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Contributing factors to the development of temporomandibular joint symptoms in a Japanese community-dwelling population

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Abstract

Background: Multicausal theories of temporomandibular disorder (TMD) are supported, but no apparent influencing factors except for bruxism have been identified.

Objective: This study aimed to cross-sectionally and longitudinally examine the oral environment and mental and psychological status in a general adult Japanese population and elucidate the relationships between these and the development of temporomandibular joint (TMJ) symptoms.

Materials and methods: A total of 1117 individuals who participated in the Iwaki Health Promotional Project in 2016 and 827 individuals who participated in the Iwaki Health Promotional Project in both 2016 and 2017 without prior TMD treatment were included. For the cross-sectional study, the relationships between the presence of TMJ symptoms and the oral environment and mental and psychological factors were analyzed for the participants in 2016; and for the longitudinal study, factors contributing to the development of TMJ symptoms were analyzed in those who participated in the project both in 2016 and 2017.

Results: Age, the existence of bruxism, and health-related quality of life—vitality scores (the vitality scale of the 36-Item Short Form Health Survey questionnaire)—were significantly associated with the development of TMJ symptoms in the cross-sectional study, while only bruxism was significantly correlated with the development of TMD in the longitudinal study (odds ratio: 2.01, 95% confidence interval: 1.044-3.868; P = .037).

Conclusions: The existence of bruxism was again identified as the only contributing factor in the development of TMD. No involvement of mental and psychological factors was found.

KEYWORDS

Bruxism, cross-sectional study, longitudinal study, temporomandibular disorder, temporomandibular symptoms

1 | INTRODUCTION

Temporomandibular disorder (TMD) is a comprehensive diagnosis for a condition that presents with primary symptoms including pain of the TMJ and masticatory muscles, TMJ sounds, trismus, or abnormal jaw movements and is an umbrella term for pathologies such as masticatory muscle pain disorder, TMJ pain disorder, TMJ disc disorder, and degenerative TMD.[1] The incidence of TMD is very high, with approximately 5%-12% of the worldwide general population affected by this disease.[2,3] Among them, patients with TMD requiring treatment were reported to constitute approximately 5%.[2]

Research regarding the cause of TMD has been underway for a long time. Previously, dental occlusion was thought to be related, but the etiological role of the occlusion is not supported by the available data.[4] On the other hand, a multifactor theory is generally supported for the cause of the development of TMD. Possible contributing factors to the development, persistence, and perpetuation of TMD include those of anatomical, occlusive, traumatic, mental, psychological, and behavioral natures. While various epidemiological studies have been conducted to date, the majority involved young children[5] or patients who visited dental facilities.[6] To the best of our knowledge, there has been no investigation completed about the relationships between TMJ symptoms and oral environment and mental and psychological factors performed in a general population with a wide range of ages. Furthermore, while the presence of multiple influencing factors has been suggested in the development of TMD, no potential factor other than bruxism has been confirmed,[5] and the role of mental and psychological factors remains unknown.

Hirosaki University hosts a medical checkup program called the Iwaki Health Promotional Project every year to promote the health of the local residents that evaluates about 80% of the local residents on 2000 items. As a part of the oral checkup portion of the examination, TMJ symptoms are reviewed. A certain percentage of participants do not visit the hospital with a chief complaint of TMJ symptoms but nevertheless are aware of TMJ symptoms. In addition, since TMD is a musculoskeletal condition and a self-limiting disease, the symptoms often spontaneously disappear.[7–9] Studies on patients who sought out medical care are biased in that these participants have already received care, which modifies the natural state of a condition.

Based on the results of the previous studies, we hypothesized that bruxism is an oral factor contributing to the development of TMD and that mental and psychological factors are not related to the development of this condition. Thus, the present study aimed to cross-sectionally and longitudinally investigate the oral environment and mental and psychological status, which are thought to be related to the development of TMJ symptoms, in a sample of the general Japanese population across a range of ages and to reveal whether oral environment or mental and psychological factors are involved in the development of TMJ symptoms.

2 | MATERIALS AND METHODS

In order to investigate the background of the development of TMJ symptoms, the study included a total of 1117 individuals (438 males and 679 females) who took part in the Iwaki Health Promotional Project in 2016 and who met the eligibility criteria: (a) being aged 20 years or older with (b) no history of rheumatism or stroke, which are considered to affect the movement of the TMJ, and (c) no prior treatment for TMD. A questionnaire was distributed before the checkup to screen for TMJ symptoms including TMJ pain, TMJ sounds, and trismus. In addition, a longitudinal study was conducted to investigate the changes that occurred over time and the contributing factors of TMJ symptoms. Eight hundred twenty-seven individuals (346 males and 481 females) who met the inclusion criteria above and who took part in the checkup in 2016 and 2017 participated in this investigation. The age of the participants followed-up with over time ranged from 20 to 93 years old (mean ± standard deviation: 54.5 ± 14.6 years).

2.1 | Physical measurements

Data on age, gender, body weight, and height were collected through the distributed questionnaire and interviews, and participants' body mass index (BMI) were calculated as weight/(height × height), represented as kg/m^2.

2.2 | Oral examination

As an examination of the oral environment, dentists asked study participants about the presence of bruxism and checked the number of functional teeth.

2.3 | Screening for TMJ symptoms

The following three questions were asked as part of a screening initiative for determining the TMJ symptoms. If a participant answered “yes” to any of them, the person was said to have TMJ symptoms.

1. Does your jaw hurt when you open and close your mouth?
2. Do you hear clicking or cracking sounds from the jaw when you move your mouth?
3. Do you have problems with opening and closing your mouth, such as that you cannot open your mouth widely or you cannot close your mouth? If yes, when you have a problem, can you open your mouth wider than three fingers vertically?

2.4 | Mental and psychological evaluation

In order to evaluate the psychological factors, the simplified Japanese version of the World Health Organization (WHO)'s Five Well-being Index (S-WHO-5),[10] the self-report Center for Epidemiologic Studies Depression Scale (CES-D),[11] and the 36-Item Short Form Health Survey Questionnaire (SF-36)[12] were used

for the evaluation of stress, depression, and health-related QOL, respectively.

2.4.1 | WHO-5

Generally, S-WHO-5 is a simplified version of the WHO-5, where a person answers five questions with five options but in this study, it instead includes four options (0-3 points) and its full possible score is 15 points' for readability.[10] Higher scores indicate lower levels of stress, while lower scores indicate higher levels of stress. The cutoff value was set as 8 points, so individuals with scores of 8 points or less were deemed to have stress.

2.4.2 | CES-D

CES-D is a self-assessment scale developed by the United States National Institutes of Health (Bethesda, MD, USA) for the application in epidemiological studies of depression.[11] Here, a person answers questions on 20 items with four options (0-3 points), and the result is different according to their score. The full possible score is 60 points, and higher scores mean a respondent's depression is more severe. The cutoff value for Japanese adults is 16 points, so individuals with scores of 16 points or more were deemed as having a tendency of depression.

2.4.3 | SF-36

SF-36 is used internationally as a scientifically reliable and validated scale for rating health-related QOL.[12] It is a comprehensive self-report evaluation method for QOL containing multiple questions to evaluate the following eight health concepts: (a) physical functioning (PF), or whether exercise is possible; (b) the role of physical activity (RP), or whether there were any problems performing regular daily activities in the past month; (c) bodily pain (BP), or whether the respondent has experienced body pain in the past month; (d) social functioning (SF), or whether there has been a problem with social activities with family, friends, and neighbors due to mental and psychological reasons in the past month; (e) general health perceptions (GH), or the respondent's health state; (f) vitality (VT), or whether the person has felt vigorous in the past month; (g) the role of emotion (RE), or whether there have been any problems with work or daily activities due to mental reasons in the past month; and (h) mental health (MH), or whether the person has been overall calm in the past month. Higher scores indicate that the respondent's QOL is better.

2.5 | Longitudinal study

The changes in TMJ symptoms over 1 year from 2016 to 2017 were examined; and age, BMI, oral environment, and mental and psychological factors were investigated as elements that may have contributed to alterations in the symptoms.

Among the individuals in the group with TMJ symptoms in 2016, relationships between changes in TMJ symptoms and the oral environment and mental and psychological factors were examined. Additionally, among the residents without TMJ symptoms in 2016, relationships between the presence of the development of TMJ symptoms at one year later and the oral environment and mental and psychological factors were examined.

2.6 | Statistical analysis

2.6.1 | Investigation of the contributing factors in the development of TMD

The study participants were divided into two groups according to the presence or absence of TMJ symptoms. In each group, univariate analyses were performed for general items (ie, age, gender, and BMI), oral environment (ie, the number of teeth and the presence of bruxism), and mental and psychological factors (ie, WHO-5, CES-D, and SF-36 scores) to investigate the presence of significant differences between the two groups. The chi-squared test was used for gender and the presence of bruxism, while a *t*-test was used to evaluate the differences in the mean values of the other items.

Next, multivariate analyses were performed using variable selection with a stepwise logistic regression analysis method to examine the contributing factors related to the development of TMJ symptoms. The dependent variable was the existence of TMJ symptoms and independent variables were those used for the univariate analyses. In addition, multicollinearity was taken into account, and we confirmed that there was no strong correlation among the independent variables.

2.6.2 | Changes in TMJ symptoms over time

In order to examine the frequency of changes that occurred over time as well as to longitudinally analyze the factors affecting the development of TMJ symptoms, a logistic regression analysis was performed involving residents who underwent checkups in both 2016 and 2017 (for both groups with and without TMJ symptoms in 2016). The dependent variable used was the changes in TMJ symptoms, while the independent variables were age; gender; BMI; the number of functional teeth; the presence of bruxism; and WHO-5, CES-D, and SF-36 VT scores. Mental and psychological factors were selected based on the results of the cross-sectional study.

SPSS version 25 (IBM Corp., Armonk, NY, USA) was used to perform all statistical analyses and $P < .05$ was considered to indicate a significant difference.

This study was approved by the institutional review board of Hirosaki University, and written consent was obtained from all participants. The study was additionally conducted in accordance with the Declaration of Helsinki.

3 | RESULTS

3.1 | Incidence of TMJ symptoms

Among the 1117 participants, 40 participants (3.5%) were aware of TMJ pain, 309 participants (26.9%) were aware of TMJ sounds, and

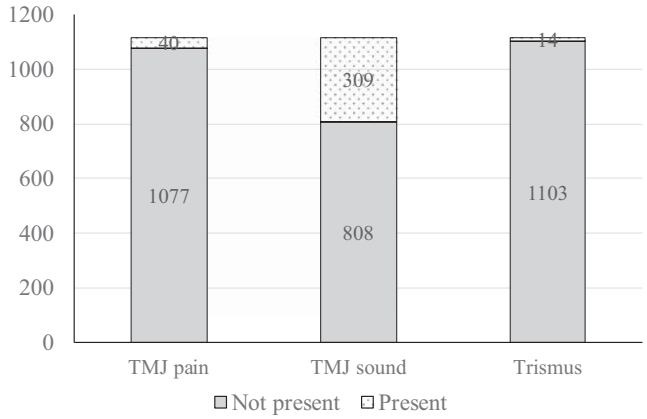

FIGURE 1 The number of participants with individual TMJ symptoms in 2016

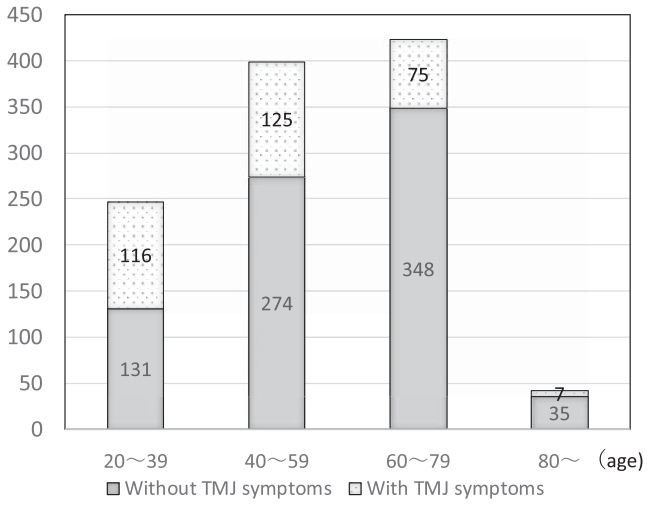

FIGURE 2 The number of participants with TMJ symptoms in different age group

14 participants (1.3%) were aware of trismus, thus, TMJ sound was the most common subjective TMJ symptom. Participants with any of these symptoms were designated as having TMJ symptoms. As a result, the number of participants with TMJ symptoms was 324 (120 males and 204 females; 28.2%). Looking at the incidence according to age group, young people aged from 20 to 39 years old were most affected, and the incidence of TMJ symptoms tended to be lower as participant age increased (Figures 1 and 2).

3.2 | Presence of TMJ symptoms and background factors

As background factors, differences in the mean values of age, BMI, and the number of remaining teeth were compared according to the presence and absence of TMJ symptoms. In addition, the relationships between bruxism and TMJ symptoms were investigated using the chi-squared test (Table 1).

Age, BMI, and the number of remaining teeth in the group of patients without TMJ symptoms were 56.6 ± 15.1 years, 23.1 ± 3.4 kg/m^2, and 22.4 ± 9.2 teeth, respectively; and those with TMJ symptoms were 48.2 ± 15.3 years, 22.6 ± 3.4 kg/m^2, and 25.5 ± 6.8 teeth, respectively. All of the aforementioned results are presented as mean ± standard deviations. Significant differences were noted in the categories of age, BMI, and the number of remaining teeth according to the presence and absence of TMJ symptoms. In comparison, no significant difference was noted in relation to participant gender.

Regarding the presence of bruxism and the development of TMJ symptoms, the level of awareness of TMJ symptoms was significantly higher among those participants who were aware of bruxism (P = .001).

TABLE 1 Characteristics of community-dwelling adults with and without TMJ symptoms

TMJ symptoms	Present n = 324	Not present n = 793	*P*-value
Age	48.2 ± 15.3	56.6 ± 15.1	.001
Gender			
Males	120	318	.188
Females	204	475	
BMI	22.56 ± 3.41	23.06 ± 3.40	.016
Number of teeth	25.5 ± 6.8	22.4 ± 9.2	.005
Bruxism[a]			
Not present	238	651	.001
Present	80	112	
SF36			
PF	50.06 ± 12.11	47.96 ± 13.6	.02
RP	50.34 ± 9.97	50.28 ± 9.96	.936
BP	49.01 ± 10.34	49.71 ± 9.73	.294
GH	47.30 ± 9.34	48.18 ± 9.09	.142
VT	46.42 ± 9.28	50.00 ± 9.68	.0001
SF	51.65 ± 8.87	52.34 ± 8.37	.194
RE	51.4 ± 8.64	51.16 ± 9.12	.975
MH	49.05 ± 9.14	51.23 ± 9.12	.0001
CESD	13.95 ± 6.03	13.35 ± 5.57	.16
WHO-5	8.35 ± 2.81	8.49 ± 2.73	.61

Notes: Student's *t*-test or chi-squae tests. Values are presented as mean ± SD.
Abbreviations: BMI, body mass index; CES-D, Center for epidemiologic studies-depression scale; SD, standard deviation; TMJ, temporomandibular joint.
[a]Edentulous participants were excluded.

3.3 | Results of the mental and psychological evaluation

3.3.1 | WHO-5 (index for stress)

WHO-5 scores were 8.49 ± 2.73 points in the group without TMJ symptoms and 8.35 ± 2.81 points in the group with TMJ symptoms, revealing no significant difference.[10]

3.3.2 | CES-D (index for depression)

CES-D scores were 13.35 ± 5.57 points in the group without TMJ symptoms and 13.95 ± 6.03 points in the group with TMJ symptoms, revealing no significant difference.

3.3.3 | SF-36 (health-related QOL)

The SF-36 consists of eight basic areas, and the scores of each were compared according to the presence and absence of subjective TMJ symptoms. Thus, the scores of the groups without and with subjective TMJ symptoms, respectively, were as follows: 47.96 ± 13.6 points and 50.06 ± 12.11 points for PF (P = .02); 50.28 ± 9.96 points and 50.34 ± 9.97 points for RP (P = .936); 49.71 ± 9.73 points and 49.01 ± 10.34 points for BP (P = .294); 48.18 ± 9.09 points and 47.30 ± 9.34 points for GH (P = .142); 50.00 ± 9.68 points and 46.42 ± 9.28 points for VT (P = .0001); 52.34 ± 8.37 points and 51.65 ± 8.87 points for SF (P = .194); 51.16 ± 9.12 points and 51.4 ± 8.64 points for RE (P = .9759); and 51.23 ± 9.12 points and 49.05 ± 9.14 points for MH (P = .0001). Significant decreases in QOL were noted in PF, VT, and MH in participants who had subjective TMJ symptoms.

3.4 | Investigation of the factors related to the development of TMJ symptoms (logistic regression analysis)

Logistic regression analysis (stepwise method) was performed with the presence of TMJ symptoms as a dependent variable and age; gender; BMI; the number of remaining teeth; the presence of bruxism; and WHO-5, CES-D, and SF-36 scores as independent variables. As a result, age [odds ratio (OR): 0.969, 95% confidence interval (CI): 0.96-0.978; P = .001], the presence of bruxism (OR: 1.528, 95% CI: 1.083-2.155; P = .015), and SF-36 VT (OR: 0.966, 95% CI: 0.952-0.98; P = .001) were significantly related to the development of TMJ symptoms (Table 2).

3.5 | Changes in TMJ symptoms overtime

TMJ symptoms were noted in 233 participants in 2016. Among them, 169 participants (73%) did not show any changes in symptoms, while symptoms had disappeared in 64 participants (27%) in 2017. Logistic regression analysis (stepwise method) was performed for statistical analysis purposes, with the changes in TMJ symptoms (no change, disappeared) as a dependent variable and age; gender; BMI; WHO-5, CES-D, and SF-36 VT scores; functional teeth; and the presence of bruxism as independent variables, respectively. Ultimately, only age was significantly correlated with the changes in TMJ symptoms (OR: 0.968, 95% CI: 0.943-0.993; P = .014), with participants of older ages showing a significantly higher trend toward the spontaneous disappearance of TMJ symptoms (Tables 3 and 4).

Separately, among 594 participants who did not have TMD in 2016, 49 participants (8%) had developed the symptoms in 2017. Logistic regression analysis (stepwise method) was performed for statistical analysis purposes, with the presence of the development of TMJ symptoms as a dependent variable and age; gender; BMI; WHO-5, CES-D, and SF-36 VT scores; the number of functional teeth; and the presence of bruxism as independent variables. Here, only bruxism was significantly correlated with the development of TMJ symptoms (OR: 2.01, 95% CI: 1.044-3.868; P = .037). Participants who were aware of bruxism in either 2016 or 2017 or in both years were regarded as having an awareness of bruxism (Table 5).

TABLE 2 Logistic regression analysis for the factors related to the development of TMJ symptoms

	Odds ratio	95% CI	*P*-value
Age	0.969	0.96-0.978	.001
SF36 VT(vitality)	0.966	0.952-0.98	.001
Bruxism	1.528	1.083-2.155	.015

Notes: Dependent variable: presence of TMJ symptoms.
Independent variables: Age, Gender, BMI, the presence of bruxism, number of teeth, WHO-5, CES-D, SF36VT.
Abbreviations: CI, confidence interval; OR, odds ratio; TMJ, temporomandibular.

TABLE 3 Changes in TMJ symptoms overtime (from 2016 to 2017)

TMJ symptoms in 2016	Changes in 2017		
	No changes	Disappeared	Developed
Present (Total 233)	169 (73%)	64 (27%)	—
Not present (Total 594)	545 (92%)	—	49 (8%)

Abbreviation: TMJ, temporomandibular joint.

TABLE 4 Analysis for the factors related to the changes in symptoms in participants with TMJ symptoms

	Odds ratio	95% CI	*P*-value
Age	0.968	0.943-0.993	.014

Notes: Logistic regression analysis (stepwise method).
Dependent variable: Change in TMJ symptoms.
Independent variables: Age, Gender, BMI, WHO-5, CES-D, SF36VT, the presence of bruxism, number of teeth.
Abbreviation: TMJ, temporomandibular joint.

TABLE 5 Analysis for the factors related to the development of symptoms in participants without TMJ symptoms

	Odds ratio	95% CI	*P*-value
Bruxism	2.01	1.044-3.868	.037

Notes: Logistic regression analysis (stepwise method).
Dependent variable: Development of TMJ symptoms.
Independent variables: Age, Gender, BMI, WHO-5, CES-D, SF36VT, the presence of bruxism, number of teeth.
Abbreviation: TMJ, temporomandibular joint.

4 | DISCUSSION

Joint sounds were the most common form of TMJ symptoms among the participants of this study, and fewer numbers of participants were aware of either trismus or pain. Screening tests for TMD in the general population are often conducted using questionnaires, as was done in this study.[13] The survey on TMJ symptoms of this study was conducted using only preliminary questions. Therefore, the possibility that other sounds, such as eminence clicking, were also included with crepitus and clicks associated with TMD. Research about joint sounds shows that such can be found in many individuals without the disorder (approximately 20%), and the adequacy of using joint sounds for the diagnosis of TMD has been previously questioned.[14,15] Not many people become candidates for treatment with TMJ sounds alone, but TMJ sounds are established as one of the current diagnostic criteria of TMD. Since the clinical condition leading to TMJ sounds is anterior disk displacement, there is a possibility that such could progress to TMD without reduction. Therefore, it is meaningful to regard people with joint sounds as having TMD during screening, even if they do not display pain or trismus. In addition, these three symptoms are not independent clinical conditions; instead, they are related to each other, so finding risk factors for the development of the TMJ symptoms including these three factors may lead to the prevention of the development of TMD.

There are still many unclear points about the cause of the development of TMD, and the theory that many factors rather than only one factor are related to the TMD onset is supported. The known contributing factors for the development of TMD include anatomical, occlusive, traumatic, psychological, and behavioral factors. In early research, occlusion was said to be related to the TMD, but this notion has been mostly discredited. According to the cross-sectional study by Pullinger et al (1998),[16] there were no occlusion factors that characterized any of the specific pathologies of TMD and so it was concluded that occlusion could not be considered as the only dominant factor.

Generally many people do not visit medical facilities even if they are aware of TMJ symptoms, and almost subjects of existing previous epidemiological studies were limited to patients who visited dental care facilities or students. To our knowledge, there has been no study involving local residents with a wide age range that also analyzed mental and psychological factors. One of a few longitudinal studies reported by Carlson et al[5] included 402 young participants (aged 7, 11, or 15 years old) randomly sampled from a city in Sweden with a population of 40 000, and these individuals were followed-up longitudinally at 5, 10, and 20 years. According to this prior longitudinal study, bruxism affected the development of TMJ symptoms. However, the study was limited to a young sample.

As an example of research about factors other than bruxism, a report examined psychological factors and behavioral factors in 511 patients with TMD who visited medical facilities with complaints of pain. The results were as follows: 64.8% of study participants had the habit of chewing on one side, 59.8% had poor posture, 50.4% had a tooth-contacting habit (TCH), and approximately 30% had anxiety.[6]

Psychological factors such as mental stress, anxiety, and depression have been suggested as possible contributing factors to TMD, but no study to date has definitively proven the relationship. Therefore, one of the purposes of this present study was to reveal whether mental and psychological factors, which are thought to be related to the TMD, actually affect the development of the disease in some way. The CES-D (index for depression), WHO-5 (index for stress), and SF-36 (scale for health-related QOL) were used for mental and psychological evaluation.

The results of our cross-sectional study showed that there were significant relationships between TMD and BMI; the number of teeth; bruxism; and the PF, VT, and MH subscales of the SF-36 according to univariate analysis, but only bruxism and the SF-36 VT subscale were significantly related to the development of TMD based on multivariate analysis. No significant relationship was noted for depression and stress in either analyses.

The SF-36 VT subscale indicates "whether the respondent has felt vigorous in the past month." An investigation of the evaluation methods of mental factors could not find any apparent relationship. However, people with vitality had fewer TMJ symptoms, and conversely, it may be possible that mental factors are involved in the onset of TMD at some level. At least, when people have TMJ symptoms, vitality was significantly lower, and it is presumed that the development of TMJ symptoms may cause lower vitality rather than reduced vitality itself being the cause.

This study also observed participants longitudinally. The results showed that 47 residents (8%) among 579 residents previously without TMJ symptoms newly developed them one year later. As in the cross-sectional study, bruxism was the only significant contributing factor observed to have a role in the development of the TMJ symptoms.

Since it was said that bruxism and stress could be related, the relationship between them was statistically examined in this study, ultimately yielding a finding of no relationship. Pierce et al also reported that no relationship existed between sleep bruxism and stress.[17] On the other hand, Manfredini et al stated in their review that, while sleep bruxism was not related to the mental and psychological factors, clenching during the day was possibly related to the mental and psychological factors.[18] Considering all of the results of this cross-sectional and longitudinal research, we confirmed that bruxism was the most influential contributing factor to TMD onset in adults who are 20 years of age or older, as reported previously.

TMD often develops in individuals aged between 10 and 29 years old. Since people in this age group have less missing teeth or poorly made or positioned prostheses, it is unlikely that occlusion is the cause, and the diminished load-resistance ability of the TMJ due to an overload to joint or weakening of joint may be related.[19] Based on these discussions, the diminished load-resistance ability of the TMJ, the overload of the TMJ due to bruxism, and the pain of the masticatory muscle due to the muscle fatigue caused by the

hypertonic masticatory muscle are considered to be related to the clinical conditions of TMJ symptoms.

A recent study revealed that many patients with TMD demonstrate unconscious TCH while their mouth is closed, and this could be a contributing factor.[20] Bruxism, clenching, and TCH cause continuous muscle tension and load to the TMJ. The number of teeth was not a risk factor for TMD in the multivariate analysis, but, in the univariate analysis, having more teeth was related to the significantly greater development of TMJ symptoms. This may indicate that having more teeth is related to the stronger occlusion. Therefore, the load of the TMJ can be the possible factor here. It is challenging to improve the load resistance of the TMJ. Preventive methods for bruxism has not been established as of present. Considering these, it is difficult to prevent TMD at this moment. A recent study using functional magnetic resonance imaging showed that different regions of the brain were activated according to the strength of bruxism.[21] Future research is required to investigate the involvement of local mechanical stimulation at the TMJ and relevant clinical conditions that originate from the central nervous system.

Meanwhile, TMD is a self-limiting disease, and it is often clinically experienced that the symptoms spontaneously disappear.[7–9] We examined the course of 233 residents with TMJ symptoms who had not visited medical facilities and found that the symptoms had disappeared in 64 (27%) of them. Multivariate analysis showed that only age was a factor significantly correlated with the disappearance of the symptoms. It is said that patients who visit the hospital with TMJ symptoms are affected by the Hawthorne effect.[22] That is, good therapeutic outcomes may be achieved in serious patients with high physician compliance who strictly refrain from any behaviors adversely affecting the TMJ as much as possible. In other words, seeking medical care may lead to good outcome, even without treatment.

Importantly, the participants of this study had not previously sought medical care for TMD and, among them, the symptoms disappeared in nearly 30%. Since the Hawthorne effect can thus be excluded from influencing the participants of this study, our findings represent the actual natural course, which makes this study meaningful as an epidemiological study. As shown in previous studies, even if TMJ symptoms develop, they often disappear spontaneously. Therefore, noninvasive treatments should be selected as much as possible, and irreversible treatments such as changing the dental occlusion should be avoided. In addition, preventing the development of TMJ symptoms is difficult at this moment because bruxism is uncontrollable.

4.1 | Study limitations

This study has several limitations that should be highlighted. First, the presence of Bruxism was determined by personal declaration. The type, degree, and time of bruxism were not evaluated and the evaluation was subjective. Second, the follow-up period was short (1 year), and joint sounds comprised the majority of TMJ symptoms identified. In addition, the presence of TMJ symptoms was determined based on participants' self-reported responses to the questionnaire and their accuracy was not confirmed by physical examination. The duration of the longitudinal study was also short (1 year).

5 | CONCLUSION

The results of the study showed that bruxism was most significantly related to the development of the symptoms of TMD. Our results also revealed that mental and psychological factors, which were thought to be related, were not statistically correlated with the development of TMD. In addition, we confirmed that, once TMJ symptoms developed, 20%-30% of affected patients experience their disappearance in 1 year and, as shown in previous studies, only bruxism was significantly related to the development of TMJ symptoms. The observation period of this study was 1 year and short, thus warranting further investigations with a more extended follow-up period.

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CONFLICT OF INTEREST

All authors declare that they have no conflict of interest.

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