

# Comorbid Disorders and Sociodemographic Variables in Temporomandibular Pain in the General Dutch Population

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**Aims:** (1) To determine the prevalence of temporomandibular disorder (TMD)–pain complaints in the general Dutch population; (2) to investigate its relationship with age, sex, educational attainment, and country of birth; (3) to determine its association with other pain complaints; and (4) to determine whether there are TMD subgroups (ie, with regard to their sociodemographic variables) that are more vulnerable for comorbid pain complaints. **Methods:** Data from two large-scale population studies were available: 975 randomly selected adults, who were interviewed by an examiner from the Institute for Applied Scientific Research (TNO), and 11,948 adults who were registered in the Netherlands Twin Register and responded to a survey questionnaire. Chi-squared tests and regression analyses were used to determine whether there were any associations between the presence of TMD pain and the various sociodemographic or comorbid variables. **Results:** The prevalence of TMD-pain complaints was 7.2% to 8.0%, and around twice as high in women than in men. The results were inconclusive for association with age, and no evidence was found for an association with country of birth or educational attainment. TMD-pain complaints were strongly related to the presence of other pain complaints. Interestingly, the number of reported comorbid complaints was related to all of the studied sociodemographic variables. **Conclusion:** In the general Dutch population, women more often report TMD-pain complaints than men, and patients with TMD-pain complaints more often show other pain complaints than persons without TMD pain. In contrast to common beliefs, no clear association with age was found. Furthermore, widespread pain complaints were more common in non-native Dutch and lower-educated females. *J Oral Facial Pain Headache* 2015;29:51–59. doi: 10.11607/ofph.1324

**Key words:** pain comorbidity, prevalence, sociodemographic variables, temporomandibular-pain complaints

Pain from the masticatory structures, such as temporomandibular disorder (TMD) pain, is the most common source of chronic pain in the orofacial region.<sup>1</sup> Similar to other chronic pain states, it is known to impair physical function<sup>2</sup> and is associated with psychological problems, such as depression and anxiety.<sup>3</sup> In addition, TMD pain may result in diminished quality of life,<sup>4,5</sup> costly treatments, and reduced productivity.<sup>6</sup>

For good health-care policies, epidemiologic data on the prevalence of specific pain disorders should be supplemented with information on the severity of the complaints (eg, in terms of its perseverance and association with other disorders). TMD pain is often assumed to be most prevalent in women in their early adulthood,<sup>7</sup> even though empirical findings on age and sex are inconsistent.<sup>8,9</sup> For patients with chronic TMD, associations with other pain complaints, such as neck pain and headaches, have frequently been reported.<sup>10–12</sup> However, these data are largely based on patient samples from secondary care clinics with relatively severe pain complaints, and they may not be representative of TMD pain patients in the general population. Moreover, while there is evidence for social and ethnic disparities in pain experiences for many health conditions,<sup>13</sup> such differences in TMD patients have not been well documented.<sup>9</sup>

Therefore, the aims of this study were to (1) determine the prevalence of TMD-pain complaints in the general Dutch population; (2) investigate its relationship with age, sex, educational attainment, and country of birth; (3) determine its association with other pain complaints; and (4) determine whether there are TMD subgroups (ie, with regard to their socio-demographic variables) that are more vulnerable for comorbid pain complaints.

## Materials and Methods

The data presented in this article were derived from two independent large-scale study population-based cohorts. The first population sample consisted of a random selection of persons from the general population, aged 25 to 74, as included in the databank available from the Institute for Applied Scientific Research (TNO). The second sample consisted of adult participants registered with the Netherlands Twin Register (NTR: [www.tweelingenregister.org](http://www.tweelingenregister.org)).

### Sample 1—TNO

As part of a continuing epidemiologic study of the general Dutch population, in 2007, a dental survey was performed among the population of the city of 's Hertogenbosch, The Netherlands. This population is considered representative of the general Dutch population in terms of age distribution, family composition, percentage of non-Dutch inhabitants, and oral health.<sup>14</sup> The predominant health insurance company in 's Hertogenbosch (VGZ-IZA) provided contact information of a random selection of 6,750 persons from its database. From this group, a random subgroup of 1,356 persons was selected and informed about the study by letter. In this letter, it was indicated that they could expect a home visit by a trained interviewer of TNO within the next couple of weeks, and that they were invited for a subsequent clinical examination in a mobile oral health facility (dental van). In case the selected person was not at home at three different home visits or did not wish to participate, a substitute person was selected (matched for age, gender, and type of insurance—as indicator for socioeconomic status). After 14 rounds of selecting substitute persons, recruitment was stopped. At that time point, 4,533 persons, aged 25 to 74 years, were selected for possible participation in the study and informed by letter. The interviewer was able to contact 2,395 persons, and 1,622 persons were willing to participate in the interview (response rate: 68%). Reasons for not participating were “not interested” (50%), “no time” (39%), or “other reasons” (31%) (multiple answers possible). From the nonresponders

(n = 773), 32% (n = 246) were willing to answer a short nonrespondent questionnaire. A nonparticipation analysis revealed that responders were higher educated (highly educated responders: 43%; highly educated nonresponders: 31%;  $\chi^2=10.10$ ;  $df = 1$ ;  $P = .001$ ). No differences between responders and nonresponders were found regarding age, sex, and ethnicity.

### Measures in the TNO Sample

During the home interview, a wide range of variables was collected, of which the following were used in this study:

#### *Sociodemographic characteristics*

- Age (stratified as 25 to 34 years, 35 to 44 years, 45 to 54 years, 55 to 64 years, and 65 to 74 years).
- Sex (male/female).
- Country of birth (non-native Dutch/native Dutch) based on the participant's country of birth (The Netherlands versus any other country).
- Educational attainment (low/high); education was regarded “high” when at least a higher-level general secondary education (HAVO) or tertiary school (ie, vocational college or university) was completed. All other education was defined as low education.

#### *TMD-pain complaints*

After the interview, persons with a natural dentition (ie, at least one natural tooth, n = 1,407) were invited to participate in a subsequent clinical assessment in the dental van, which was performed by a dental examiner. From the dentate responders, 975 (69%) attended the van. Their mean age was 47.5 years (SD = 12.5), and 54% were female. During the clinical assessment, the condition of the natural teeth and surrounding soft tissues was checked, and the presence and type of prosthodontic appliances were noted (for more details, see Visscher et al<sup>15</sup>). In addition, the following questions about temporomandibular pain were asked:

- Have you experienced pain, at least now and then, in the region of your temporomandibular joint or masticatory muscles when you open your mouth widely? (no/yes)
- Have you experienced pain, at least now and then, in the region of your temporomandibular joint or masticatory muscles while chewing? (no/yes)
- Have you experienced, at least now and then, pain in the region of your temporomandibular joint or masticatory muscles during other mandibular movements? (no/yes)

The dentists performing the clinical assessment pointed toward the areas of interest (being the masticatory muscles and the temporomandibular joints) and explained to the patient that if they had only experienced pain occasionally, it was not considered relevant. No additional TMD examinations (such as palpation tests) were performed. However, when the pain complaints appeared to relate to a dental problem, the patient was informed that this pain was not considered relevant for the TMD-pain questions. Patients were classified as suffering from a TMD-pain complaint when at least one of the three questions was answered positively.

The ethics committee of the Leiden University Medical Center concluded that no formal application was needed for approval of the study because the procedures were harmless. The TNO study was performed in accordance with the ethical standards laid down in the 1964 Declaration of Helsinki and its later amendments. All persons gave their informed consent prior to their inclusion in the study, and the study was registered at the Dutch Data Protection Authority (no. m 1313002).

### Sample 2—NTR

The second sample consisted of adult twins and their family members registered in the NTR.<sup>16</sup> Since 1991, every 2 to 3 years the adult participants of the NTR are invited to participate in a survey on physical and mental health, lifestyle, and personality. As part of this continuing study, between January 2011 and February 2012 participants received a written invitation to participate in a web-based survey that included questions regarding pain complaints (the ninth wave of questionnaire research, or “Survey 9”). A hard-copy version of the questionnaire was available on request. If subjects did not complete the questionnaire within a few months after the invitation was sent, they received a written reminder. When necessary, a second reminder was sent. In July 2012, a general reminder was sent to selected groups of participants: an email was sent to those participants who had provided the NTR with their email address, and a reminder was sent to twins whose co-twin had already completed the questionnaire. Finally, a selection of participants who had not completed the questionnaire after the reminders were contacted by telephone, prioritizing participants who had previously supplied DNA samples to the NTR, or participants whose co-twin had completed the survey.

From the total number of 27,892 persons who were invited to participate, 11,948 persons responded (response rate: 43%), comparable to previous studies in the adult NTR sample.<sup>16</sup> Of them, 6 persons were excluded because they were under 18 years of age, and another 294 persons were excluded because they

did not fill in the TMD-pain question. The remaining subjects ( $n = 11,648$ , of 5,276 families) had a mean age (SD) of 44 (16) years (age range 18 to 100 years), and 62% were female.

### Measures in the NTR Sample

The survey included questions about age and sex. Information regarding the participant's country of birth and level of education was available from previous questionnaire surveys that were sent to the participants of the NTR.<sup>16</sup>

#### *Sociodemographic characteristics*

- Age (stratified as 18 to 25 years, 25 to 34 years, 35 to 44 years, 45 to 54 years, 55 to 64 years, 65 to 74 years, > 74 years)
- Sex (male/female)
- Country of birth (non-native Dutch/native Dutch)
- Educational attainment (low/high)

#### *TMD-pain and other pain complaints*

The NTR survey also included questions about pain complaints. Participants were asked to report on a variety of pain complaints. The stem of the question was: “In the last year, did you experience ...”. The questions ended with:

- a) back ache
- b) neck ache
- c) headache or migraine
- d) pain in abdomen or stomach
- e) pain in the joints (of arms, hands, legs or feet)
- f) pain on the chest
- g) toothache
- h) pain in the face (eg, cheeks, temples, or jaw joints) [from here on referred to as TMD-pain complaints]
- i) pain somewhere else: ..... [free text box]

Response options were “no”; “yes, occasionally”; and “yes, a lot of the time.” When a participant rated positive on a pain question (ie, “yes, occasionally” or “yes, a lot of the time”), a follow-up question appeared to inquire about the cause of that pain (free text answer). Afterwards, these free text answers were screened to exclude apparent false-positive answers to the pain questions. For the TMD-pain question (question h), reasons to recode a positive answer into a negative answer were: dental pain, neurologic pain, and pain due to a cerebrovascular incident or disease ( $n = 149$ , 1.4% of the total sample). If recoding led to

loss of information (ie, when the recoded pain complaint was not already covered by one of the other pain questions), question i (pain somewhere else) was recoded into “yes, occasionally” or “yes, a lot of the time” (according to the response option provided by the participant). The NTR survey was approved by the Medical Ethics Committee of the VU University Medical Center Amsterdam (nr. 2010/130) and followed the ethical standards of the 1964 Declaration of Helsinki and its later amendments. All participants gave their informed consent prior to their inclusion in the study.

### Statistical Analyses

Descriptive statistics were produced using SPSS 21.0 (IBM, 2012). First, for both population samples, the prevalence of TMD-pain complaints was determined for the total sample, and for subsamples stratified by sex, age, ethnicity, and educational attainment. For this analysis, the NTR data on TMD pain complaints were dichotomized into “no-TMD pain” and “TMD pain” (“occasionally” and “a lot of the time” combined). For the TNO sample, chi-squared tests were used to determine whether there were any associations between the prevalence of TMD pain and the various sociodemographic variables (in SPSS 21.0). To correct for the non-independence of data derived from family members in the NTR sample, NTR-group differences were tested with logistic regression analyses in STATA 12.1 (StataCorp), using a robust variance estimator and including family identification (ID) as a cluster variable.

Second, and only for the NTR sample, prevalence data of the various other pain conditions in the patients with TMD-pain complaints were presented. Data on the presence of the various pain disorders were dichotomized into “no” or “yes” (“occasionally” and “a lot of the time” combined). Additionally, a new variable was calculated, called “any comorbid pain.” This variable was scored as “no” when no other pain complaints were reported, or as “yes” when at least one of the other pain questions (ie, excluding the TMD-pain question) was rated as “occasionally” or “a lot of the time.” Logistic regression analyses, using a robust variance estimator and including family ID as a cluster variable, were used to test for an association between the various pain disorders and the frequency of TMD pain complaints (STATA 12.1).

Third, a hierarchical linear regression analysis was performed with the total number of comorbid pain complaints as the outcome measure, the frequency of TMD pain complaints (no, occasionally, a lot of the time) as the main predictor (entered in block 1), and age, sex, ethnicity, and educational attainment as potential covariates (entered in block 2). The

“total comorbid pain” variable represents the sum of the dichotomized pain variables, excluding TMD pain (range: 0 to 8). Also for this analysis, the robust variance estimator and family ID as a cluster variable were used (STATA 12.1). The assumptions for linearity of the regression analysis (linear relation of residuals, normal distribution of the residuals, and equal standard deviations of the residuals) were confirmed by inspection of the “normal P-P plot of regression standardized residual” and of the “scatterplot of the standardized residuals and the standardized predicted values.”

To correct for multiple testing, Holm’s Bonferroni procedure was used.<sup>17</sup> The Bonferroni corrected *P* values are presented, and  $\alpha = .05$  was considered to reflect statistical significance.

## Results

### Association Between TMD-Pain Complaints and Sociodemographic Variables

Table 1 shows the prevalence of TMD-pain complaints in various subsamples from the two populations. The overall prevalence of TMD-pain complaints in both study populations was comparable: 7.2% and 8.0%. In both samples, women more frequently reported complaints of TMD pain than men, although the difference was only significant in the NTR sample ( $OR = 2.2, P < .001$ ). While in the TNO sample an association between age and the prevalence of TMD-pain complaints was found (it was highest in young adults and decreased with increasing age; linear-by-linear association  $\chi^2 = 7.75, df = 1, P = .020$ ), this could not be confirmed in the NTR sample. No associations were found between TMD-pain complaints and ethnicity or educational attainment (see Table 1).

### Association Between TMD-Pain Complaints and Other Pain Complaints

Table 2 presents the prevalence of the various pain complaints, other than TMD pain, in the NTR sample. The most prevalent pain disorders were back pain, neck pain, joint pain, and headache. For all pain complaints, the prevalence was higher in patients with TMD-pain complaints as compared to those without TMD-pain complaints ( $OR = 2.0-3.7; P < .001$ ). Moreover, all of the participants with frequent TMD-pain complaints (“a lot of the time”) had at least one pain complaint elsewhere (“any comorbid pain,” see Table 2).

The total number of comorbid pain complaints ranged from 0 to 8. In Table 3, the mean number of comorbid pain disorders is presented, stratified by TMD-pain complaints, sex, age, educational attain-

**Table 1 Prevalence of TMD-Pain Complaints in the Two Study Samples, and Stratified for the Various Sociodemographic Variables**

	Sample 1 (TNO)			Sample 2 (NTR)		
	n	TMD pain n % (95% CI)	Group diff <sup>a</sup> ( <i>P</i> )	n	TMD pain n % (95% CI)	Group diff <sup>b</sup> ( <i>P</i> )
<b>Total study population</b>	975	78 8.0% (6.5–9.9%)	NA	11,648	840 7.2% (6.7–7.7%)	NA
<b>Sex</b>			.168			< .001
Female	524	50 9.6% (7.4–12.4%)		7,183	647 9.0% (8.4–9.7%)	
Male	451	28 6.2% (4.3–8.8%)		4,465	193 4.3% (3.7–4.9%)	
<b>Age (y)</b>			.020			.756
18–24	NA	NA		2,135	154 7.2% (6.2–8.4%)	
25–34	179	21 11.8% (7.7–17.4%)		1,469	102 6.9% (5.7–8.3%)	
35–44	232	21 9.1% (6.0–13.5%)		2,318	165 7.1% (6.1–8.2%)	
45–54	272	22 8.1% (5.4–12.0%)		2,306	186 8.1% (7.1–9.3%)	
55–64	190	10 5.3% (2.9–9.5%)		2,278	162 7.1% (6.1–8.3%)	
65–74	102	4 4.0% (1.6–9.8%)		974	58 6.0% (4.7–7.7%)	
> 75	NA	NA		168	13 7.7% (4.6–12.7%)	
<b>Educational attainment</b>			.914			.288
High	463	41 8.9% (6.6–11.8%)		6,715	465 6.9% (6.3–7.5%)	
Low	491	37 7.6% (5.6–10.3%)		1,720	137 8.0% (6.8–9.4%)	
Missing	21	NA		3,213	NA	
<b>Country of birth</b>			.638			1
Native Dutch	843	69 8.2% (6.5–10.3%)		10,458	746 7.1% (6.6–7.6%)	
Non-native Dutch	129	9 7.0% (3.7–12.8%)		221	18 8.1% (5.2–12.5%)	
Missing	3	NA		968	NA	

<sup>a</sup>Differences between groups in the TNO sample were analyzed with  $\chi^2$  tests.

<sup>b</sup>Differences between groups in the NTR sample were analyzed with logistic regression analyses.

NA = not applicable; 95% CI = 95% confidence interval; *P* = corrected *P* value (according to Holm's Bonferroni correction).

**Table 2 Prevalence of Comorbid Pain Complaints in Participants of the NTR Sample**

Pain complaint	n	No TMD pain	Occasional TMD pain	TMD pain a lot of the time	OR (95% CI)	<i>P</i>
Back pain	11,610	57.6%	75.0%	86.2%	2.2 (1.9–2.6)	< .001
Neck pain	11,590	39.0%	71.2%	85.1%	3.7 (3.2–4.3)	< .001
Headache	11,587	52.1%	81.2%	75.5%	3.1 (2.6–3.7)	< .001
Pain in abdomen or stomach	11,551	32.7%	59.2%	57.1%	2.5 (2.2–2.8)	< .001
Joint pain	11,620	40.9%	63.6%	73.7%	2.4 (2.1–2.7)	< .001
Chest pain	11,601	10.6%	27.5%	31.6%	2.6 (2.3–3.0)	< .001
Toothache	11,579	11.9%	24.7%	22.3%	2.0 (1.7–2.3)	< .001
Pain elsewhere	11,225	14.3%	33.1%	29.2%	2.3 (2.0–2.7)	< .001
Any comorbid pain	11,605	88.5%	98.9%	100.0%	12.1 (6.1–24.2)	< .001

OR = odds ratio (from logistic regression analysis); 95% CI = 95% confidence interval; *P* = corrected *P* value (according to Holm's Bonferroni correction).

**Table 3 Hierarchical Linear Regression Analysis for the Other (Comorbid) Pain Disorders in Participants of the NTR Sample\***

	Other pain disorders			Model	
	Mean (SD)	b	P	R <sup>2</sup>	P
<b>Block 1</b>				0.06	< .001
<b>TMD pain</b>		1.5	< .001		
No pain	2.5 (1.7)				
Occasionally	4.3 (1.8)				
A lot of the time	4.6 (1.8)				
<b>Block 2</b>				0.10	< .001
<b>TMD pain</b>		1.4	< .001		
No pain	2.5 (1.7)				
Occasionally	4.3 (1.8)				
A lot of the time	4.6 (1.8)				
<b>Sex</b>		0.7	< .001		
Male	2.2 (1.7)				
Female	3.0 (1.7)				
<b>Age</b>		0.03	.023		
18–24	2.6 (1.8)				
25–34	2.6 (1.7)				
35–44	2.6 (1.7)				
45–54	2.8 (1.8)				
55–64	2.7 (1.7)				
65–74	2.6 (1.7)				
> 75	2.5 (1.8)				
<b>Educational attainment</b>		-0.19	< .001		
Low	2.9 (1.8)				
High	2.6 (1.7)				
<b>Country of birth</b>		0.34	.005		
Native Dutch	2.7 (1.7)				
Non-native Dutch	3.0 (1.8)				

\*Due to missing data on comorbid pain, educational attainment, and country of birth, the number of subjects included in the analysis is 7,454.

b = regression coefficient; R<sup>2</sup> = explained variance of the regression model; P = corrected P value (according to Holm's Bonferroni correction).

ment, and ethnicity. The hierarchical regression analysis shows that the number of comorbid disorders was not only associated with the frequency of the TMD-pain complaint, but also (and independently) with sex, educational attainment, and ethnicity. For age, a borderline significant association with the number of comorbid disorders was found.

## Discussion

The data from this epidemiologic study were derived from two large and independent study samples, with quite different study designs. Information on TMD-pain complaints was gathered during an interview in the TNO sample, whereas questionnaires were used in the NTR sample. Also, the precise formulation of the TMD-pain questions and response options was different. In both approaches, however, a comparable description of the pain location was used (temporomandibular joint and masticatory muscles versus jaw joint, cheeks, and

temples). In addition, the three-value response of the NTR sample was recoded into a yes (ie, "occasionally" and "a lot of the time" combined) or no outcome, which improves the comparability with the TNO sample (where yes stands for "at least now and then"). Moreover, in both studies, special attention was given to the exclusion of dental pain (as the most frequent cause of orofacial pain) from the TMD-pain classification. Since TMD pain is the second most frequent cause of orofacial pain,<sup>7</sup> and other causes (such as neuropathic injury or malignancies) present quite differently and are quite rare, the authors are confident that most, if not all, cases indeed suffered from a TMD complaint. The overall prevalence of TMD-pain complaints in the two study populations was almost equivalent (7.2% and 8.0%) and quite comparable to that reported in other samples from the general population.<sup>8,18</sup> Together with the above-described arguments for comparability, this supports the assumption that the same construct (ie, TMD pain) was measured with the two different approaches.

## Sex Difference

Up to 90% of patients attending TMD pain clinics are women.<sup>19</sup> Interestingly, TMD-pain prevalence studies in the general population usually report much smaller differences between men and women compared to studies in clinical samples. Women are usually found to report TMD pain twice as often as men.<sup>8,19,20</sup> Also in the present study, TMD-pain complaints were 1.5 to 2 times more common in women as in men. There are several possible reasons for the higher prevalence of TMD pain in women, including sex-specific differences in pain perception. For example, experimental studies have shown that women report more pronounced pain responses to noxious stimuli than men.<sup>21–24</sup> Experimentally evoked pain also persists longer<sup>25</sup> and leads to more temporal summation<sup>26,27</sup> in women. Still, the large discrepancy in the reported sex difference between population studies and studies from clinical samples suggests that

it is not only the perception of pain that leads to the higher level of care-seeking in women. This increased care-seeking behavior in female TMD-pain patients seems to be related in part to fear of movement: A recent study found that, independent of pain intensity, high levels of pain-related fear of movement were a predictor for care-seeking in women but not in men.<sup>28</sup> Apparently, women not only experience their pain differently from men, but also appreciate their pain in a different way, which leads to a higher use of the health care system.

### Age Distribution

TMD pain is often assumed to be most prevalent in young and middle-aged adults.<sup>7</sup> However, the scientific evidence for this assumption is inconsistent.<sup>29</sup> An often-cited review states that TMD pain usually declines in frequency after age 45 to 50.<sup>18</sup> However, the reported differences in prevalence rates of various age groups, as reported in the papers included in that review, were usually quite small (for example, in one of the included studies: 8.3% in people < 45 years versus 7.2% in people > 45 years) and not tested for statistical significance.<sup>18</sup> A more recent, large population study in the United States showed that the prevalence of self-reported TMD pain in white women increased up to the age of 40 and then decreased, while in Hispanic and black women, TMD-pain prevalence increased up to the age of 60. For men, smaller age differences were found.<sup>30</sup>

In the present study, the findings for the prevalence of TMD-pain complaints in different age groups were inconsistent. In the TNO sample, the youngest age group (25 to 34 years) had the highest report of TMD pain, and a decrease in the prevalence of the pain complaints was found with increasing age. In the NTR sample, however, a quite stable pattern of TMD-pain complaints was seen over the various age groups. Also a multivariate analysis with age, sex, ethnicity, and education did not reveal any relationship between the various sociodemographic variables and age, which could account for the lack of association between age and the prevalence of TMD pain (data not presented). Hence, there is insufficient evidence for an association between age and TMD pain.

### Country of Birth and Educational Attainment

In general, the experience of pain is not uniformly distributed across ethnic subgroups.<sup>31</sup> For example, results from a large population study indicated that African Americans and Hispanic whites were more likely than non-Hispanic whites to report severe pain.<sup>32</sup> Comparable disparities in the prevalence of pain have been described for subgroups with different socioeconomic status. For instance, in headache patients, lower socioeconomic status has been associated with

higher pain prevalence.<sup>33</sup> Even though socioeconomic status and ethnic background are intercorrelated,<sup>34</sup> in an analysis of covariance controlling for pain duration and education, African American chronic-pain patients reported higher levels of pain unpleasantness and emotional responses to pain and pain behavior, but not pain intensity, than whites.<sup>35</sup> Contrary to these findings, a review on neck pain in the general population found no sound evidence for an association between musculoskeletal pain and ethnicity.<sup>36</sup>

Much less has been reported on the possible relationship between ethnicity, socioeconomic status, and the presence of TMD-pain complaints. An epidemiologic survey in the general population found no association between educational attainment (college graduate) and the prevalence of orofacial pain.<sup>37</sup> In a Dutch study of TMD patients, no association was found between ethnic background and TMD pain, even though non-Western TMD patients had higher scores on psychologic factors, such as pain-related disability and depression.<sup>38</sup> Surprisingly, in a more recent population study in the United States, a higher prevalence of TMD complaints was reported by Caucasians as compared to ethnic minorities (Hispanics and African-Americans).<sup>39</sup> In the present study, for both study samples, no association between the prevalence of TMD-pain complaints and country of birth was found, nor was there any association with educational attainment. Perhaps differences in the definitions of ethnicity applied may account for the various study outcomes. In the present study, the country of birth of the participant was used, and thereby represented whether the participant had moved to a new country. In the previous Dutch study, a slightly different approach was used: ethnic background was not only rated based on the country of birth of the TMD patients, but also on that of their parents.<sup>38</sup> In both studies, however, no association with the presence of TMD pain was found. In the US sample (where they did find an association with the prevalence of TMD complaints), the racial background of the participants, not the country of birth, was used.<sup>39</sup> Dutch inhabitants are a very heterogeneous group with respect to their racial background. So, taken together, these findings might indicate that psychosocial or environmental factors that are associated with moving to another country (non-natives) are less important predictors of TMD pain than racial factors. At the same time, it is important to note that the ethnic disparities reported for the US sample were found only for TMD-pain complaints, not for other pain complaints such as back pain or neck pain.<sup>39</sup>

### Other Pain Complaints (Comorbidity)

A strong association between TMD pain and all other painful conditions was found. Persons with mild TMD

pain showed approximately 1.5 times more comorbid pain complaints than persons without TMD pain (Table 3), whereas persons with severe TMD-pain complaints showed approximately twice as many comorbid pain complaints. These results are in line with earlier findings in samples of TMD patients<sup>40,41</sup> and population-based studies.<sup>41–43</sup> The hierarchical regression analysis showed that the association between TMD pain and comorbidity was independent of the influence of sex, age, educational attainment, and ethnicity. The analysis also revealed that the number of reported comorbid pain complaints was associated with each of the sociodemographic variables, even though the association with age was weak. In other words, lower-educated females, not born in The Netherlands, and with more frequent TMD-pain complaints, had the highest risk of suffering from more widespread pain complaints. These results are in line with and expand upon earlier findings in a Dutch sample of TMD patients, that non-native non-Western patients, independent of their socioeconomic background, show more signs of somatization.<sup>38</sup>

The associations between TMD-pain complaints and the sociodemographic variables pose an interesting question: Is TMD pain a different type of disorder as compared to the other pain complaints studied? Or is not the location of pain, but merely the spreading of pain related to the sociodemographic characteristics of the patients? Further analyses of the current data are planned to disentangle the association between specific pain complaints and the sociodemographic variables.

## Conclusions

The prevalence of TMD-pain complaints in the general Dutch population was 7.2% to 8.0%, and approximately twice as high in women as in men. In contrast to common beliefs, no clear association with age was found. In addition, no evidence was found for an association between TMD-pain complaints and country of birth or educational attainment. A strong association was found between TMD-pain complaints and the prevalence of other pain complaints. Furthermore, widespread pain complaints were more common in non-native Dutch and lower-educated females.

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## References

1. Fillingim RB, Wallace MR, Herbstman DM, Ribeiro-Dasilva M, Staud R. Genetic contributions to pain: A review of findings in humans. *Oral Dis* 2008;14:673–682.
2. Bush FM, Harkins SW. Pain-related limitation in activities of daily living in patients with chronic orofacial pain: Psychometric properties of a disability index. *J Orofac Pain* 1995;9:57–63.
3. Von Korff M, Simon G. The relationship between pain and depression. *Br J Psychiatry Suppl* 1996;30:101–108.
4. Campbell LC, Clauw DJ, Keefe FJ. Persistent pain and depression: A biopsychosocial perspective. *Biol Psychiatry* 2003; 54:399–409.
5. Dahlstrom L, Carlsson GE. Temporomandibular disorders and oral health-related quality of life. A case-control study. *J Orofac Pain* 2001;15:218–227.
6. Stowell AW, Gatchel RJ, Wildenstein L. Cost-effectiveness of treatments for temporomandibular disorders: Biopsychosocial intervention versus treatment as usual. *J Am Dent Assoc* 2007; 138:202–208.
7. De Leeuw R, Klasser GD (eds). *Orofacial Pain: Guidelines for assessment, diagnosis, and management*. Chicago: Quintessence, 2013:127–186.
8. Carlsson GE. Epidemiology and treatment need for temporomandibular disorders. *J Orofac Pain* 1999;13:232–237.
9. Manfredini D, Guarda-Nardini L, Winocur E, Piccotti F, Ahlberg J, Lobbezoo F. Research diagnostic criteria for temporomandibular disorders: A systematic review of axis I epidemiologic findings. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod* 2011;112:453–462.
10. Visscher CM, Lobbezoo F, de Boer W, van der Zaag J, Naeije M. Prevalence of cervical spinal pain in craniomandibular pain patients. *Eur J Oral Sci* 2001;109:76–80.
11. Bevilacqua Grossi D, Lipton RB, Bigal ME. Temporomandibular disorders and migraine chronification. *Curr Pain Headache Rep* 2009;13:314–318.
12. Browne PA, Clark GT, Kuboki T, Adachi NY. Concurrent cervical and craniofacial pain. A review of empiric and basic science evidence. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod* 1998;86:633–640.
13. Green CR, Anderson KO, Baker TA, et al. The unequal burden of pain: Confronting racial and ethnic disparities in pain. *Pain Med* 2003;4:277–294.
14. Schuller AA. *Mondgezondheid volwassenen 2007*. Leiden: TNO Kwaliteit van Leven, 2009.
15. Visscher CM, Lobbezoo F, Schuller AA. Dental status and oral health-related quality of life. A population-based study. *J Oral Rehabil* 2014;41:416–422.
16. Willemsen G, Vink JM, Abdellaoui A, et al. The Adult Netherlands Twin Register: Twenty-five years of survey and biological data collection. *Twin Res Hum Genet* 2013;16:271–281.
17. Aickin M, Gensler H. Adjusting for multiple testing when reporting research results: The Bonferroni vs Holm methods. *Am J Public Health* 1996;86:726–728.



18. LeResche L. Epidemiology of temporomandibular disorders: Implications for the investigation of etiologic factors. *Crit Rev Oral Biol Med* 1997;8:291–305.
19. Bush FM, Harkins SW, Harrington WG, Price DD. Analysis of gender effects on pain perception and symptom presentation in temporomandibular pain. *Pain* 1993;53:73–80.
20. Rugh JD, Solberg WK. Oral health status in the United States: Temporomandibular disorders. *J Dent Educ* 1985;49:398–406.
21. Chesterton LS, Barlas P, Foster NE, Baxter GD, Wright CC. Gender differences in pressure pain threshold in healthy humans. *Pain* 2003;101:259–266.
22. Dao TT, LeResche L. Gender differences in pain. *J Orofac Pain* 2000;14:169–184; discussion 184–195.
23. Riley JL 3rd, Robinson ME, Wise EA, Myers CD, Fillingim RB. Sex differences in the perception of noxious experimental stimuli: A meta-analysis. *Pain* 1998;74:181–187.
24. van Selms MK, Wang K, Lobbezoo F, Svensson P, Arendt-Nielsen L, Naeije M. Effects of masticatory muscle fatigue without and with experimental pain on jaw-stretch reflexes in healthy men and women. *Clin Neurophysiol* 2005;116:1415–1423.
25. Karibe H, Goddard G, Gear RW. Sex differences in masticatory muscle pain after chewing. *J Dent Res* 2003;82:112–116.
26. Sarlani E, Grace EG, Reynolds MA, Greenspan JD. Sex differences in temporal summation of pain and aftersensations following repetitive noxious mechanical stimulation. *Pain* 2004;109:115–123.
27. Sarlani E, Garrett PH, Grace EG, Greenspan JD. Temporal summation of pain characterizes women but not men with temporomandibular disorders. *J Orofac Pain* 2007;21:309–317.
28. Rollman A, Visscher CM, Gorter RC, Naeije M. Care seeking for orofacial pain. *J Orofac Pain* 2012;26:206–214.
29. Anastassaki Kohler 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;70:213–223.
30. Plesh O, Adams SH, Gansky SA. Racial/Ethnic and gender prevalences in reported common pains in a national sample. *J Orofac Pain* 2011;25:25–31.
31. Mossey JM. Defining racial and ethnic disparities in pain management. *Clin Orthop Relat Res* 2011;469:1859–1870.
32. Reyes-Gibby CC, Aday LA, Todd KH, Cleeland CS, Anderson KO. Pain in aging community-dwelling adults in the United States: Non-Hispanic whites, non-Hispanic blacks, and Hispanics. *J Pain* 2007;8:75–84.
33. King S, Chambers CT, Huguet A, et al. The epidemiology of chronic pain in children and adolescents revisited: A systematic review. *Pain* 2011;152:2729–2738.
34. Laveist TA, Thorpe RJ Jr, Mance GA, Jackson J. Overcoming confounding of race with socio-economic status and segregation to explore race disparities in smoking. *Addiction* 2007;102(Suppl 2):65–70.
35. Riley JL 3rd, Wade JB, Myers CD, Sheffield D, Papas RK, Price DD. Racial/ethnic differences in the experience of chronic pain. *Pain* 2002;100:291–298.
36. Carroll LJ, Hurwitz EL, Cote P, et al. Research priorities and methodological implications: The Bone and Joint Decade 2000–2010 Task Force on Neck Pain and Its Associated Disorders. *Spine* 2008;33:S214–S220.
37. Von Korff M, Dworkin SF, Le Resche L, Kruger A. An epidemiologic comparison of pain complaints. *Pain* 1988;32:173–183.
38. van der Meulen MJ, Lobbezoo F, Aartman IH, Naeije M. Ethnic background as a factor in temporomandibular disorder complaints. *J Orofac Pain* 2009;23:38–46.
39. Plesh O, Crawford PB, Gansky SA. Chronic pain in a biracial population of young women. *Pain* 2002;99:515–523.
40. Visscher CM, Lobbezoo F, de Boer W, van der Meulen M, Naeije M. Psychological distress in chronic craniomandibular and cervical spinal pain patients. *Eur J Oral Sci* 2001;109:165–171.
41. Turp JC, Kowalski CJ, O'Leary N, Stohler CS. Pain maps from facial pain patients indicate a broad pain geography. *J Dent Res* 1998;77:1465–1472.
42. Plesh O, Adams SH, Gansky SA. Temporomandibular Joint and muscle disorder-type pain and comorbid pains in a national US sample. *J Orofac Pain* 2011;25:190–198.
43. Macfarlane TV, Blinkhorn AS, Davies RM, Ryan P, Worthington HV, Macfarlane GJ. Orofacial pain: Just another chronic pain? Results from a population-based survey. *Pain* 2002;99:453–458.