10 were selected in the multiple regression analyses. The multiple regression analyses (backward selection procedures, $P > 0·05$ for removal) were used to find out the best independent variables that can predict pain intensity or pain-related disability. All results were considered statistically significant at $P < 0·05$.

All the statistics mentioned above were performed using SPSS 21.0*.

Results

A total of 320 patients (250 females and 70 males) met the inclusion criteria and were enrolled in the study. The mean age of included patients was 43·2 ± 14·6 years (females 43·4 ± 14·5 and males 42·1 ± 15·2).

As for CPI, 156 (48·8%) patients had low intensity of TMD pain and 164 (51·3%) had high intensity of TMD pain. The distributions of psychological and socio-demographic factors for the two pain intensity groups are presented in Table 1. Statistically significant differences between the low pain intensity group and the high pain intensity group were found for anxiety ($U = 10\,576·0$, $P = 0·003$), somatisation ($U = 7917·5$, $P < 0·001$), depression ($U = 9311·5$, $P < 0·001$), stress ($U = 9725·5$, $P < 0·001$) and optimism ($t = 2·275$, $P = 0·024$).

As for the pain-related disability, 236 (73·8%) patients had no disability and 84 patients (26·2%) had moderate-to-severe disability due to TMD pain. The summary scores of psychological and socio-demographic factors based on pain-related disability are presented in Table 1. Statistically significant differences between the two disability groups were found for anxiety ($U = 6327·0$, $P < 0·001$), somatisation ($U = 5810·0$, $P < 0·001$), depression ($U = 5524·0$, $P < 0·001$), stress ($U = 7089·5$, $P < 0·001$) and optimism ($t = 3·024$, $P = 0·003$).

The correlation coefficients between variables were all smaller than 0·9 (Table 2). Hence, all the variables could be included for logistic regression analyses.

*IBM, New York, NY, USA

As for the CPI, in the univariate analyses, the direction of overall effect was the same for all included independent variables, except optimism, gender and age. That is, higher pain intensity tended to be associated with more severe anxiety, somatisation, depression, stress and daytime sleepiness but lower optimism and younger age. Also, females were more likely to have higher pain intensity than males. The variables of anxiety, somatisation, depression, stress, optimism and gender did not reach the 0·10 threshold for significance and were included for multivariate analyses (Table 3). In the multivariate analyses, the results showed that only somatisation was included in the final model as a significant predictor of pain intensity (Table 3).

As for the pain-related disability, in the univariate analyses, the direction of overall effect was the same for all included independent variables, except optimism and age. That is, higher pain-related disability tended to be associated with more severe anxiety, somatisation, depression, stress and daytime sleepiness but lower optimism. Also, males were more likely to have higher pain-related disability than females and age were not associated with pain-related disability. The variables of anxiety, somatisation, depression, stress, daytime sleepiness and optimism did not reach the 0·10 threshold for significance (Table 4). In the multivariate analyses, the results showed that only depression was included in the final model as a significant predictor of pain-related disability (Table 4).

Discussion

In the present study, somatisation was the best predictor of pain intensity. Higher pain intensity was associated with more severe somatisation. Patients with low somatisation, medium somatisation and high somatisation had 1·5, 3·7 and 9·5 times higher odds of suffering high pain intensity relative to no somatisation. The size, direction and significance of somatisation did not change from univariate analyses to multivariate analyses. In the PHQ-15, physical symptoms include pain such as headache and pain in stomach, back, chest, arms, legs or joints as well as non-pain symptoms such as feeling tired or having low energy or dizziness. The reason why TMD patients with more severe somatisation are more likely to have higher intensity of oro-facial pain may be due to chronic widespread musculoskeletal pain (CWMP) (24). The muscles, whether

Table 1. Distributions of data of psychological and socio-demographic variables based on both pain intensity and pain-related disability (N = 320)

		Pain intensity			Pain-related disability		
	Number of patients	Low intensity (N = 156)	High intensity (N = 164)	P value	No disability (N = 236)	Moderate-to-severe disability (N = 84)	P value
Anxiety							
No anxiety	187	101	86	0·003	155	32	<0·001
Mild	69	37	32		54	15	
Moderate	41	14	27		19	22	
Severe	23	4	19		8	15	
Somatisation							
No somatisation	64	44	20	<0·001	57	7	<0·001
Low	115	69	46		97	18	
Medium	88	33	55		57	31	
High	53	10	43		25	28	
Depression							
No depression	156	91	65	<0·001	134	22	<0·001
Mild	93	49	44		74	19	
Moderate	37	11	26		15	22	
Moderate-to-severe	21	3	18		9	12	
Severe	13	2	11		4	9	
Stress							
No stress	37	21	16	<0·001	31	6	<0·001
A little bit	155	90	65		123	32	
Somewhat	61	25	36		48	13	
Much	41	15	26		25	16	
Very much	26	5	21		9	17	
Daytime Sleepiness							
Normal	260	128	132	0·600	197	63	0·067
Sleepy	49	26	23		34	15	
Very sleepy	11	2	9		5	6	
Optimism (mean ± s.d.)	320	16·13 ± 4·42	14·96 ± 4·77	0·024	16·00 ± 4·50	14·24 ± 4·79	0·003
Gender							
Female	250	115	135	0·063	186	64	0·617
Male	70	41	29		50	20	
Age (mean ± s.d.)	320	43·58 ± 15·40	42·73 ± 13·91	0·604	43·17 ± 14·66	43·08 ± 14·66	0·963

Table 2. Correlation coefficients between variables

	Anxiety	Somatisation	Depression	Stress	Daytime sleepiness	Optimism	Gender
Somatisation	0·453						
Depression	0·678	0·625					
Stress	0·684	0·453	0·615				
Daytime sleepiness	0·294	0·189	0·303	0·268			
Optimism	−0·417	−0·237	−0·422	−0·366	−0·141		
Gender	−0·023	−0·209	−0·073	−0·049	0·041	−0·029	
Age	−0·015	−0·024	0·028	−0·046	0·029	0·038	−0·037

healthy or painful, have the capacity to produce symptoms. Evidence points towards a significant role of the central nervous system (CNS), with central sensitisation as the presumed underlying mechanism (25). Central sensitisation is defined as an amplification of neural signalling within the CNS that elicits pain

Table 3. Univariate and multivariate (backward selection, $P > 0{\cdot}05$ for removal) logistic regression analyses of psychological variables for characteristic pain intensity in temporomandibular disorders patients ($N = 320$)

	Univariate analyses				Multivariate analyses			
Variables	*B*	Standard error (SE)	Odds ratio (OR) (95% CI)	*P* value	*B*	Standard error (SE)	Odds ratio (OR) (95% CI)	*P* value
Anxiety				0·004*				
No anxiety	Reference							
Mild	0·016	0·282	1·016 (0·584 1·767)	0·956				
Moderate	0·818	0·361	2·265 (1·117 4·592)	0·023				
Severe	1·719	0·569	5·578 (1·828 17·027)	0·003				
Somatisation				<0·001*				<0·001*
No somatisation	Reference				Reference			
Low	0·383	0·330	1·467 (0·768 2·801)	0·246	0·383	0·330	1·467 (0·768 2·801)	0·246
Medium	1·299	0·348	3·667 (1·853 7·255)	<0·001	1·299	0·348	3·667 (1·853 7·255)	<0·001
High	2·247	0·443	9·460 (3·973 22·528)	<0·001	2·247	0·443	9·460 (3·973 22·528)	<0·001
Depression				<0·001*				
No depression	Reference							
Mild	0·229	0·264	1·257 (0·750 2·108)	0·385				
Moderate	1·197	0·395	3·309 (1·527 7·172)	0·002				
Moderate-to-severe	2·128	0·644	8·400 (2·376 29·703)	0·001				
Severe	2·041	0·786	7·700 (1·651 35·913)	0·009				
Stress				0·001*				
No stress	Reference							
A little bit	−0·053	0·370	0·948 (0·459 1·956)	0·885				
Somewhat	0·637	0·422	1·890 (0·827 4·320)	0·131				
Much	0·822	0·464	2·275 (0·916 5·648)	0·076				
Very much	1·707	0·598	5·512 (1·707 17·802)	0·004				
Daytime sleepiness				0·147				
Normal	Reference							
Sleepy	−0·153	0·312	0·858 (0·465 1·581)	0·623				
Very sleepy	1·473	0·792	4·364 (0·925 20·587)	0·063				
Optimism	−0·056	0·025	0·946 (0·901 0·993)	0·025*				
Gender								
Female	Reference							
Male	−0·507	0·274	0·603 (0·352 1·031)	0·064				
Age	−0·004	0·008	0·996 (0·981 1·011)	0·603				

*Overall *P* value of the variable is <0·05.

hypersensitivity and can cause a spread of pain sensitivity across the peripheral nerve system (26). This spread of pain is a normal and short-lived response of the nervous system in case of nociceptive input (25). However, in some patients, this normally transient response develops into a chronic state (25). In this situation, pain usually becomes more widespread and may result in CWMP. Pain hypersensitivity can cause heightened responsiveness to quantitative sensory testing as well as spontaneous clinical pain from deep tissues such as muscles, joints and visceral organs (27). So, patients with CWMP often present with multiple pain conditions including oro-facial pain (25). Genetic predisposition and psychological stressors are thought to influence the development of central sensitisation (24, 25, 27–29). Also, some other possible reasons were reported based on the previous literature. Firstly, somatic symptoms could result from parafunctional behaviours such as bruxism or nail-biting or other behavioural changes such as sleep disturbance, and this can in turn increase the risk of TMD, thus exacerbating the symptoms of TMD including pain intensity (29). Secondly, somatic symptoms can reflect underlying physiological perturbation that might contribute directly to the pathogenesis of TMD (29). Also, brain imaging findings suggest that overlapping neural alterations may lead to somatisation and chronic pain states (30). Additionally, persistent TMD pain may heighten

Table 4. Univariate and multivariate (backward selection) logistic regression analyses of psychological variables for pain-related disability in temporomandibular disorders patients (N = 320)

	Univariate analyses				Multivariate analyses			
Variables	*B*	Standard error	Odds ratio (OR) (95% CI)	*P* value	*B*	Standard error	Odds ratio (OR) (95% CI)	*P* value
Anxiety				<0·001*				
No anxiety	Reference							
Mild	0·297	0·351	1·345 (0·677 2·675)	0·397				
Moderate	1·724	0·368	5·609 (2·724 11·548)	<0·001				
Severe	2·206	0·479	9·082 (3·552 23·219)	<0·001				
Somatisation				<0·001*				
No somatisation	Reference							
Low	0·413	0·476	1·511 (0·595 3·839)	0·385				
Medium	1·488	0·458	4·429 (1·803 10·877)	0·001				
High	2·210	0·486	9·120 (3·519 23·638)	<0·001				
Depression				<0·001*				<0·001*
No depression	Reference				Reference			
Mild	0·447	0·345	1·564 (0·795 3·075)	0·195	0·447	0·345	1·564 (0·795 3·075)	0·195
Moderate	2·190	0·406	8·933 (4·029 19·807)	<0·001	2·190	0·406	8·933 (4·029 19·807)	<0·001
Moderate-to-severe	2·094	0·497	8·121 (3·064 21·526)	<0·001	2·094	0·497	8·121 (3·064 21·526)	<0·001
Severe	2·618	0·643	13·705 (3·883 48·369)	<0·001	2·618	0·643	13·705 (3·883 48·369)	<0·001
Stress				<0·001*				
No stress	Reference							
A little bit	0·296	0·488	1·344 (0·516 3·499)	0·545				
Somewhat	0·336	0·545	1·399 (0·481 4·070)	0·537				
Much	1·196	0·549	3·307 (1·127 9·699)	0·029				
Very much	2·278	0·607	9·759 (2·968 32·091)	<0·001				
Daytime sleepiness				0·080				
Normal	Reference							
Sleepy	0·322	0·342	1·380 (0·706 2·697)	0·347				
Very sleepy	1·322	0·623	3·752 (1·108 12·713)	0·034				
Optimism	−0·082	0·028	0·921 (0·872 0·973)	0·003*				
Gender								
Female	Reference							
Male	0·151	0·302	1·162 (0·644 2·100)	0·618				
Age	0·000	0·009	1·000 (0·983 1·017)	0·963				

*Overall *P* value of the variable is <0·05.

sensitivity to internal physical sensations and pain. A biological sensitivity to somatic feelings could predispose a person to developing somatisation (31). Other psychological factors, such as depression, anxiety or stress, may also be associated with pain intensity based on the previous literature, but the association was not direct, because pain was not their major symptom. So, it is not surprising that the association between pain intensity and other psychological factors may be weaker than that between pain intensity and somatisation.

Also, we found that depression was the best predictor of pain-related disability. Higher pain-related disability was associated with more severe depression. Patients with mild depression, moderate depression, moderate-to-severe depression and severe depression had about a 1·6, 8·9, 8·1 and 13·7 times higher odds of suffering moderate-to-severe pain-related intensity relative to no depression. The size, direction and significance of depression did not change from univariate analyses to multivariate analyses. Depression is defined as a state of low mood and aversion to activity which have a negative effect on a person's thoughts, behaviour, feelings and sense of well-being (32). Compared to other psychological factors, such as anxiety, stress or sleep disorders, the most evident characteristic of depression is that patients may lose interest in all what happens around them and they

may get no satisfaction from the activities that were pleasurable before (33). It is reported that a patient who suffers from more severe depression may become increasingly disabled because of a reduction in activity through low motivation and energy levels, thus leading to muscle deconditioning and stiffness (34). Also, they may have problems concentrating or communicating and be always in a sad mood, a gloomy solitary and apathetic attitude (33). So, it is not surprising that patients with depression caused by chronic pain may have difficulties in coping with daily activities such as work, school or housework. Other psychological factors may be also associated with pain-related disability, but the association may not be direct considering these psychological factors are less likely to make patients lose the interest in daily life directly. So, the association between pain-related disability and other psychological factors may not be as large as that between pain-related disability and depression.

In clinical practice, early biobehavioural intervention is thought to reduce the risk of patients developing persistent or chronic pain (35, 36). A psychosocial disorder should be regarded a very important comorbid condition contributing to TMD onset and being associated with TMD pain (29, 36). Hence, clinicians should attach importance to the relationship between pain intensity and somatisation and between pain-related disability and depression. If a patient has a high TMD pain intensity or pain-related disability in clinic, he/she has high possibility to suffer more severe somatisation or depression. So in this situation, clinicians should assess the somatisation or depression conditions of patients with high pain intensity or pain-related disability in time. If the patients have diagnosis of somatisation or depression, they should be provided with multiple treatments including psychological support instead of only physical treatments.

One important limitation of the present study is its cross-sectional design, which only allows for the evaluation of the associations between TMD pain and psychological factors rather than causal mechanisms between TMD pain and psychological factors. Nevertheless, this type of approach may provide future studies with relevant information on which variables to focus in longitudinal studies for causality. Furthermore, Item 3 of the PHQ-15 includes pain in the joints which may include pain from the temporomandibular joint. Consequently, there may have been some overlap in outcomes of the PHQ15 and the CPI, which may partly explain the association found between somatisation and pain intensity and may cause bias to the outcome. Besides, a small number of events relative to a high number of potential predictors (i.e. the number of response categories without the reference category for ordinal or nominal independent variables plus the number of continuous independent variables) is a common limitation in many studies. To obtain a reliable outcome, general guidelines have been suggested for the minimum number of events per variable (EPV). An EPV of 10 is widely advocated for multivariable logistic regression analyses to obtain a reliable outcome (37, 38). In the present study, the number of response categories without the reference category for ordinal or nominal independent variables plus the number of continuous variables included in the multivariate models of both pain intensity and pain-related disability was 16. Hence, 160 events for both models are recommended in the present study. For the model of pain intensity, the events of 'high pain intensity' were 164, which meets the criteria. However, for the model of pain-related disability, the events of 'moderate-to-severe pain-related disability' were 84, which is smaller than the criteria. So, the sample size in the present study may limit statistical power for parts of the analysis. Moreover, in general, all these kinds of regression modelling approaches carry a large burden of inflation of their goodness of fit, so commonly there is over-fitting of the regression model on the data from which it is derived. Nevertheless, this is how far we can get in our centre for this with the data at hand, and we would be neglecting important information contained by this study if we would dismiss our study based on a conservative approach to priori sample size assumptions.

For the future, more follow-up studies are needed for exploration of the causal relationship between psychological factors and TMD pain and the changes in psychological functioning that accompany the onset of TMD. Also, future researches are needed to examine the role of these psychological variables in the transition from acute to chronic pain in TMD patients.

In a conclusion, from the psychological and sociodemographic factors included in the present study, somatisation is the best predictor of pain intensity, while depression is the best predictor of pain-related disability in TMD patients.

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Correspondence: Naichuan Su, State Key Laboratory of Oral Disease, West China Hospital of Stomatology, Sichuan University, Chengdu, 610000 China; Department of Social Dentistry, Academic Center for Dentistry Amsterdam (ACTA), University of Amsterdam and VU University Amsterdam, Amsterdam 1081LA, The Netherlands.
E-mails: naichuansu@hotmail.com; n.su@acta.nl