# Gender Differences in Associations Between Occlusal Support and Signs of Temporomandibular Disorders: Results of the Population-Based Study of Health in Pomerania (SHIP)

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**Purpose:** The aim of this study was to investigate whether gender-dependent associations exist between signs of temporomandibular disorders (TMD) and occlusal support. Materials and Methods: Stratified by gender, the data of 2,963 35- to 74year-old participants from the epidemiologic Study of Health in Pomerania were used in logistic regression analyses with temporomandibular joint (TMJ) tenderness and muscle tenderness as the dependent variables. Occlusal support was classified according to the Eichner index, a classification system based on occluding pairs of teeth. The final model was adjusted for bruxism, age, and various sociodemographic data. Results: Logistic regression analyses revealed increased odds ratios for TMJ tenderness in men with loss of all four molar and premolar supporting zones (odds ratio 3:9) and without antagonist contact (odds ratio 2:7). Significant relationships in men were also found between muscle tenderness and loss of one (odds ratio 2:1), three (odds ratio 2:1), or four supporting zones (odds ratio 2:7), and loss of any tooth contact (odds ratio 2:3). In women, significant associations between occlusal support and TMD signs were absent. Subjects with bruxism were more likely to have TMJ tenderness (odds ratio women 2:0, men 1:9). In women, an additional relationship existed between bruxism and muscle tenderness (odds ratio 1:7). The following habits showed no significance: gum chewing, unilateral chewing, and lip/tongue/cheek biting. **Conclusion:** Only in men was the loss of occlusal support significantly associated with muscle and TMJ tenderness. The association between bruxism and TMD signs supports the theory that repetitive adverse loading of the masticatory system may cause functional disturbances. Int J Prosthodont 2005;18:232-239.

Temporomandibular disorders (TMD) are common among all age groups.<sup>1</sup> Symptoms have been found more frequently in females than in males,<sup>2–9</sup> but these findings have not always been confirmed.<sup>1,10</sup> However,

**Correspondence to:** Dr Torsten Mundt, Center of Oral Health, Department of Prosthodontics and Dental Materials, Rotgerberstraße 8, Greifswald D-17487, Germany. Fax: + 49 3834-867148. e-mail: mundt@uni-greifswald.de the frequencies differ between epidemiologic studies because subjective symptoms alone,<sup>9-12</sup> subjective and objective symptoms and signs,<sup>6,13-21</sup> or combinations of symptoms within indices<sup>1-4,22-25</sup> have been examined. Additionally, various age groups, different examination methods, and gender distributions lead to different results. Therefore, TMD prevalences are rarely comparable.<sup>26,27</sup>

Modern etiologic theories for the development of TMD contain different external and internal factors. Aside from the biopsychosocial and multifactorial theories,<sup>28</sup> Greene<sup>29</sup> advocates an idiopathic concept of etiology at the level of the individual patient. Currently, the multifactorial concept including predisposing (systemic, psychologic, anatomic, occlusal), initiating (micro- and macrotrauma, parafunctional habits, overloading), and perpetuating (mechanical and muscular stress, metabolic, behavioral, social, and emotional) factors is accepted.<sup>10,16,30</sup>

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Today, the effect of occlusion within the etiology of TMD is not reflected in evidence-based data.<sup>30,31</sup> The relationship between TMD and loss of occlusal support is still a subject of contentious discussion. A number of studies have connected tooth loss with TMD.<sup>11,12,15,22,32-40</sup> On the other hand, some authors do not find any association between the number of remaining teeth and the frequency of dysfunctional symptoms.<sup>6,24,41-44</sup> Others report that shortened dental arches with premolar occlusion are sufficient in terms of mandibular stability and may not increase the risk of developing TMD.<sup>45-47</sup>

The goal of this study was first to investigate the relationship of TMD signs to occlusal support, taking sociodemographic and oral parafunctional data of a population-based study into consideration. Second, the hypothesis of whether these postulated associations differ by gender was examined.

# **Materials and Methods**

# **Data Collection**

From October 1997 to May 2001, a population-based, randomized, cross-sectional study was carried out in the region of West Pomerania in northeast Germany. The aim of the Study of Health in Pomerania (SHIP-0) was to determine the prevalence of various general and dental diseases through interviews, questionnaires, and clinical examinations to ascertain possible causes and interrelationships with the socioeconomic status and behavior of participants. The study's management randomized subjects, made selections from county Registry Office files, and invited the subjects to the study examination center.<sup>48</sup> The net sample comprised 6,267 people with an age range of 20 to 81 years. With a response rate of 68.8%, 4,310 subjects were examined.

From the oral health section,<sup>49</sup> the number and position of missing teeth, extant prosthetic status, and TMD signs were used. The examinations were performed by eight clinicians. The TMD examination followed the guidelines of the Academy of Orofacial Pain.<sup>10</sup> According to the examiner manuals, training of the examiners and consensus discussions were performed before the study started and took place twice a year while the study was running. In the final calibration session, interexaminer kappa values varied from .53 to .63 for detecting palpation pain of the masticatory muscles and temporomandibular joint (TMJ).<sup>27,49</sup> The present investigation was limited to 3,036 participants aged 35 to 74 years (response 69.4%). Thirty-five women (3.33%) and 38 men (2.48%) with incomplete records had to be excluded; thus, the data of 2,963 subjects (1,493 women, 1,470 men) were ultimately evaluated.

### Assessment of Variables

The following TMD signs were used for statistical analyses:

- Tenderness or pain of one or more muscles on bilateral palpation (temporalis, masseter, medial pterygoid, suboccipitalis, sternocleidomastoid) or pain during an isometric contraction test of the lateral pterygoid, as it is difficult to palpate this muscle<sup>50</sup>
- Uni- or bilateral tenderness or pain on direct preauricular palpation of one or both TMJs or by dorsocranial compression of the joints

The independent variable of interest was occlusal support, as classified by the Eichner index.<sup>22,24</sup> The Eichner classification is based on occlusal contact areas in antagonist jaws for the natural dentition, including fixed dentures. Class A contains four support zones; this means there is a minimum of one tooth in contact between the maxilla and the mandible in both the premolar and molar regions on each side. Class B contains three (B1), two (B2), or one (B3) support zones, or support in the anterior area only (B4). In class C, there are no antagonist contacts in the dentition.

The following oral habits were selected from the dental interview: grinding or clenching the teeth = awake or sleep bruxism (yes/no); gum chewing (yes/no); lip/tongue/cheek biting (yes/no); and chewing mostly on one side = unilateral chewing (yes/no). School education was categorized into three levels: < 10 years; 10 to 11 years (reference); or > 11 years. Marital status was also included: married = reference; married but separated; single; divorced; or widowed.

### Statistical Analysis

The relationship between TMD signs and loss of occlusal support was separately analyzed for women and men. For the logistic regression analyses, cases were defined as either persons with muscle tenderness or pain, or persons with TMJ tenderness or pain. To describe these two groups (cases and noncases), data on qualitative characteristics were expressed as absolute numbers, including percentage values. Comparisons between these two groups were done using the chi-square test. The odds ratios (OR), with their 95% confidence intervals (CI), were calculated for the two TMD signs.

For the logistic regression models, potential confounders of the Eichner classification (A = reference, B1, B2, B3, B4, C) were assessed as recommended by Greenland and Rothman<sup>51</sup>: Inclusion in the model led to a 10% change in the Eichner coefficient. Age was defined categorically with both 5- and 10-year intervals

Fable 1	Frequency of Presence or A	Absence of Muscle	Tenderness and/or F	Pain Within Women and Men
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	Women (n $= 1.493$ )			M	Men $(n = 1.470)$		
	Absent	Present	Р	Absent	Present	Р	
Variable	(n = 1,217)	(n = 276)	value	(n = 1,330)	(n = 140)	value	
Age group (y)							
35-44	317 (26.0)	72 (26.1)	_	323 (24.3)	35 (25.0)	-	
45-54	341 (28.0)	57 (20.7)	NS	318 (23.9)	20 (14.3)	NS	
55-64	326 (26.8)	91 (33.0)	NS	366 (27.5)	39 (27.9)	NS	
65-74	233 (19.1)	56 (20.3)	NS	323 (24.3)	46 (32.9)	NS	
School education (y)							
< 10	526 (43.2)	138 (50.0)	.024	617 (46.4)	74 (52.9)	NS	
10-11	529 (43.5)	100 (36.2)	_	498 (37.4)	43 (30.7)	-	
> 11	162 (13.3)	38 (13.8)	NS	215 (16.2)	23 (16.4)	NS	
Marital status							
Married	845 (69.4)	189 (68.5)	_	1,091 (82.0)	109 (77.9)	-	
Married but separated	25 (2.1)	6 (2.2)	NS	16 (1.2)	3 (2.1)	NS	
Single	69 (5.7)	18 (6.5)	NS	83 (6.2)	11 (7.9)	NS	
Divorced	132 (10.8)	31 (11.2)	NS	95 (7.1)	11 (7.9)	NS	
Widowed	146 (12.0)	32 (11.6)	NS	45 (3.4)	6 (4.3)	NS	
Eichner class							
A	465 (38.2)	98 (35.5)	_	535 (40.2)	35 (25.0)	_	
B1	154 (12.7)	32 (11.6)	NS	154 (11.6)	20 (14.3)	.020	
B2	105 (8.6)	32 (11.6)	NS	124 (9.3)	10 (7.1)	NS	
B3	91 (7.5)	18 (6.5)	NS	107 (8.0)	14 (10.0)	.038	
B4	114 (9.4)	25 (9.1)	NS	91 (6.8)	15 (10.7)	.005	
С	288 (23.7)	71 (25.7)	NS	319 (24.0)	46 (32.9)	.001	
Oral habits							
Unilateral chewing	657 (54.0)	171 (62.0)	.019	530 (39.8)	64 (45.7)	NS	
Lip/tongue/cheek biting	95 (7.8)	34 (12.3)	.023	47 (3.5)	10 (7.1)	NS	
Gum chewing	472 (38.8)	103 (37.3)	NS	454 (34.9)	37 (26.4)	NS	
Bruxism	307 (25.2)	97 (35.1)	.001	381 (28.6)	48 (34.3)	NS	

\*No. (%).

NS = not statistically significant (P < .050).

in preliminary analyses. The two definitions of age produced similar results; all models presented in this article were adjusted for age using four 10-year intervals: 25 to 34 years (reference); 35 to 44 years; 45 to 64 years; and 65 to 74 years.

A value of P < .050 was considered statistically significant.<sup>52</sup> All statistical analyses were conducted with SPSS for Windows, version 11.5 (SPSS).

## Results

### **Baseline Characteristics**

Of 1,493 women, 276 (18.5%) had tenderness or pain on palpation of at least one muscle; of 1,470 men, 140 (9.5%) had tenderness or pain on palpation. One hundred nine women (7.3%) and 50 men (3.4%) showed TMJ tenderness or pain on pressure. Tables 1 and 2 contain the observed proportions of independent variables with respect to muscle tenderness or TMJ tenderness. A trend toward less muscle tenderness was observed in men aged 45 to 54 years compared to other age groups (P=.062). For both TMD signs, the differences in proportions of other age groups were not significant according to bivariate tests. Of the women 13.4% and of the men 16.2% had attended school for 12 years. Subjects with a school education of up to 9 years (44.5% of women, 47.0% of men) were more likely to have muscle tenderness or pain (women P=.102, men P=.024).

More men (81.6%) than women (69.3%) were married. There were more widowed women (11.9%) than men (3.5%). Married but separated women tended to show more TMJ tenderness (P=.057).

The total distribution of the Eichner classes between men and women was almost the same (Eichner class A, 38.8% of men vs 37.7% of women; class B1, 11.8% vs 12.5%; class B2, 9.1% vs 9.2%; class B3, 8.2% vs 7.3%; class B4, 7.2% vs 9.3%; class C, 24.8% vs 24.0%). Men with loss of occlusal support were more likely to have muscle tenderness or pain (Eichner A = reference; class B1, P = .020; class B2, P < .05; class B3, P = .038; class B4, P = .005; class C, P = .001). Similarly, men in Eichner class B4 tended to show more TMJ tenderness or pain (7.0% vs 14.0%, P = .055) compared to the reference, class A (39.0% vs 32.0%). In women, most differences in the percentages were small. Greater distinctions, for example, of Eichner classes A and B3 for TMJ tenderness, did not reach statistical significance.

	Women (n $=$ 1,493)			N	Men $(n = 1.470)$		
	Absent	Present	Р	Absent	Present	Р	
Variable	(n = 1,384)	(n = 109)	value	(n = 1,420)	(n = 50)	value	
Age group (y)							
35-44	359 (25.9)	30 (27.5)	-	343 (24.2)	15 (30.0)	_	
45-54	370 (26.7)	28 (25.7)	NS	327 (23.0)	11 (22.0)	NS	
55-64	383 (27.7)	34 (31.2)	NS	391 (27.5)	14 (28.0)	NS	
65-74	272 (19.7)	17 (15.6)	NS	359 (25.3)	10 (20.0)	NS	
School education (y)							
< 10	616 (44.5)	48 (44.0)	NS	669 (47.1)	22 (44.0)	NS	
10–11	588 (42.5)	41 (37.6)	-	522 (36.8)	19 (38.0)	_	
> 11	180 (13.0)	20 (18.3)	NS	229 (16.1)	9 (18.0)	NS	
Marital status							
Married	963 (69.6)	71 (65.1)	-	1,157 (81.5)	43 (86.0)	—	
Married but separated	26 (1.9)	5 (4.6)	NS	18 (1.3)	1 (2.0)	NS	
Single	83 (6.0)	4 (3.7)	NS	91 (6.4)	3 (6.0)	NS	
Divorced	151 (10.9)	12 (11.0)	NS	104 (7.3)	2 (4.0)	NS	
Widowed	161 (11.6)	17 (15.6)	NS	50 (3.5)	1 (2.0)	NS	
Eichner class							
A	514 (37.1)	49 (45.0)	-	554 (39.0)	16 (32.0)	-	
B1	172 (12.4)	14 (12.8)	NS	169 (11.9)	5 (10.0)	NS	
B2	128 (9.2)	9 (8.3)	NS	130 (9.2)	4 (8.0)	NS	
B3	105 (7.6)	4 (3.7)	NS	117 (8.2)	4 (8.0)	NS	
B4	132 (9.5)	7 (6.4)	NS	99 (7.0)	7 (14.0)	NS	
С	333 (24.1)	26 (23.9)	NS	351 (24.7)	14 (28.0)	NS	
Oral habits							
Unilateral chewing	758 (54.8)	70 (64.2)	NS	572 (40.3)	22 (44.0)	NS	
Lip/tongue/cheek biting	113 (8.2)	16 (14.7)	.031	55 (3.8)	3 (6.0)	NS	
Gum chewing	532 (38.4)	43 (39.4)	NS	488 (34.4)	9 (18.0)	.015	
Bruxism	361 (26.1)	43 (39.4)	.003	407 (28.7)	22 (44.0)	.026	

 Table 2
 Frequency of Presence or Absence of TMJ Tenderness and/or Pain Within Men and Women\*

\*No. (%).

NS = not statistically significant (P < .050).

More women (55.5%) than men (40.4%) reported chewing mostly on one side. Women who chewed unilaterally reported more muscle tenderness or pain (54.0% vs 62.0%, P = .019). In subjects who sometimes or often bit their lips, tongues, or cheeks (8.6% of women, 3.9% of men), increased muscle tenderness or pain was found (women 7.8% vs 12.3%, P=.021; men 3.5% vs 7.1%, P = .060). Of the women with TMJ tenderness or pain, 14.7% reported lip, tongue, or cheek biting, compared to 8.2% of those without TMJ tenderness or pain (P=.031). Self-reported gum chewing was found less frequently in men with either muscle and TMJ tenderness or pain compared to those without these TMD signs (muscle tenderness or pain 34.9% vs 26.4%, P = .060; TMJ tenderness or pain 34.4% vs 18.0%, *P*=.015). Of the men, 29.2% and of the women, 27.1% reported grinding or clenching their teeth. Subjects with bruxism showed more TMJ tenderness or pain (women 26.1% vs 39.4%, P=.003; men 28.7% vs 44.0%, P = .026). Women who bruxed also showed a significant difference in muscle tenderness (25.2% vs 35.1%, P=.001).

#### Logistic Regression

Regarding loss of occlusal support and bruxism, Fig 1 demonstrates the results of four logistic regression models with the dependent variables muscle and TMJ tenderness or pain in women and men. Compared to the 35- to 44-year-old reference groups, subjects aged 45 to 54 years had less muscle tenderness or pain (OR women 0:7, P = .048; men 0:5, P = .022).

School education and marital status were included as confounders according to the criterion  $\ge 10\%$ change in the Eichner coefficient. The OR for muscle tenderness in widowed women was significantly increased (3:0, P = .039).

Women did not show any significant relationships between loss of occlusal support and dysfunctional signs. In men, the ORs for muscle tenderness of all Eichner classes (except B2) were > 2 in relation to reference class A, with *P* values ranging from .005 to .032 (Fig 1). Furthermore, men in Eichner class B4 (OR 3:9, P=.008) and class C (OR 2:7, P=.037) demonstrated significant associations to TMJ tenderness on pressure.

Bruxism was associated with muscle tenderness or pain in women (OR 1:7, P < .001) and with TMJ



**Fig 1** Odds ratios (95% confidence intervals [CI]) of Eichner classes (B1 to C; class A is reference) and bruxism; results adjusted for age, school education, and marital status plotted on a doubling or logarithmic scale; \*P < .050; †P < .010; ‡P < .001; filled circle, women; open square, men.

tenderness or pain in women (OR 2:0, P=.001) and men (OR 1:9, P=.028). Reported gum chewing, lip/tongue/ cheek biting, and unilateral chewing were either not significant or did not meet the criteria for confounding and were thus excluded from the final analyses.

#### Discussion

The present study provides evidence that a reduction of occlusal units is associated with muscle and TMJ tenderness or pain only in men. This effect modification was also supported by the interaction between gender and Eichner classification in an additional analysis without gender stratification. Furthermore, our results support the theory that there is an association between oral parafunctions (eg, bruxism) and TMD signs in males and females.

This study has several strengths. The populationbased sample covered a broad age range. Numerous covariates, such as age, gender, school education, and marital status, were included in statistical analyses.

Some aspects of the present report merit consideration. In epidemiologic population-based studies, specific TMD diseases cannot be determined.<sup>4,6,12,13,15,17,22-24</sup> Combinations of dysfunctional signs and symptoms, such as in an index,<sup>4,22-24</sup> are unspecific and do not lead to clear conclusions.<sup>26,53,54</sup> Therefore, tenderness or pain of the TMJ or the muscles (dependent variables) were analyzed separately. As in other, similar studies, this study possesses the limitations inherent in cross-sectional data. Because SHIP has a large number of subjects and the present study evaluated two TMD signs, statistical significance does not always coincide with clinical significance. Because of a lack of time sequence, the associations observed here, while robust, should not be interpreted as causal.<sup>31</sup> As in other similar studies, it also needs to be kept in mind that this study may be subject to several limitations (eg, data of oral habits came from the dental interview and were not quantitative).

Higher TMD prevalences for women in the present study<sup>27</sup> are confirmed by numerous epidemiologic studies<sup>2,4,6,9,19,55,56</sup> and are in contradiction to some studies that used composite indices.<sup>1,10</sup> Primary statistical analyses without gender stratification demonstrated significant interactions between gender and Eichner classification. Therefore, women and men were analyzed separately because gender seems to have a great influence on the development of functional disturbances.

The higher prevalence of TMD signs in females may be due to a higher biologic sensitivity to stimuli.<sup>55,57</sup> Women may detect signals that men might not notice.<sup>58</sup> Furthermore, social differences make it more acceptable for women to report the experience of pain.<sup>56</sup> In terms of biologic background, the higher number of estrogen receptors in the female TMJ itself has been suggested to be important in gender differences.<sup>59</sup>

236

Recent reports have shown a significant influence of the menstrual cycle on musculoskeletal pain.<sup>60,61</sup>

Eichner class B assumes a loss of at least one supporting zone of molars or premolars. In Eichner class C, no antagonistic relationship exists between teeth or cantilevers. Of 973 subjects aged 20 to 34 years, Eichner class B1 occurred in 47 of them (4.8%), class B2 occurred in 25 (2.6%), class B3 occurred in 5 (0.5%), class B4 occurred in 2 (0.2%), and class C occurred in 10 subjects (1.0%). Because 231 of 301 (76.7%) subjects over 75 years old belonged to Eichner class C, the frequencies of other Eichner classes were inadequate for statistical calculations. Therefore, data from subjects aged 34 years or younger and 75 or older could not be analyzed regarding occlusal support.

In subjects with removable partial dentures—usually classified as Eichner classes B3, B4, or C—occlusal disturbances that were present before tooth loss occurred were not determined. Therefore, we had to work without statistical inclusion of occlusal interferences or malocclusions, although their predictive value for TMD has been proven in cross-sectional studies,<sup>8,13,20,21,23</sup> case-control studies,<sup>25,31</sup> and cohort studies.<sup>16</sup>

Subjects aged 45 to 54 years had significantly less muscle tenderness or pain in relation to the younger reference group. These findings agree with a report that found muscle disorders to be more frequent in younger patients.<sup>62</sup> A review of the literature revealed that the age of peak prevalence is around 35 to 45 years.<sup>56</sup> As an explanation for this observation, Macfarlane et al<sup>58</sup> suppose general changes in the relative perception versus expectation of pain in older age groups. The importance of TMD pain may be lessened in the oldest individuals. Hiltunen et al<sup>63</sup> report milder or absent signs and symptoms of TMD in elderly persons during a 5-year follow-up. On the other hand, older studies report an increase of clinical dysfunctional signs with age.<sup>2,18,42</sup>

The association between marital status and TMJ tenderness in women might be due to a psychosocial component of these variables. The psychologic literature describes the influence of separation from the partner on women's general well-being and health, which confirms our results.<sup>64,65</sup>

Significant associations between TMD signs and tooth loss were found, in agreement with various clinical and epidemiologic studies.<sup>11,12,14,22,32,34,35,39,40</sup> However, such associations were discovered only in men. Other studies did not find any effect modifications similar to these.<sup>6,8,24,41-44</sup> Some of those authors made no distinctions with regard to gender in their analyses.<sup>6,8,24,43,44</sup> For this reason, findings in females might mask the overall results. Alternatively, the deterioration of the dentition was perhaps not severe enough (eg, in younger age groups) to affect the masticatory muscles or TMJ components.<sup>8</sup> Some examinations took just the number, and not the position, of missing teeth into account.<sup>44</sup>

The muscle and TMJ tenderness to palpation was highest in men with remaining anterior teeth (Eichner class B4) and in subjects without antagonist contact (class C), as found in other studies.<sup>22,35</sup> This agrees with authors who consider the concept of shortened dental arches with premolar support as sufficient.45,46 However, more muscle dysfunctions were also found in men with loss of one (class B1) and three (class B3) supporting zones. The decrease of occlusal units may cause impairment of masticatory performance and initial changes in the neuromuscular pattern of jaw muscle activity.<sup>15</sup> The distribution and load of occlusal contacts seem to be important in relation to craniomandibular function.<sup>47,66,67</sup> Tallents et al<sup>39</sup> relate the long-term effect of missing teeth on altered jaw function, rather than the missing teeth themselves, to the development of TMD. In 50-year-old subjects, Johansson et al<sup>9</sup> identify reduced number of teeth as the highest risk factor for impaired chewing ability. With TMJ pain as the dependent variable, the logistic regression analysis showed that bruxism, impaired chewing efficiency, and being female are the most significant risk factors. Agerberg and Bergenholtz<sup>2</sup> insist that natural teeth be saved to avoid parafunctions or unilateral chewing, which may result in nonphysiologic loading of structures within the masticatory system. Experimental and autopsy studies indicate degenerative changes of the articular tissue because of tooth loss.34,36-38

The absence of a relationship between loss of occlusal support and muscle/TMJ disturbances in women may indicate that other factors have more influence. The lack of significance can also be explained by lower bite forces exerted by females.<sup>47</sup>

The higher rate of bruxism in subjects with muscle and/or TMJ tenderness in the present study agrees with the results of other authors.<sup>4,9,68-70</sup> A 20-year follow-up study found bruxism and oral parafunctions to be possible predictors of TMD.<sup>68</sup> By means of a multifactorial analysis, Vanderas und Papagiannoulis<sup>69</sup> demonstrated that clenching and biting on objects has an effect on muscle tenderness. Using a questionnaire in 50-year-old subjects, Johansson et al<sup>9</sup> report that bruxism is a significant risk factor for TMJ pain. Others<sup>4</sup> found a significant association between the number of parafunctional habits and severity of TMD. TMD patients show higher values for total number and time of tooth contacts, as well as several contacts of extended duration.<sup>71</sup> Among the initiating factors for TMD, repetitive adverse loading of the masticatory system is listed as a result of bruxism.<sup>30</sup> However, a direct cause-and-effect relationship has yet to be demonstrated between parafunction and TMD.9,28,72

#### Conclusion

To the best of our knowledge, this is the first population-based study that demonstrates that tooth loss has a different influence on TMD signs in men and women. The loss of occlusal support is significantly and relevantly associated with both TMJ and muscle tenderness or pain only in men. These relationships can be partly explained by the impact of masticatory force or irregular functional stress of muscular and articular tissue as a result of tooth loss. In women, other factors seem to be more important in developing functional disturbances (eg, lower bite forces compared to men). Sociodemographic data such as age, marital status, and school education modified the observed effects. Bruxism showed significant relationships to TMD signs in women and men. The present study therefore supports the theory of a multifactorial etiology of TMD.

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