Association Between Clinical Signs of Temporomandibular Disorders and Psychological Distress Among an Adult Finnish Population

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Aims: To evaluate the association between signs of temporomandibular disorders (TMD) and psychological distress in a general population-based sample of Finnish adults. **Methods:** The Health 2000 Survey was conducted in 2000–2001 by the National Institute for Health and Welfare in Finland. Of the sample of adults aged 30 or over (n = 8,028), 79% participated in a clinical oral health examination, which included examination of TMD signs. The participants (n = 6,155) also completed questionnaires, including the 12-item General Health Questionnaire (GHQ-12), which measured psychological distress. Associations between TMD signs and psychological distress measured by the GHQ-12 were examined in both genders. Statistical measures included chi-square tests, *t* tests, and logistic regression analyses. **Results:** The prevalence of the TMD signs (limited opening, clicking, crepitation, temporomandibular joint [TMJ] palpation pain, and muscle palpation pain) was 11.2%, 17.6%, 10.5%, 5.1%, and 18.9% in women, and 6.1%, 12.9%, 5.3%, 2.4%, and 7.2% in men, respectively. High GHQ-12 scores, measured as continuous variables and in quartiles by distress level, were significantly associated with masticatory muscle pain on palpation in both genders ($P < .05$) and with TMJ pain on palpation in women ($P < .05$). Additionally, high GHQ-12 scores as continuous were associated with TMJ crepitation in men ($P < .05$). The logistic regression analyses showed that higher GHQ-12 scores were associated significantly with masticatory muscle pain on palpation both in women (odds ratio [OR] = 2.18; 95% confidence interval [CI] = 1.6–2.9) and men (OR = 2.03; 95% CI = 1.3–3.1). **Conclusion:** TMD signs and psychological distress appear to be associated. However, due to the limitations of the study, the findings can be regarded as preliminary. *J Oral Facial Pain Headache 2015; 29:370–377. doi: 10.11607/ofph.1439*

Keywords: *GHQ, Health 2000 Survey, psychological distress, temporomandibular disorders, TMD*

Temporomandibular disorders (TMD) involve clinical problems in the masticatory muscles, the temporomandibular joints (TMJs), and associated anatomical structures. Common TMD findings are facial pain, clicking or crepitation of the TMJ, limited jaw opening, and deviation in the movements of the mandible.[1] In the Finnish adult population, the prevalence of having at least one TMD sign is 38%, with the signs being more common among women than men.[2]

The etiology and pathology of TMD vary and are controversial. General factors such as impaired health and general joint and muscle diseases, and local factors such as occlusal disturbances and traumas, may exist alongside TMD.[1] Moreover, the role of psychological and psychosocial factors in TMD has been emphasized.[3] There is consensus that chronic pain disorders and psychological problems are related, and like other musculoskeletal disorders, TMD are no exception.[4] A modern biopsychosocial model has integrated earlier psychological and biomedical models together in the background of TMD.[3] In the Northern Finland 1966 Birth Cohort, parental depression during the offspring's childhood was found to be a risk factor for later pain-related TMD symptoms in the offspring, even after controlling for potential covariates.[5] TMD are often associated with the presence of psychological complaints, including fatigue, sleep disturbances, anxiety, stress, and

depression.[6] Moreover, psychological factors, such as depression, have a weakening impact on treatment response.[7] Therefore, their role in the diagnosis and treatment of TMD is important, and further studies are needed to examine the association.

Psychological distress is a concept comprising five defining attributes: perceived inability to cope effectively, change in emotional status, discomfort, communication of discomfort, and harm.[8] Stressors bring on psychological distress; its duration and harmfulness depend on individual coping skills, ie, the ability to adapt to or delete the stressor. Together, these attributes control the harmfulness of psychological distress. The 12-item General Health Questionnaire (GHQ-12)[9] is a screening instrument for measuring psychological distress or minor psychiatric disorders at the population level. The GHQ-12 is a well-known screening device for psychological distress, and its validity has been evaluated in the Finnish Health Survey by Aalto et al.[10] It is based on the hypothesis that psychiatric disorders share an element of psychological distress.

In the literature, there are only a few studies of the association between TMD and psychological distress. Recently, Tjakkes et al[11] reported that among TMD patients, high scores of psychological distress measured by the GHQ-12 were associated with prolonged stages of TMD. Miyachi et al reported overlapping of occlusion-related problems and mental disorders,[12] but they did not study the association between TMD and the GHQ-12. A study by Wan[13] with 400 elderly subjects from Hong Kong reported that the prevalence of orofacial pain symptoms was associated with higher GHQ-12 scores, particularly in a group of institutionalized elderly. Resende et al reported an association between mild TMD and high GHQ-12 scores in a small patient population.[14] Many of the studies of TMD and psychological problems have been based on clinical populations in which bias due to treatment-seeking behavior may appear. Therefore, there is a need for general population–based studies. To the authors' knowledge, there are no general population–based studies of the association between psychological distress measured by the GHQ-12 and TMD findings. The aim of this study was to evaluate the association between psychological distress and TMD signs in a large general population–based sample of Finnish adults.

Materials and Methods

The nationwide Health Survey was conducted in 2000–2001 by the National Institute for Health and Welfare (THL, which includes the former National Public Health Institute of Finland, KTL).[15] The two-stage, stratified, cluster sampling was designed by Statistics Finland. The sampling frame comprised 8,028 adults, aged 30 years or over, living in mainland Finland.[15] A comprehensive health examination included a clinical oral examination (79% of the original sample). The data for this study were obtained from 6,155 subjects whose oral health was clinically examined and who had answered questionnaires, including the GHQ-12. Additional information about the Health 2000 Survey is available at http://www.terveys2000.fi/indexe.html. Permission for the study was given by the ethics committees of the University Hospital Region of Helsinki and Surroundings and the National Public Health Institute. Informed consent was obtained from each survey participant.

Assessment of TMD Signs

A standardized clinical oral examination was performed by five calibrated and experienced examiners (dentists) who assessed the signs of TMD and denture status. The examiners were trained by experienced specialists in order to increase the reproducibility of the clinical examination. The clinical examination technique for assessment of the signs of TMD was trained and calibrated, and each examiner's courses of procedure were videotaped to be immediately reviewed and discussed. Reference measurements were performed for 269 study subjects by the examiner, followed immediately by the reference examiner. The percent agreement between examiners and the reference examiner was 95% (kappa value 0.56; 95% confidence interval [CI] = 0.34–0.77) for maximum interincisal distance, 84% (kappa value 0.44; 95% CI = 0.35–0.52) for clicking, 91% (kappa value 0.21; 95% CI = 0.13–0.29) for crepitation, 92% (kappa value 0.26; 95% CI = 0.19–0.34) for pain in joints, and 95% (kappa value 0.47; 95% CI = 0.41–0.53) for pain in muscles.[16]

The clinical study protocol was designed to comply with the Research Diagnostic Criteria for Temporomandibular Disorders (RDC/TMD)[17] protocol as much as possible, taking into account the limitation of the large study sample. According to the RDC/TMD,[17] the presence of pain on muscle and TMJ palpation is registered as dichotomized (only pain present or absent), and this also was done in the present study.

The assessment of TMD signs included the recording of maximum vertical mouth opening, auscultation of TMJ noises, and palpation of the TMJ and two masticatory muscles (anterior temporalis and superficial masseter). Maximum mouth opening was measured with a ruler and reported as maximum interincisal distance without overbite. It was categorized as limited when less than 40 mm. The mouth opening was measured in both dentate participants and denture wearers. TMJ noises (clicking and crepitation)

were recorded with gentle digital palpation bilaterally over the TMJ region while the subject opened and closed the mouth. TMJ pain was measured by palpating with a force of about 5 N over the immovable condyle, and muscle pain by palpating with a force of about 10 N. Attempts were made to standardize the palpation force by exerting the forces on a measuring scale between the examinations. TMJ and muscle pain on palpation were recorded if subjects reported pain when asked or showed a protective response. Except for the maximum interincisal distance, all the findings were recorded separately for both sides, and they were combined and categorized as either present or absent. Five dichotomous variables were formed: limited maximum mouth opening, TMJ clicking, TMJ crepitation, pain in at least one TMJ, and pain in at least one masticatory muscle.

Psychological Distress

Information on psychological distress was obtained through the GHQ-12 with 12 Likert-type items with four answering options.[18,19] To achieve more statistical power, the Likert scoring (0-1-2-3) was retained, corresponding to the four response options of each item: "not at all," "same as usual," "rather more than usual," and "much more than usual." The responses were combined into a sum score. A high score in any question indicated greater distress, the range being 0–36. These GHQ-12 scores were obtained from 6,155 subjects. Two out of 12 questions were allowed to be missing and they were replaced by the mean value of the remaining GHQ-12 items of the individual. In the analyses, the total GHQ-12 scores were used both as a continuous variable and split into quartiles by distress level. Four groups were formed by rising GHQ-12 scores: the lowest quartile with a total score of 8 or less, medium low with a total score of 9 to 11, medium high with a total score of 12 to 13, and the highest with a total score of 14 or more.

Potential Confounding Factors

Age, gender, marital status, level of education, self-reported general health, and denture status were obtained from the questionnaires, the interview, and clinical examination (denture status) and were used as cofactors. Age was categorized into six groups (30–34, 35–44, 45–54, 55–64, 65–74, and 75+ years). Education was categorized into basic, secondary, or higher education. The basic education category included those with no formal vocational training or senior secondary education, secondary education included those who had completed vocational training or passed the matriculation examination, and higher education comprised degrees or diplomas from higher vocational institutions, polytechnics, and universities. Marital status was dichotomized, with married or cohabiting subjects forming one group and the rest (divorced, widowed, or single subjects) forming another group. Subjects were asked how they rated their health with the response options "good," "rather good," "moderate," "rather poor," or "poor." The answers were further categorized as "good" (good/rather good) or "poor" (moderate/rather poor/poor). Denture status was categorized as "dentate, no removable dentures," "dentate with removable dentures," or "edentulous/complete dentures."

Statistical Analyses

SAS-callable SUDAAN was used to analyze the clustered data. Poststratum weights, based on gender, age, region, and language, were used for correcting the effects of oversampling people aged 80 years or more and nonresponse. Statistical analyses included chi-square tests between each of the five TMD signs and GHQ-12 quartiles, gender, age group, marital status, level of education, and self-reported general health. *T* tests were used to compare means of age and GHQ-12 scores between men and women, as well as means of GHQ-12 scores according to the occurrence of each TMD finding separately in men and women. Logistic regression analysis included TMD signs as an outcome. Both GHQ-12 modifications were used as an exposure, and age, marital status, level of education, and self-reported general health as cofactors. Also, separate logistic regressions were run by adding denture status into the models, as well as by replacing age with denture status.

Results

Basic characteristics of the study population related to gender are shown in Table 1. Except for self-reported general health, all cofactors associated with gender have a significance level of .05.

The prevalence of the TMD findings (limited opening, clicking, crepitation, TMJ palpation pain, and muscle palpation pain) was 11.2%, 17.6%, 10.5%, 5.1%, and 18.9% in women and 6.1%, 12.9%, 5.3%, 2.4%, and 7.2% in men, respectively. High GHQ-12 scores, measured both as a continuous variable and in quartiles by distress level, were statistically significantly associated with masticatory muscle pain on palpation in both genders ($P < .05$) and with TMJ pain on palpation in women ($P < .05$). Additionally, higher GHQ scores as a continuous variable were associated with TMJ crepitation in men ($P < .05$) (Table 2).

The logistic regression analysis showed that masticatory muscle pain on palpation increased across the GHQ-12 quartiles both among women (odds ratio [OR] = 2.18; 95% CI = 1.6–2.9) and men

Table 1 Description of the Study Population

	Men (n = 2,798)		Women (n = 3,357)		Total (n = 6,155)		
	Mean	SE	Mean	SE	Mean	SE	*P* value
Age (y)	50.7	0.271	52.8	0.241	51.8	0.195	< .001*
GHQ-12† score as continuous	11.3	0.980	11.8	0.897	11.6	0.661	< .001*
	n	%	n	%	n	%	*P* value
Age group (y)							< .001‡
30–34	319	11.6	366	10.6	685	11.1	
35–44	682	24.9	757	22.2	1,439	23.5	
45–54	774	28.5	830	26.0	1,604	27.2	
55–64	502	18.0	580	18.5	1,082	18.2	
65–74	333	12.0	440	14.1	773	13.1	
75+	188	5.0	384	8.6	572	6.9	
Marital status							< .001‡ < .001‡,§
Married	1,796	64.4	1,863	56.7	3,659	60.4	
Cohabiting	330	12.1	332	10.0	662	11.0	
Divorced	219	8.0	377	11.5	596	9.8	
Widowed	96	3.0	446	12.0	542	7.7	
Single	348	12.6	333	9.8	681	11.2	
Missing	9		6		15		
Level of education							< .001‡
Basic	1,050	37.0	1,321	39.0	2,371	38.0	
Secondary	1,063	38.5	932	28.0	1,995	33.0	
Higher	677	24.5	1,095	33.0	1,772	29.0	
Self-reported general health							< .361‡ < .504‡,‖
Good	906	33.0	1,091	32.8	1,997	32.9	
Rather good	830	20.1	1,029	31.1	1,859	30.6	
Moderate	739	26.2	875	26.2	1,614	26.2	
Rather poor	224	7.8	264	7.7	488	7.7	
Poor	85	3.0	87	2.2	172	2.6	
GHQ-12† quartiles¶							< .001‡
Lowest	854	30.6	879	26.2	1,733	28.3	
Medium low	818	29.3	971	29.0	1,789	29.1	
Medium high	508	18.1	626	18.9	1,134	18.5	
Highest	618	22.0	881	25.9	1,499	24.0	
GHQ-12† score as continuous							< .001‡
Under average	1,672	59.9	1,850	55.2	3,522	57.4	
Over average	1,126	40.1	1,507	44.8	2,633	42.6	

*t test between genders.
†12-item General Health Questionnaire (GHQ-12) with Likert score 0 to 3, total minimum 0, maximum 36 points.
‡Chi-square test between genders.
§Dichotomized to married/cohabiting and others; others includes divorced, widowed, singles.
‖Dichotomized to good and poor. Good includes good and rather good; poor includes moderate, rather poor, and poor.
¶Lowest 0–8; medium low 9–11; medium high 12–13; highest 14–36, a higher score indicating greater distress.

Table 2 Prevalence of Clinical Signs of Temporomandibular Disorders (TMD) in Men and Women by Psychosocial Distress Measured by GHQ-12 Scores

	Maximum interincisal distance < 40 mm		Clicking		Crepitation		TMJ pain†		Muscle pain‡	
	Men	Women	Men	Women	Men	Women	Men	Women	Men	Women
n	172	385	360	589	149	350	66	176	208	651
All (%)	6.1	11.2	12.9	17.6	5.3	10.5	2.4	5.1	7.2	18.9
GHQ-12* quartiles§										
Lowest	5.6	12.0	13.1	18.3	4.1	12.3	1.9	4.1	5.5	12.9
Medium low	5.8	9.5	12.9	17.5	5.6	9.2	2.2	4.6	4.7	15.3
Medium high	5.9	9.5	12.4	19.3	6.3	10.8	2.8	4.0	7.6	17.8
Highest	7.3	13.8	13.2	15.7	5.7	9.7	3.0	7.3	12.5	29.8
P value‖	.648	.017	.971	.232	.242	.172	.443	.015	< .001	< .001
GHQ-12* as continuous										
Mean (SE)	11.52 (0.385)	12.15 (0.293)	11.38 (0.273)	11.52 (0.202)	12.14 (0.472)	11.33 (0.258)	12.74 (0.716)	12.99 (0.435)	13.12 (0.437)	13.47 (0.244)
P value¶	.519	.066	.476	.184	.018	.096	.058	.002	<. 001	< .001

*12-item General Health Questionnaire with Likert score 0–3, total minimum 0, maximum 36 points.
†Either at least one of the temporomandibular joints (TMJs).
‡In one of the following: right or left masseter superficialis or temporalis anterior muscle.
§Lowest 0–8; medium low 9–11; medium high 12–13; highest 14–36, a higher score indicating greater distress.
‖Chi square test between GHQ-12 quartiles and TMD finding separately in females (F) and males (M).
¶*t* tests between the GHQ-12 as continuous and TMD finding separately in females (F) and males (M).

Table 3 Associations of Psychological Distress (as Measured with GHQ-12) and Cofactors with Clinical Signs of Temporomandibular Disorders by Means of Logistic Regression Models (as Described by Odds Ratio [OR] and 95% Confidence Interval [CI]), Fitted Separately for Men and Women

	Maximum interincisal distance < 40 mm		Clicking		Crepitation	
	Men OR (95% CI)	Women OR (95% CI)	Men OR (95% CI)	WomenOR (95% CI)	Men OR (95% CI)	Women OR (95% CI)
Age (y)						
30–34	Ref	Ref	Ref	Ref	Ref	Ref
35–44	2.0 (0.8–5.3)	1.5 (0.9–2.7)	0.9 (0.6–1.4)	0.7 (0.5–1.0)	2.2 (1.0–4.7)	1.3 (0.7–2.2)
45–54	2.8 (1.1–7.1)	2.0 (1.2–3.5)	0.9 (0.6–1.4)	1.1 (0.8–1.5)	3.1 (1.4–6.9)	2.4 (1.4–4.2)
55–64	4.8 (1.8–12.8)	3.3 (1.9–5.7)	0.9 (0.6–1.4)	0.8 (0.5–1.1)	3.6 (1.5–8.6)	3.1 (1.8–5.3)
65–74	8.0 (3.2–20.1)	4.0 (2.2–7.2)	0.9 (0.6–1.4)	1.0 (0.7–1.5)	2.7 (1.1–6.3)	3.5 (2.0–6.1)
75+	12.0 (4.4–32.0)	6.6 (3.5–12.2)	1.0 (0.5–1.7)	0.9 (0.5–1.4)	2.8 (1.0–8.2)	5.1 (2.8–9.3)
P value	< .001	< .001	.992	.053	.083	< .001
Marital status						
Married/cohabiting	Ref	Ref	Ref	Ref	Ref	Ref
Others‡	1.5 (1.0–2.2)	1.1 (0.8–1.4)	1.1 (0.9–1.4)	0.9 (0.8–1.2)	0.8 (0.5–1.3)	1.2 (0.9–1.5)
P value	.028	.481	.407	.593	.448	.227
Level of education						
Basic	1.6 (1.0–2.5)	0.9 (0.7–1.3)	1.3 (0.9–1.7)	1.0 (0.8–1.3)	0.9 (0.6–1.5)	0.8 (0.6–1.1)
Secondary	1.4 (0.8–2.3)	0.8 (0.6–1.0)	1.0 (0.7–1.3)	1.1 (0.9–1.4)	1.0 (0.7–1.6)	0.8 (0.6–1.1)
Higher	Ref	Ref	Ref	Ref	Ref	Ref
P value	.132	.228	.110	.684	.845	.304
Self-reported general health§						
Good	Ref	Ref	Ref	Ref	Ref	Ref
Poor	1.1 (0.8–1.5)	1.2 (0.9–1.6)	1.0 (0.7–1.3)	1.0 (0.8–1.2)	0.9 (0.6–1.2)	1.0 (0.7–1.2)
P value	.592	.184	.923	.821	.396	.701
GHQ-12‖ quartiles¶						
Lowest	Ref	Ref	Ref	Ref	Ref	Ref
Medium low	1.02 (0.7–1.5)	0.69 (0.5–0.9)	0.98 (0.7–1.3)	0.94 (0.7–1.2)	1.38 (0.9–2.2)	0.69 (0.5–0.9)
Medium high	0.98 (0.6–1.6)	0.66 (0.5–0.9)	0.91 (0.7–1.3)	1.05 (0.8–1.4)	1.57 (0.95–2.6)	0.80 (0.6–1.1)
Highest	1.05 (0.7–1.6)	0.95 (0.7–1.3)	0.97 (0.7–1.4)	0.85 (0.7–1.1)	1.42 (0.9–2.3)	0.70 (0.5–0.9)
P value	.993	.018	.953	.377	.310	.052
Hosmer & Lemeshow test#	4.4/8/0.816	7.4/8/0.496	6.7/8/0.574	8.2/8/0.416	6.9/8/0.544	7.4/8/0.499
GHQ-12‖ continuous**	1.993(0.96–1.03)	1.000(0.98–1.02)	1.001 (0.98–1.03)	0.990 (0.97–1.01)	1.038 (1.00–1.07)	0.972 (0.95–1.00)
P value of GHQ	.713	.995	.958	.289	.027	.026
Hosmer & Lemeshow test§	9.2/8/0.322	8.0/8/0.433	5.6/8/0.692	4.13/8/0.845	13.2/8/0.105	12.6/8/0125

Ref = Reference category.
*At least one of the temporomandibular joints (TMJs).
†In one of the following: right or left masseter superficialis or temporalis anterior muscle.
‡Others includes divorced, widowed, and singles.
§Good includes good and rather good; poor includes moderate, rather poor, and poor.
‖12-item General Health questionnaire (GHQ) with Likert score 0–3, total minimum 0, maximum 36 points.
¶Lowest 0–8; medium low 9–11; medium high 12–13; highest 14–36, a high score indicating greater distress.
#Hosmer and Lemeshow test: chi-square/df/sig.
**Adjusted for age, marital status, level of education, and self-reported general health.

(OR = 2.03, 95% = 1.3–3.1). The association was also significant with continuous GHQ-12 scores. Additional logistic regression analyses, including denture status and denture status replaced by age, did not significantly change the results. Due to the high correlation between age groups and denture status (Spearman, 0.615), age was kept in the analysis as a more relevant factor instead of denture status (Table 3).

Discussion

The results of this study indicate that higher psychosocial distress seems to be associated with pain-related TMD findings, especially with masticatory muscle pain on palpation. This is in line with previous studies showing that stress and other psychological elements are associated with pain-related TMD signs.[3,4,6,12,20–23] However, due to the limitations of

	TMJ pain*		Muscle pain†	
	Men OR (95% CI)	Women OR (95% CI)	Men OR (95% CI)	Women OR (95% CI)
	Ref	Ref	Ref	Ref
	0.8 (0.4–1.5)	1.9 (0.8–4.2)	1.1 (0.6–2.1)	1.2 (0.8–1.8)
	0.6 (0.3–1.3)	2.1 (0.9–4.6)	1.0 (0.5–2.0)	1.2 (0.8–1.8)
	0.3 (0.1–0.9)	2.4 (1.1–5.4)	1.2 (0.7–2.3)	1.4 (0.9–2.1)
	0.3 (0.1–0.8)	2.4 (1.0–5.8)	2.3 (1.1–4.7)	2.0 (1.3–3.1)
	0.3 (0.1–1.0)	3.3 (1.5–7.4)	2.7 (1.3–5.4)	2.6 (1.7–4.1)
	.105	.083	< .001	< 0.001
	Ref	Ref	Ref	Ref
	1.0 (0.6–1.8)	0.6 (0.4–0.8)	1.4 (0.9–2.0)	1.0 (0.8–1.2)
	.995	.003	.099	.623
	1.3 (0.7–2.3)	1.8 (1.1–3.0)	1.3 (0.8–2.1)	1.3 (1.0–1.7)
	1.2 (0.6–2.1)	1.9 (1.2–2.9)	1.2 (0.7–1.8)	1.2 (0.9–1.6)
	Ref	Ref	Ref	Ref
	.674	.011	.467	.115
	Ref	Ref	Ref	Ref
	2.0 (1.2–3.4)	1.5 (1.1–2.1)	1.5 (1.0–2.1)	1.9 (1.6–2.3)
	.010	.013	.037	<.001
	Ref	Ref	Ref	Ref
	1.09 (0.6–2.1)	1.07 (0.7–1.8)	0.83 (0.5–1.3)	1.13 (0.9–1.5)
	1.27 (0.7–2.4)	0.82 (0.5–1.3)	1.29 (0.8–2.1)	1.20 (0.9–1.6)
	1.28 (0.6–2.6)	1.48 (0.9–2.3)	2.03 (1.3–3.1)	2.18 (1.6–2.9)
	.829	.055	< .001	< .001
	5.2/8/0.733	4.1/8/0.850	6.9/8/0.543	6.4/8/0.601
	1.035 (0.99–1.08)	1.032 (1.00–1.06)	1.050 (1.02–1.08)	1.056 (1.04–1.08)
	.102	.032	<.001	<.001
	10.8/8/0.215	8.3/8/0.403	3.9/8/0.870	3.2/8/0.924

the study, the findings can be regarded as preliminary and their application to the general population is limited, which is why further studies with a proper diagnosis of TMD are needed.

In the present study, TMJ crepitation among men seemed to be related to elevated psychosocial distress. Crepitation is a finding related to TMJ arthrosis.[17] A conceivable explanation may be that higher masticatory forces among men, as compared to women, are linked with parafunctions induced by stress and excessive strain,[24] which in turn may predispose to degenerative alterations in the TMJ. It has been shown that there may be sex differences in the responses of the TMJ to occlusal loading.[25] The etiopathogenesis of TMD is uncertain, and numerous factors have been proposed to predispose to TMD. Multivariable logistic regression models suggest that occlusal factors account for up to 27% of the etiology of TMJ disorders and 10% of masticatory muscle disorders, still leaving many options for genetics and neuroplasticity,[1] including a biopsychosocial model.[3] This study supports the biopsychosocial model by emphasizing the role of psychological distress, especially with pain-related TMD findings.

In 2008, Wells and Ridner[26] evaluated pain-related distress in relation to pain intensity and psychological distress. Their proposed hybrid model of pain-related distress, pain intensity, and psychological distress might explain how elevated GHQ-12 scores are associated with pain-related TMD signs. In the proposed hybrid model, psychological factors (context, past experience, meaning, coping demands, and resources) contribute to second-order processing of the overall pain experience, and thereby to the development of psychological distress. Psychological distress modulates first-order processing. In 2011, Elman et al[27] presented three important lines related to neurobiological and psychological aspects of pain. First, there may be a neuroanatomical and functional overlap between the brain circuitry involved in pain and emotion or reward and motivation, suggesting integration and mutual modulation of these systems. Second, mental disorders are frequently associated with pain processing, and chronic pain may impair both emotional and neurocognitive functioning. Third, as pain is stressful, it might represent pathophysiologic mechanisms inherent in psychiatric morbidity.[27]

The present study was part of a comprehensive and nationally representative health survey. Because of the sampling design and high response rates, it was possible to obtain information about the signs of TMD in the Finnish adult population as a whole, which is one of the major strengths of the study. In contrast to patient studies, the population-based sample may at least partly exclude the bias related to care-seeking behavior. The study design also allowed the use of several outcome variables, including the main signs of TMD, as well as consideration of the potential confounders. However, due to practical reasons, all signs examined in a proper clinical examination for TMD, ie, pain on mandibular

movements or measurements of ranges of laterotrusion and protrusion movements, as well as pain on palpation in all masticatory muscles, could not be included in the present study. Based on the TMD clinical examination procedures that are validated and generally used (ie, RDC/TMD[17] and the recently published new Diagnostic Criteria for TMD (DC/TMD[28]), the clinical findings are based on dichotomization (muscle palpation present/absent, etc), which is why it was also used in the present study. Also, for practical reasons, the clinical examinations were not performed by specialists but by general dentists, which may have led to errors in measurement. These measurement errors most likely indicate that the true associations could be stronger than those observed in this study.

Data were analyzed separately between genders, because women seem to be more prone to perceiving TMD signs than men.[2,29] The signs studied here represent five distinct TMD signs with different etiologic risk factors and were therefore analyzed separately.

The relationship between psychological distress and pain may be interdependent: Prolonged psychological distress may induce pain synthesis and, on the other hand, chronic pain may induce psychological problems.[23] Although the present findings do not resolve the causality, they do support the earlier studies emphasizing the role of psychological factors in the background of TMD at the general population level.[3,6,13]

The pathophysiologic basis for the association between psychological distress and pain-related TMD symptoms might be related to dysregulation of the hypothalamic-pituitary-adrenal (HPA) axis.[30] High levels of cortisol, indicating HPA hyperactivity, have been noted to occur in both depression and facial pain,[30] for example. In another general population–based Finnish study, both self-reported depression and parental depression during the subjects' childhoods were associated with increased risk for pain-related TMD symptoms,[5] which may be explained by hyperactivation of the HPA axis, resulting in alterations in pain perception.[31]

The present study used the GHQ-12 with Likert scoring. The GHQ was created to identify minor psychiatric disorders or the presence of psychological distress in nonpsychiatric populations.[9] Each question gives 0 to 3 points. Higher scores indicate a higher probability of psychiatric disorders or elevated psychological distress. Psychological distress may be part of respondents' lives so that while the subjective rating is "normal" or "average," they may actually be under the influence of psychological distress. The GHQ may be more selective in the case of people with increasing distress, giving lower scores for people in the decreasing stressor phase.

Screening devices for mental health may overlap with each other. Sense of coherence (SOC) is widely used to evaluate psychological factors in relation to health.[32] The association of weak SOC and TMD signs has been shown in earlier studies.[33] The SOC and GHQ are both questionnaires measuring different psychological elements of the human mind. The SOC measures comprehensibility, manageability, and meaningfulness. According to the creator of the SOC, a strong SOC indicates a person's ability to adapt to stressors in a positive way.[34] The relation of SOC and GHQ has also been studied by Nilsson et al,[35] who reported that females show higher GHQ scores than men in all age groups at the population level. In TMD, the trend is known to be similar, and the present study supports the findings that females are more prone to both elevated GHQ scores and TMD findings. The findings of the present study support the view that psychological factors, including psychological distress, are part of the etiopathology of TMD.

At the general population level, psychological distress and pain-related TMD signs seem to be associated, suggesting that psychological factors are important in the background of TMD. However, due to the limitations of the study, the findings can be regarded as preliminary and their application to the general population also limited, and thus further studies with a proper diagnosis of TMD are needed.

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