

Prevalence of the Signs and Symptoms of Temporomandibular Disorders Among Spanish Adults and Seniors According to Five National Surveys Performed Between 1993 and 2015

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Aims: To determine the prevalence of the signs and symptoms of temporomandibular disorders (TMD) and associated variables over the past two decades in samples of Spanish adults and seniors. **Methods:** Data from Spanish national oral health surveys from the last two decades (1993, 2000, 2005, 2010, and 2015) were analyzed from a total of 2,602 adults (35–44 years of age) and 2,529 seniors (65–74 years of age). All surveys were carried out using similar methods (according to World Health Organization standards) for determining prosthetic, dental, and periodontal statuses. For TMD (assessed only among the adults and seniors), inspection/palpation of the temporomandibular joint and masticatory muscles was used to evaluate three different domains: joint sounds; pain-related conditions (joints/muscles); and range of jaw motion. Risk factors were identified using bivariate analysis and were confirmed after a multivariate logistic regression analysis for predicting the presence of TMD pain/dysfunction.

Results: Despite the clear improvement in oral health status observed over the entire study period (1993–2015), the prevalence of temporomandibular pain and dysfunction increased over time in both adults and seniors (the odds ratio [OR] 95% confidence interval [CI] for the entire study period increased, to 2.39 to 4.29). The odds of women and those living in rural areas developing TMD were higher than for men (OR = 1.85; 95% CI 1.52 to 2.25; $P < .001$) and for those living in urban areas (OR = 1.55; 95% CI 1.24 to 1.94; $P < .001$), respectively; however, the prevalence of joint sounds (with no pain or functional restrictions) appeared to be stable throughout the study period at around 14%. **Conclusion:** The prevalence of painful or dysfunctional TMD has significantly increased in the last 22 years in Spain. Besides the time factor, other major predictors of TMD were gender and place of residence. *J Oral Facial Pain Headache* 2018;32:349–357. doi: 10.11607/ofph.2085

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The term temporomandibular disorders (TMD) refers to musculoskeletal problems affecting the masticatory muscles, the temporomandibular joints (TMJs), and associated anatomical structures. The main clinical manifestations are pain in the jaw, face, and temple regions; TMJ sounds; impaired jaw opening; and associated headaches.¹

Most epidemiologic studies have indicated that TMD are more common in women² and in young and middle-aged adult populations³; in contrast, it has been reported that in a Swedish population the symptoms indicative of TMD have quite similar age- and gender-related patterns.⁴ Despite the clearly improved oral health status of some populations in developed countries, there is also an increasing prevalence of the signs⁵ and symptoms⁶ of TMD, as supported by the recent report of Swedish adults and elderly individuals from Jönköping. One might expect that the benefits of improved oral health would be improved functioning of the stomatognathic system owing to better chewing capacity and occlusal support; however, paradoxically, elderly people tend to report fewer symptoms of TMD despite the fact that the severity of TMD tends to increase with age.^{7–11}

Great variability in the prevalence of TMD signs and symptoms has been found in the large epidemiologic studies that have been reported over the decades. This is likely due to the lack of consensus on a TMD case definition and on the criteria and methodology used in assessing different populations and age cohorts.^{4–10} Furthermore, the diagnosis of TMD in the past has often been based on the presence of a single symptom, which has also probably contributed to variation in reported findings. Some symptoms, such as TMJ sounds and jaw tiredness, are mild and frequently occurring, while others, such as limited jaw opening and painful mandibular function, are more severe but less common.^{5,6}

Most of the data about the prevalence of TMD come from Scandinavian countries, which are known to have better oral health status in general.^{4–10} During the last few decades in Spain, oral health has improved with respect to the number of standing teeth, the prevalence of full edentulism, and the prevalence of dental caries and periodontal disease.¹¹ However, until now, there has been no report published regarding the signs and symptoms of TMD among Spanish adults despite the fact that TMD have been routinely assessed in all of the national oral health surveys conducted to date and using the same evaluation methods.

To the authors' knowledge, there is only one other group that has carried out a similar study. It was based on data from three cross-sectional epidemiologic surveys involving 1,740 Swedish individuals aged between 20 and 70 years and over a period of 20 years (data collected in 1983, 1993, and 2003).^{5,6} Köhler et al concluded that the prevalence and severity of TMD symptoms have significantly increased in the last two decades,⁶ that the estimated need for treating TMD has increased from 5% in 1983 to 8% in 2003, and that the prevalence was higher in women than in men throughout the study period.⁵ These authors also concluded that further population-based research should be repeated over long time periods and from other geographic regions to provide further information for understanding TMD prevalence around the world.

The present study was conducted to assess change over time in the prevalence of TMD in Spanish adults and seniors and to identify major TMD predictors among a representative sample of Spanish adults and seniors based on data from the last five national oral health surveys, carried out in 1993, 2000, 2005, 2010, and 2015. The null hypothesis was that no change would be observed in the prevalence of the signs and symptoms of TMD in adults and seniors over a 22-year period.

Materials and Methods

This study was based on a series of five cross-sectional, stratified, population-based studies carried out in Spain from 1993 to 2015 in individuals aged 35 to 44 years (adults) and 65 to 74 years (seniors) in order to investigate oral health among a general population. Although the study focused solely on adults and seniors, each survey followed the World Health Organization (WHO) guidelines for developing an oral health survey¹² and included five age cohorts (5–6, 12, 15, 35–44, and 65–74 years) because the TMD data were only available for these ages.

The institutional research committee of the Spanish Dental Association gave its approval for all surveys, and all individuals included signed a written informed consent. The clinical examination method was in accordance with the method established by the WHO in 1997,¹² except for the survey performed in 1993, which used an earlier version of the method (from 1987¹³). The masticatory system was examined using inspection and palpation to assess three different domains: (1) sounds; (2) pain-related conditions (joints/muscles); and (3) functional limitation. The TMJ was assessed for the presence of audible sharp sounds and was palpated during condylar movement for signs of clicking or crepitus. Tenderness of the jaw elevator muscles (masseter and temporalis muscles on both sides) was assessed with palpation using two fingers on the most bulky part of the muscle with approximately 1 kg of force applied twice. Tenderness was only recorded if palpation provoked a spontaneous avoidance reflex. Similarly, a positive painful joint was identified using palpation of the lateral pole of both condyles, applying about 0.5 kg of force. Reduced jaw mobility was recorded when the distance between the incisal edges of the maxillary and mandibular central incisors was less than 30 mm with the mouth wide open without assistance (taking into account the vertical incisal relationship at maximal intercuspal occlusion).

For recording the TMD symptoms, all subjects were asked "Do you suffer from clicking, jaw pain, or difficulties in opening or closing the jaw once or more than once per week?"¹² Furthermore, participants of the survey in 2000, 2005, and 2015 were questioned about how frequently they had experienced any sort of pain or eating difficulties in the previous 12 months due to problems with their mouth, teeth, or dentures.¹¹ The replies about pain or eating problems were recorded on a Likert-type scale where 0 = never; 1 = hardly ever; 2 = sometimes; 3 = fairly often; and 4 = very often. For analysis, the categories were collapsed into two: never and hardly ever; and fairly often and very often.

All examinations were performed by eight calibrated examiners. Before each survey (in 1993, 2000, 2005, 2010, and 2015), the examiners attended a calibration course (8 to 10 examiners, depending on the survey) to evaluate inter-examiner reliability against a gold standard experienced examiner, with three to five adult patients per examiner (depending on the survey, and with different patients from those participating in the final survey). Intra-examiner reliability was tested with 5 to 10 adult patients per examiner who were examined twice with about 7 days between examinations. TMD status was collapsed into four categories: 0 = asymptomatic; 1 = painless joint sounds; 2 = pain-related TMD without limited opening < 30 mm; and 3 = restricted jaw mobility with or without pain or symptoms. Reliability was measured using the kappa statistic. The kappa figures ranged between .58 and .82, depending on the type (inter or intra) assessed and the examiner dentist (detailed results not shown). This suggested adequate reliability.¹⁴

All surveys and examinations were carried out by the same primary investigators (J.C.L. and M.B.), while the other examiners did not participate in all of the surveys. The main investigators alternated in acting as gold-standard examiners for all calibration training; thus, each survey had a single experienced gold-standard examiner. The data regarding sociodemographic status (age, gender, place of residence, social/economic class) and other clinical conditions (prosthetic, dental and periodontal status and needs) were collected and analyzed as potential predictors of the prevalence and severity of TMD.

Statistical Analyses

The analytical strategy was to compare the prevalence and severity of TMD across the surveys (1993, 2000, 2005, 2010, and 2015); however, regression analyses were carried out on the aggregated sample in order to increase the analytical power for detecting predictors.

Analysis of variance (ANOVA) with Bonferroni correction and chi-square test were used to compare quantitative and nominal variables, respectively, between surveys. Modulating factors were initially explored using Spearman correlation coefficient (r_s), then the crude associations between risk factors and the outcome variable (TMD pain/dysfunction) were assessed using odds ratios (OR) with 95% confidence intervals (95% CI). The adjusted OR values were calculated with multivariate logistic regression using generalized linear models with a binomial distribution. For the bivariate analysis, all risk/protective factors were observed as independent variables, with presence of pain-related TMD or functional limitation as dependent variables. The IBM-SPSS Statistics

20.0 (IBM) was used for the statistical analyses. The cut-off level for statistical significance was $P < .05$.

Results

Table 1 shows the results obtained for age and sex, which were comparable in all of the oral health surveys. Social/economic class distribution was significantly different among the surveys: In the 2005 survey, it was found that significantly higher proportions of adults and seniors belonged to the lowest economic social class (70.1% and 85.4%, respectively) in comparison to the findings of the survey performed in 2000 (37.9% and 48.5%, respectively). A clear improvement in oral health was observed over the entire study period (1993 to 2015) with respect to the number of standing teeth, the decayed, missing, and filled permanent teeth (DMFT) index, and the number of healthy sextants. Regarding prosthetic status, the presence of fixed prosthodontics significantly increased in both adults and seniors. In contrast, the presence of removable partial dentures significantly decreased in adults, while the presence of complete dentures significantly decreased in seniors.

In general, three out of four adults and seniors had no signs or symptoms of TMD (Table 2). Among the adults, the prevalence of joint sounds appeared to be stable throughout the study period at around 14% (with the exception of 2000, when it was 6.9%), but varied among the seniors (6.1% in 2000 and 23% in 1993). In addition, the prevalence of temporomandibular pain and dysfunction showed a clear trend of increasing over time in both adults and seniors.

It is noteworthy that the prevalence of TMD symptoms seemed to be quite stable and similar among adults (12.5%) and seniors (11.5%) and that the self-rated pain and chewing difficulties due to oral health-related problems seemed to improve with time in both groups. While the prevalence of the self-reported pain was similar in both groups, the prevalence of eating problems was significantly higher in the senior group than in the adult group.

Table 3 shows that the temporomandibular status in both adults and seniors was significant and slightly increased over time ($r_s = .1$; $P < .001$). Also, women suffered significantly more from severe stages of TMD than men. Place of residence tended to correlate linearly with the stages of TMD, with those living in rural areas more at risk than those living in urban areas. No clinical variable was found to be significantly correlated with TMD stage among the seniors, but in adults, the number of healthy dental sextants, the number of filled teeth, and prosthetic status were significantly correlated with TMD, although with low Spearman coefficients (ranging from 0.05 to 0.07).

Table 1 Sociodemographic and Clinical Characteristics of Age Cohorts over the Entire Study Period (N = 5,131)

	Age intervals					
	Adults 35–44 y (n = 2,602)					
	All	1993 (n= 534)	2000 (n = 535)	2005 (n = 540)	2010 (n = 393)	2015 (n = 600)
Sociodemographic variables						
Age (y), mean ± SD	39.5 ± 3.2	39.4 ± 3.3	39.3 ± 3.1	39.5 ± 3.2	39.5 ± 3.4	39.7 ± 3.0
Sex, %						
Female	58.6	55.8	63.7	57.0	57.0	59.2
Male	41.4	44.2	36.3	43.0	43.0	40.8
Economic class, ^a %						
High	16.5	–	6.5	14.0	24.7	23.4
Medium	30.9	–	55.6	15.9	29.0	23.0
Low	52.6	–	37.9	70.1	46.3	53.6
Clinical variables, mean ± SD						
Standing teeth ^a	25.1 ± 3.9	24.2 ± 4.0	24.9 ± 4.3	25.0 ± 3.8	26.2 ± 3.0	25.3 ± 4.0
Healthy teeth ^a	23.5 ± 4.8	21.4 ± 5.0	23.7 ± 4.8	23.6 ± 4.6	25.2 ± 3.9	24.2 ± 4.7
Missing teeth ^a	2.9 ± 3.9	3.8 ± 4.0	3.0 ± 4.2	3.0 ± 3.8	1.7 ± 2.9	2.6 ± 4.0
Decayed teeth ^a	1.6 ± 2.4	2.8 ± 3.0	1.3 ± 2.2	1.4 ± 2.2	1.0 ± 2.1	1.1 ± 2.1
Filled teeth ^a	4.2 ± 3.8	2.7 ± 3.3	4.1 ± 3.8	5.2 ± 4.0	4.3 ± 3.7	4.7 ± 3.8
DMFT ^a	8.6 ± 5.2	9.3 ± 5.0	8.4 ± 5.2	9.6 ± 5.1	7.1 ± 4.9	8.4 ± 5.3
Healthy sextants (CPI = 0) ^a	2.5 ± 2.3	1.3 ± 1.8	2.9 ± 2.4	2.5 ± 2.2	2.7 ± 2.2	3.0 ± 2.3
Prosthetic status,^a%						
None	81.3	86.7	79.4	79.6	84.7	77.5
Fixed prosthesis	10.8	0	11.6	13.1	10.7	17.6
Partial denture	7.1	12.9	7.6	6.5	3.8	3.9
Complete denture	0.9	0.4	1.3	0.7	0.8	1.0
Prosthetic needs,^a%						
None	62.2	62.2	54.4	72.2	66.3	57.2
Single-unit	13.3	0	21.8	8.7	16.8	19.9
Multi-unit	23.0	32.2	23.3	18.3	16.3	22.9
Complete unit	1.5	5.6	0.6	0.7	0.5	0

^aHighly significant differences ($P < .01$) for both adults and seniors between the distinct surveys after performing analysis of variance with post hoc Bonferroni correction for quantitative variables and chi-square test for nominal variables. DMFT = sum of decayed, missing, and filled permanent teeth; CPI = Community Periodontal Index according to WHO guidelines.

Table 2 Prevalence and Severity of Temporomandibular Disorders Among Adults and Seniors over the Entire Study Period (N = 5,131)

	Age intervals					
	Adults 35–44 y (n = 2,602)					
	All	1993 (n = 534)	2000 (n = 535)	2005 (n = 540)	2010 (n = 393)	2015 (n = 600)
TMJ status^a %						
Asymptomatic	73.2	77.3	80.9	67.8	72.4	68.3
Joint sounds (clicking or crepitation)	13.3	14.6	6.9	16.5	14.0	14.3
Pain-related disorders (joints/muscles)	11.9	7.9	10.5	14.5	11.7	14.4
Restricted jaw mobility	1.6	0.2	1.8	1.1	1.8	3.0
TMD symptoms	12.5	–	10.8	14.3	11.2	13.3
Self-rated oral pain^a %						
No	65.1	–	–	60.4	62.0	71.4
Sometimes	26.3	–	–	28.1	31.6	21.1
Frequently	8.6	–	–	11.5	6.4	7.5
Self-rated eating difficulties^a %						
No	79.5	–	–	78.1	77.8	81.9
Sometimes	14.2	–	–	14.6	17.9	11.4
Frequently	6.3	–	–	7.2	4.3	6.7

^aHighly significant differences ($P < .01$) for both adults and seniors between the distinct surveys after performing analysis of variance with post hoc Bonferroni correction for quantitative variables or chi-square test for nominal variables.

In addition, the frequency of self-reported problems when chewing was significantly correlated with TMD stage ($r = .07$; $P = .004$), but only in the adult group.

Age intervals						
Seniors 65–74 y (n = 2,529)						
All	1993 (n = 479)	2000 (n = 538)	2005 (n = 540)	2010 (n = 407)	2015 (n = 565)	
69.6 ± 3.2	69.0 ± 3.2	69.7 ± 3.3	70.1 ± 3.2	69.8 ± 3.3	69.0 ± 3.0	
52.5	53.0	51.1	48.5	54.5	55.6	
47.5	47.0	48.9	51.5	45.5	44.4	
7.5	–	4.1	4.8	12.7	11.3	
25.5	–	47.5	9.8	20.1	22.8	
67.0	–	48.5	85.4	67.3	65.9	
13.8 ± 9.5	11.9 ± 9.7	12.4 ± 9.9	14.2 ± 9.2	14.6 ± 9.8	16.0 ± 8.7	
12.3 ± 9.3	9.7 ± 9.0	10.9 ± 9.5	12.8 ± 8.9	13.4 ± 9.6	14.7 ± 8.8	
14.1 ± 9.5	16.1 ± 9.7	15.4 ± 9.8	13.8 ± 9.2	13.2 ± 9.8	11.9 ± 8.7	
1.5 ± 2.6	2.1 ± 3.2	1.5 ± 2.4	1.4 ± 2.4	1.2 ± 2.7	1.3 ± 2.2	
1.7 ± 2.8	.6 ± 1.5	1.2 ± 2.2	1.6 ± 2.5	1.8 ± 3.0	3.0 ± 3.6	
17.3 ± 8.3	18.9 ± 8.4	18.1 ± 8.6	16.8 ± 8.2	16.2 ± 8.5	16.3 ± 7.7	
0.9 ± 1.5	0.3 ± 0.7	0.8 ± 1.5	1.1 ± 1.5	0.8 ± 1.5	1.4 ± 1.8	
37.3	46.3	37.7	33.3	40.2	30.8	
11.9	0	6.2	12.6	16.3	23.7	
24.1	21.3	21.6	28.5	17.8	29.0	
26.8	32.4	34.5	25.6	25.7	16.5	
46.2	22.8	50.4	65.2	44.2	45.6	
4.8	0	4.9	3.5	8.6	7.4	
33.8	41.1	33.8	24.3	35.1	35.9	
15.1	36.1	11.0	7.0	12.1	11.1	

Age intervals						
Seniors 65–74 y (n = 2,529)						
All	1993 (n = 479)	2000 (n = 538)	2005 (n = 540)	2010 (n = 407)	2015 (n = 565)	
72.7	72.0	80.8	–	–	65.8	
14.6	23.0	6.1	–	–	15.3	
9.5	4.8	10.2	–	–	13.0	
3.2	0.2	2.9	–	–	5.9	
11.5	–	11.2	–	–	11.9	
62.5	–	–	54.4	67.9	66.4	
26.6	–	–	30.6	24.9	24.0	
10.9	–	–	15.0	7.2	9.6	
68.6	–	–	65.7	68.9	71.0	
20.4	–	–	21.3	23.0	17.8	
11.0	–	–	13.0	8.1	11.2	

The logistic regression analysis (Table 4) showed that the prevalence of temporomandibular pain or dysfunction among Spanish adults and seniors increased with time (over the entire 22 years the OR

Table 3 Spearman Correlation Coefficients Between Severity of TMD and all Potential Predictors

Variables	Age intervals			
	Adults 35–44 y (n = 2,602)		Seniors 65–74 y (n = 2,529)	
	<i>r_s</i>	<i>P</i> value	<i>r_s</i>	<i>P</i> value
Time-dependent				
Study year	0.10	< .001	0.09	< .001
Sociodemographic				
Age	0.02	.38	0.04	.13
Sex (0 = male; 1 = female)	0.11	< .001	0.07	.005
Economic class (1 = high; 2 = medium; 3 = low)	0.03	.21	–0.04	.20
Residence (1 = urban; 2 = suburban; 3 = rural)	0.04	.06	0.05	.06
Clinical				
Healthy sextants (CPI = 0)	0.07	.001	0.04	.14
Standing teeth in premaxilla	–0.04	.06	0	.99
Standing teeth in the posterior mandible	–0.02	.22	–0.04	.09
Healthy and nonrestored teeth	–0.04	.07	–0.02	.47
Filled teeth	0.05	.01	.04	.11
DMFT	0.04	.07	.02	.39
Prosthetic status (0 = none; 1 = fixed; 2 = removable partial denture; 3 = complete denture)	0.05	.008	–0.03	.16
Self-rated disruption on daily performance because of the mouth, teeth, and/or dentures				
Frequency of oral pain (0 = never; 1 = always)	0.04	.17	–0.02	.71
Frequency of chewing difficulties (0 = never; 1 = always)	0.07	.004	–0.05	.27

DMFT = sum of decayed, missing, and filled permanent teeth; CPI = Community Periodontal Index according to WHO guidelines.

Table 4 Logistic Regression Analyses for Predicting the Presence of Temporomandibular Pain or Dysfunction Among Spanish Adults and Seniors over the Entire Study Period (n = 5,131)

Parameters	OR	95% CI lower limit	95% CI upper limit	<i>P</i> value
Sex (reference: male)	1.85	1.52	2.25	< .001
Residence (urban vs rural)	1.55	1.24	1.94	< .001
1993–2000	2.07	1.51	2.82	< .001
1993–2005	2.63	1.87	3.81	< .001
1993–2010	2.22	1.51	3.25	< .001
1993–2015	3.20	2.39	4.29	< .001

$\chi^2 = 110.98$; degrees of freedom = 4; *P* < .001; Nagelkerke $R^2 = .05$.

95% CI increased, to 2.39 to 4.29). Also, the prevalence was associated with gender and place of residence. The odds of women and those living in rural areas developing TMD were higher than for men (OR = 1.85; 95% CI 1.52 to 2.25; *P* < .001) and those living in urban areas (OR = 1.55; 95% CI 1.24 to 1.94; *P* < .001), respectively. The logistic model was significant, but with low predictability ($R^2 = .05$); however, 86.8% of the cases were properly classified. No clinical variable was able to significantly predict the occurrence of temporomandibular pain/dysfunction.

Discussion

Given the cost of managing TMD, monitoring the prevalence of TMD over time is important for informing health care policy and resource allocation on a population basis and also contributes to an increased understanding of potential etiologic factors. This

study, with its repeated cross-sectional design, focused mainly on the identification of possible trends in the prevalence of the signs and symptoms of TMD in a Spanish population of adults and seniors.

Regarding the external validity of the present study, it should be noted that the sampling strategy met WHO requirements^{12,13} and ensured a representative sample of the target ages. Therefore, it can be assumed that the findings of this study are representative of the general Spanish population and that the results obtained can be used to predict trends that may occur in other populations with similar demographic characteristics.

However, the collection of data over extended periods of time and the comparison of data from different time points in an attempt to visualize time-dependent trends are complex procedures and may limit the validity and comparability of this type of study for several reasons. The major concern is based on the difficulty in standardization of data collection, as different examiners participated in the surveys over the course

of the study. The standards for assessment may also change over time. Even when the method for assessing patients remains the same, the standardization of clinical methods such as palpation (pressure magnitude and rate) is difficult. The fact that these surveys were conducted by the same main investigators and calibrated examiners according to the methods recommended by the WHO guidelines was an attempt to minimize these concerns.

It should be noted that these surveys used a simple assessment method to identify the presence and severity of signs and symptoms of TMD and do not provide specific TMD diagnoses. As the assessment of TMD was based on the third version of a method established by the WHO¹⁴ for the survey carried out in 1993 and the fourth version for surveys carried out in 2000, 2005, 2010, and 2015, there were slight differences.¹² Both methods are very similar for evaluating TMD and include the following three domains: (1) the presence of jaw clicking (joint sounds); (2) tenderness of the jaw elevator muscles on palpation; and (3) reduced jaw mobility (jaw opening < 30 mm). However, since these three clinical domains may occur simultaneously in any given individual, the data were combined in mutually exclusive categories that follow a hierarchical treatment-related strategy (sounds–pains–restrictions). This means that those individuals with restricted jaw mobility may also have experienced painful joints and/or muscles and even joint sounds; however, those individuals who were assigned to the category of TMJ sounds had no pain or functional restrictions, because in this case they would have been assigned to the other categories. This strategy was intended to be useful for estimating the need for treatment, but underestimates the prevalence of the articular sounds shown in the different tables.

Regarding the prevalence of TMD, it seems that TMD signs and symptoms are common in nonpatient adult populations due to a high prevalence of mild signs and symptoms. The findings of the present study are in agreement with those of Gesch et al,¹⁵ who reported that in German adults the prevalence of TMJ tenderness upon pressure was 6.0%, the prevalence of tenderness of masticatory muscles was 12.0%, and the prevalence of clicking and crepitation joint sounds was 24.9%. Similarly, the prevalence of TMJ tenderness on palpation according to Salonen et al among Swedish adults was about 2%⁷ and about 5% in Finnish adults and seniors in the 1980s according to Tervonen and Knuutila.¹⁶ According to Matsuka et al,¹⁷ 6% of a Japanese sample reported TMJ tenderness to palpation. TMJ sounds such as clicking and crepitation had a prevalence of around 15% in the Matsuka et al study,¹⁷ 15.4% in a Danish sample described by Jensen et al,¹⁸ 20% in the study

by Tervonen and Knuutila,¹⁶ and 24.9% in a sample of German adults.¹⁵ Matsuka et al¹⁷ did not report the total number of TMJ sounds, but the prevalence of clicking (46%) and crepitation (19%) were both higher in their sample population. As discussed above, the present findings for articular sounds are underestimated because only those sounds without concomitant pain or functional limitation were considered.

Recent evidence in a Swedish survey suggests that elderly people who reported having TMJ sounds also suffered decreased jaw mobility six times more frequently.¹⁹ However, the presence of articular sounds without pain-related or function-related disturbance is typically not a cause for seeking treatment, making this domain less useful for planning and allocating health care resources.²⁰ According to the well-performed meta-analysis done by Al-Jundi et al, the prevalence of the need for treatment for TMD in adult nonpatients is around 15%.²¹ This value is very close to the present findings when only pain- and function-related conditions are considered in adults (Table 2). Several authors have found that joint clicking and muscle tenderness are the most common manifestations of TMD in nonpatient populations, while reduced jaw mobility is much less common.^{5,6,22} In agreement with these reports,^{5,6,22} the present study found that restricted jaw mobility due to pain is uncommon in both adults (1.6%) and seniors (3.2%). This restricted movement of the mandible (ie, pain on opening the mouth and lateral movement of the mandible) occurred in 9.1% of the participants in the Gesch study,¹⁵ in 3% in the study by Tervonen and Knuutila,¹⁶ and in 0.7% in Salonen et al.⁷

With respect to factors explaining the prevalence of TMD in Spain, only some sociodemographic factors (gender and place of residence) and the year of the survey were found to be significant predictors. Female predisposition to TMD symptoms has been widely documented.^{3,15,16,23,24} Gesch et al¹⁵ reported that the prevalence of TMD in German adults was higher among females (56.9%) than among males (42.5%). Similarly, Yekkalam and Wänman⁴ reported a higher prevalence of severe symptoms such as face and jaw pain on palpation among 50-year-old women (60%) than in men (30%). Several underlying factors (genetic, hormonal, behavioral, and psychosocial aspects) may explain these differences between the sexes²⁵ and at different ages.²⁶ Unell et al reported that the prevalence of TMD-related symptoms was higher in women than in men, but the differences found in older adults were smaller than those previously reported for younger adults.²⁷

The design of the present study hampered the quantification of the effect of age on the prevalence and severity of TMD, since only two distinct age cohorts were analyzed (35 to 44 years and 65 to 74

years) and they exhibited comparable prevalence. This may be due to the fact that some investigators have reported the peak prevalence at about 50 years,⁴ an age between the spans of these cohorts.

Several factors apart from age and gender have been reported to be associated with TMD. Anxiety and emotional distress have been traditionally considered to be etiologic factors of TMD.²⁸ Some studies have emphasized the role of psychological distress, especially with pain-related TMD within certain populations.^{24,29} The present study found that those persons living in rural areas were at a higher risk of suffering from TMD. However, there is no evidence to suggest that persons from rural areas suffer greater psychological distress than those living in urban areas. Regarding occlusal factors, it was observed that people living in rural areas had significantly more missing posterior (7.0 ± 5.6) and anterior teeth (2.9 ± 4.3) than people living in urban areas (5.3 ± 5.4 and 2.0 ± 3.8 , respectively), although these results were not shown in the tables. Gesch et al¹⁵ also found a high prevalence of the signs and symptoms of TMD in the rural German region of Pomerania. However, their study did not specifically look at the influence of urban vs rural areas, but instead combined the data for both urban and rural participants.¹⁵ In summary, biologic, cultural, and environmental factors, independently or in combination, may be responsible for the observed association between TMD and rural subjects. Future research is needed to further investigate these relationships.

In agreement with Boscatto et al,²⁹ the present study found no association between TMD and the use of and need for dental prostheses, nor with the number of remaining teeth. A similar study on a Swedish population reported no differences between denture wearers and nondenture wearers in terms of the signs or symptoms of TMD.⁶

Regarding the prevalence and severity of TMD, this study identified increased prevalence and severity over time in both adults and seniors (Tables 3 and 4). To the authors' knowledge, there is only one other cohort study carried out that focused on the trends of TMD symptoms in adults and seniors over a similar period of time,^{5,6} and it also found a significant increment in the prevalence and severity of TMD during this period. According to Köhler,⁶ 73% of the examined individuals in 1983, 67% in 1993, and 62% in 2003 were identified as being without TMD symptoms; 16.5%, 17%, and 22%, respectively, reported mild symptoms; and 10.5%, 16%, and 16%, respectively, suffered from severe TMD symptoms. In the present study, the regression analyses were focused on the effect of time on the prevalence of temporomandibular pain/dysfunction. The findings of every subsequent oral health survey performed in Spain

indicated that the odds of suffering from temporomandibular pain/dysfunction significantly increased with respect to those recorded in the first survey done in 1993. This would seem to be a public health concern. Given the fact that the same methodology and methods for examining TMD were used over the duration of the study period, it can be presumed that this is real change that has occurred in the Spanish population.

Conclusions

The prevalence of pain or dysfunctional TMD significantly increased from 1993 to 2015 in Spain. Besides the time factor, other major predictors of TMD were gender and place of residence.

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