# The Association Between Temporomandibular Disorders and Suicide Ideation in a Representative Sample of the South Korean Population

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**Aims:** To investigate in a representative sample of South Koreans *(1)* the prevalence of and associations between general pain, temporomandibular disorders (TMD), and suicide ideation (SI), and *(2)* whether the associations between general pain, TMD, and SI differ according to cancer history. **Methods:** Data were from the Fourth Korean National Health and Nutrition Examination Survey (KNHANES IV; N = 16,658). KNHANES IV participants provided reports regarding their cancer history, EQ-5D (a measure of health status from the EuroQoL Group), and TMD symptoms including clicking of one or both temporomandibular joints, pain, and mouth-opening limitation (MOL). Participants were assessed for any SI over the last 12 months, as a dependent variable. The independent variables were pain/discomfort (EQ-PD) reported by the subjects on the EQ-5D, severe TMD (tenderness or reduced jaw mobility once or more per week), and total TMD (occurrence of clicking, tenderness on palpation, or reduced jaw mobility [opening < 30 mm] once or more per week). Demographic information (age and gender), socioeconomic status (income, education, occupation, and marital status), behavioral factors (smoking and binge drinking), and cancer history were evaluated as covariates. The association of TMD with SI was assessed by the prevalence ratio (PR) and 95% confidence intervals. **Results:** In fully adjusted models, elevated PRs for SI were observed for each pain condition (PR = 1.26 for total TMD, PR = 1.35 for severe TMD, and PR = 1.75 for EQ-PD). In the subgroup analyses by cancer history, the PRs were higher in the cancer history (+) group; the order of magnitude was severe TMD (PR = 2.20), EQ-PD (PR = 2.16), and total TMD (PR = 2.02). **Conclusion:** Pain conditions, including TMD pain, might aggravate SI among those with a cancer history. These findings add to a growing body of evidence indicating that TMD warrants further attention in relation to suicide. *J Oral Facial Pain Headache 2014;28:338–345. doi: 10.11607/ofph.1229*

**Key words:** *epidemiology, pain, suicide, temporomandibular disorders*

The suicide rate in South Korea is the highest among the members of the Organization for Economic Cooperation and Development (OECD). The suicide rate in South Korea has risen sharply during the last two decades; the rate increased from 7.8 per 100,000 in 1989 to 15.6 per 100,000 in 1999 and 31.7 per 100,000 in 2011, which is 2.6 times greater than the OECD average.[1] Suicide is the fourth leading cause of death following cancer, stroke, and cardiovascular disease.[1] Therefore, suicide is considered one of the most serious and urgent public health and social issues in Korea.

Suicidal ideation (SI) may precede completed suicides. Thus, understanding the risk factors for SI may offer information that can be used in efforts to prevent suicide completion.[2–4] The prevalence of SI in Britain and Australia has been reported to be 8.6% and 0.6%, respectively.[2,5] Known risk factors for suicide include sociodemographic factors (age, gender, race/ethnicity, socioeconomic status, non-religiosity), health behavior (smoking and excessive alcohol intake), and somatic problems (blood cholesterol and obesity).[6]

Several studies have shown that cancer patients are at increased risk for suicide compared with the general population.[7–11] This is very much the case for cancer suicide victims, who often suffer from severe mental disorders, particularly depression, in addition to pain and physical disability at the time of death.[12] Cancer has a special psychological significance because it is associated with pain, suffering, and death.

Several studies have found that chronic pain patients have elevated rates of SI.[13–15] One survey reported that the presence of any pain condition had a 1.4 times higher risk of lifetime SI, and severe headache, among pain subtypes, remained significantly associated with lifetime SI.[13] Few of these studies, however, have carefully compared pain patients who had a history of cancer with suicide risk. Moreover, no study has investigated the association between temporomandibular disorders (TMD) and SI. TMD have been associated with other chronic pains, including headache[16] and neck, back, and joint pain,[17] and they negatively impact on daily life activities.[18]

It is therefore reasonable to assume that pain observed after cancer treatment may play a role in SI. The aims of this study were to investigate in a representative sample of South Koreans *(1)* the prevalence of and associations between general pain, TMD, and SI, and *(2)* whether the associations between general pain, TMD, and SI differ according to cancer history.

## Materials and Methods

### Database

Data from the Fourth Korean National Health and Nutrition Examination Survey (KNHANES IV), conducted from 2007 to 2009, were used. This survey, which has been conducted since 1998, assesses health and nutrition among the nation's population to improve health conditions and to increase participation in healthy behaviors, consciousness about health-related issues, and nutrition quality in the population. This survey employed a stratified, multistage, clustered probability sampling method to select a representative sample of the non-institutionalized, civilian South Korean population.

### Sample

The target population of KNHANES IV was residents of South Korea. Based on the 2005 Population and Housing Census, 13,800 households and 31,705 members of these households older than 1 year of age were selected from 500 geographical areas. The KNHANES IV was approved by the Institutional Review Board for Human Subjects of the Korea Center for Disease Control and Prevention. Each participant in the survey signed an informed consent form. Overall response rates were 65.8% in 2007, 74.3% in 2008, and 79.2% in 2009. The number of participants who completed the KNHANES IV was 24,871 (11,310 males and 13,561 females). Among them, 21,047 answered the SI questionnaire. There were 19,851 who participated in the pain and/or discomfort questionnaire, and 17,313 respondents for the TMD symptom questionnaire. Exclusion criteria were twofold: *(1)* those aged < 19 and *(2)* those with missing values in the health assessment or questionnaires. The final sample size for this study was 16,658 (7,055 males and 9,603 females, 67.0% of all participants in KNHANES IV).

### Definition of Cancer History

Based on self-reports of having been diagnosed by a physician with a condition included in the Korean Standard Classification of Disease,[19] the study population included individuals with cancer-related disorders. Participants were asked if they were diagnosed with cancer in their lifetime and in the past year, and if they are receiving any current treatment for cancer and if the cancer was cured or not. Cancer history was defined in terms of those who were diagnosed with one or more cancers in their lifetime, were not under any current treatment, and had been completely cured of cancer.

### SI

SI was assessed by a positive answer to the question "In the last 12 months, did you think about committing suicide?" Responses to the question were treated as dichotomous variables (yes or no). The indicator has been a well-documented predictor of suicide attempts that was previously used in other surveys on adults.[20]

### Health-Related Quality of Life

The EQ-5D was administered to investigate the quality of life. The EQ-5D, which was developed by the EuroQoL Group,[21] is a standardized instrument used to measure the quality of life in the general population. The Korean version of the EQ-5D was evaluated according to the EuroQoL guidelines[22] for validity and sensitivity in patients with rheumatic conditions. The EQ-5D evaluation is stable over time; its validity is sufficient, and it has been adapted based on culture and language.[22–25]

The EQ-5D consists of five dimensions: mobility, self-care, usual activities, anxiety/depression, and pain/discomfort. Respondents choose one of three answers: no problem, some/moderate problem, or severe problem.[26]

General pain/discomfort status was defined by EuroQoL pain/discomfort (EQ-PD); those subjects who answered some/moderate problem or severe problem in that study were considered EQ-PD (+).

### TMD Assessment

All the TMD examinations were performed by dentists. To assess TMD, the following criteria by the World Health Organization (WHO)[27] were used:

- **Clicking of one or both temporomandibular joints**. Clicking was evaluated directly by an audible sharp sound or by palpation of the temporomandibular joints.
- **Tenderness (on palpation) of the anterior temporalis and/or masseter muscles on one or both sides.** The tenderness was evaluated by unilateral palpation with the firm pressure of two fingers, exerted twice on the most voluminous part of the muscle. Tenderness was recorded only if the palpation spontaneously provoked an avoidance reflex.
- **Reduced jaw mobility-opening of < 30 mm.** This was taken as the distance between the incisal tips of the central maxillary and mandibular incisors. As a general guide, mobility was considered to be reduced if the subject was unable to open his or her jaw to the width of two fingers.

Total TMD was defined as present if the subject reported having at least one of the following signs: occurrence of clicking, tenderness (on palpation), or reduced jaw mobility (opening < 30 mm) once or more per week. Severe TMD was defined as present if the subject reported having the above symptoms but no clicking once or more per week.

### Assessment of Covariates

The confounders in this study were major sociodemographic factors that included age, gender, income, education, occupation, marital status, smoking, and binge drinking. Education level was categorized into four groups: below primary school, middle school, high school, and college or higher. Monthly household income was adjusted for the number of household members and categorized into four groups: < 25%, 25% to 49%, 50% to 75%, and > 75% of the total equivalized income in the survey. Occupation was categorized into four groups: white collar (manager, professionals, and office workers), blue collar (agriculture/fishing, mechanics, and simple laborer), pink collar (service and sales workers), and others (housewives and students). Marital status was categorized as married and single. Smoking status was divided into four categories: never smokers, ex-smokers, current smokers who smoked less than one pack per day, and current smokers who smoked one or more packs per day. The definition of binge drinking was consuming more than seven drinks (men) and five drinks (women) on one occasion at least once a week.

### Statistical Analyses

The independent variables were total TMD, severe TMD, and EQ-PD, and the dependent variable was any SI over the last 12 months. The characteristics of the study subjects according to SI were presented with frequency distributions for the categorical variables and means (and standard deviations) for continuous variables. Chi-square tests for categorical variables and *t* tests for continuous variables were used to assess the associations of SI with total TMD/severe TMD/EQ-PD and confounders. The roles of total TMD, severe TMD, and EQ-PD and confounders were determined by age- and gender-adjusted prevalence ratios (PR) for SI (Table 1). The associations of confounders with total TMD, severe TMD, and EQ-PD were also assessed. Series of log-binomial regression models were constructed to assess the association of total TMD, severe TMD, and EQ-PD with SI. The age- and gender-adjusted models were presented (model 1), followed by models for incremental adjustments for socioeconomic factors (model 2), behavioral factors (model 3), and cancer history (model 4).

Cross-sectional studies are sometimes used for descriptive purposes when the prevalence is clearly the appropriate measure of disease frequency and no link to incidence is sought. In these situations, the appropriate ratio measure is the PR. The PR is conservative, consistent, and interpretable rather than the odds ratios.[28] Because there was significant interaction between total TMD, severe TMD, EQ-PD, and cancer history, subgroup analyses by cancer history were performed. The level of statistical significance was set at 5%.

## Results

Of the total subjects (n = 16,658), 16.1% (95% confidence intervals [CI]: 15.4%–16.9%) had SI. Total TMD accounted for 11.6% (95% CI: 10.8%–12.4%), severe TMD for 3.0% (95% CI: 2.6%–3.4%), EQ-PD for 23.7% (95% CI: 22.7%–24.6%), and cancer experience for 2.2% (95% CI: 2.0%–2.5%) of the total population. Table 1 shows that significant differences in the distribution of SI were found with regard to all variables. Except for cancer history, all variables showed significant age- and gender-adjusted PR for SI (Table 1). A significant age- and gender-adjusted PR for SI was present in total TMD (PR = 1.32), severe TMD (PR = 1.45), and EQ-PD (PR = 1.90).

Table 2 shows the relationship of total TMD, severe TMD, and EQ-PD with confounders. Total TMD showed no pattern by income and cancer history, and severe TMD showed no pattern by income, occupation, health behavior, and cancer history. However,

**Table 1 Characteristics of Study Subjects According to Suicide Ideation (SI; n = 16,658)**

| | SI | | | |
|---|---|---|---|---|
| | No | Yes | *P* value* | Age and gender adjusted PR (95% CI) for SI |
| Age, mean (SD) | 47.9 (16.1) | 53.6 (17.7) | < **.001**† | |
| < 45 years (n = 7,243) | | | | 1.00 (reference) |
| 45–64 years (n = 5,760) | | | | 1.11 (0.96–1.29) |
| ≥ 65 years (n = 3,655) | | | | **1.58 (1.24–2.03)** |
| Gender, n (%) | | | | |
| Male (n = 7,055) | 6,207 (88.0) | 848 (12.0) | < **.001** | 1.00 (reference) |
| Female (n = 9,603) | 7,396 (77.0) | 2,207 (23.0) | | **1.90 (1.77–2.04)**‡ |
| Income, n (%) | | | | |
| IV (highest) (n = 4,170) | 3,635 (87.2) | 535 (12.8) | < **.001** | 1.00 (reference) |
| III (n = 4,174) | 3,445 (82.5) | 729 (17.5) | | **1.37 (1.24–1.51)** |
| II (n = 4,145) | 3,350 (80.8) | 795 (19.2) | | **1.48 (1.34–1.64)** |
| I (lowest) (n = 4,169) | 3,173 (76.1) | 996 (23.9) | | **1.84 (1.67–2.02)** |
| Education, n (%) | | | | |
| ≥ College (n = 4,257) | 3,792 (89.1) | 465 (10.9) | < **.001** | 1.00 (reference) |
| High school (n = 5,755) | 4,910 (85.3) | 845 (14.7) | | **1.30 (1.17–1.44)** |
| Middle school (n = 1,863) | 1,532 (82.2) | 331 (17.8) | | **1.50 (1.31–1.72)** |
| ≤ Primary school (n = 4,783) | 3,369 (70.4) | 1,414 (29.6) | | **2.17 (1.92–2.46)** |
| Occupation, n (%) | | | | |
| White collar (n = 3,048) | 2,739 (89.9) | 309 (10.1) | < **.001** | 1.00 (reference) |
| Blue collar (n = 4,606) | 3,828 (83.1) | 778 (16.9) | | **1.35 (1.19–1.53**) |
| Pink collar (n = 2,080) | 1,729 (83.1) | 351 (16.9) | | **1.40 (1.22–1.62)** |
| Others (n = 6,924) | 5,307 (76.6) | 1,617 (23.4) | | **1.57 (1.39–1.77)** |
| Marital status, n (%) | | | | |
| Married (n = 12,009) | 10,089 (84.0) | 1,920 (16.0) | < **.001** | 1.00 (reference) |
| Single (n = 4,649) | 3,514 (75.6) | 1,135 (24.4) | | **1.39 (1.30–1.48)** |
| Smoking, n (%) | | | | |
| Never smoker (n = 10,170) | 8,149 (80.1) | 2,021 (19.9) | < **.001** | 1.00 (reference) |
| Ex-smoker (n = 2,864) | 2,449 (85.5) | 415 (14.5) | | **1.30 (1.16–1.45)** |
| Current smoker < 1 pack/day (n = 2,015) | 1,669 (82.8) | 346 (17.2) | | **1.58 (1.42–1.75)** |
| Current smoker ≥ 1 pack/day (n = 1,609) | 1,336 (83.0) | 273 (17.0) | | **1.83 (1.61–2.07)** |
| Binge drinking, n (%) | | | | |
| No (n = 13,452) | 10,876 (80.9) | 2,576 (19.1) | < **.001** | 1.00 (reference) |
| Yes (n = 3,206) | 2,727 (85.1) | 479 (14.9) | | **1.20 (1.09–1.32)** |
| Cancer history, n (%) | | | | |
| No (n = 16,168) | 13,238 (81.9) | 2,930 (18.1) | < **.001** | 1.00 (reference) |
| Yes (n = 490) | 365 (74.5) | 125 (25.5) | | 1.13 (0.97–1.31) |
| Total TMD, n (%) | | | | |
| No (n = 14,872) | 12,196 (82.0) | 2,676 (18.0) | **.001** | 1.00 (reference) |
| Yes (n = 1,786) | 1,407 (78.8) | 379 (21.2) | | **1.32 (1.20–1.45)** |
| Severe TMD, n (%) | | | | |
| No (n = 16,158) | 13,229 (81.9) | 2,929 (18.1) | < **.001** | 1.00 (reference) |
| Yes (n = 500) | 374 (74.8) | 126 (25.2) | | **1.45 (1.25–1.68)** |
| EQ-PD, n (%) | | | | |
| No (n = 11,974) | 10,376 (86.7) | 1,598 (13.3) | < **.001** | 1.00 (reference) |
| Yes (n = 4,684) | 3,227 (68.9) | 1,457 (31.1) | | **1.90 (1.78–2.03)** |

*Obtained from chi-square test.
†Obtained from independent *t* test.
‡Age adjusted PR (95% CI).
Bold denotes statistical significance at $P < .05$.

total TMD and severe TMD were more likely to be associated with younger, female, more educated, and single subjects. EQ-PD was more likely to be associated with subjects who were older, female, poorer, less educated, non–white collar, single, nonsmoker, and non–binge drinker, and with a cancer history (Table 2).

**Table 2 Characteristics of Study Subjects According to Total TMD, Severe TMD, and EQ-PD (n = 16,658)**

| | Total TMD | | | Severe TMD | | |
|---|---|---|---|---|---|---|
| | No | Yes | *P* value* | No | Yes | *P* value* |
| Age, mean (SD) | 49.8 (16.4) | 41.9 (16.0) | < **.001**† | 49.1 (16.5) | 44.2 (17.7) | < **.001**† |
| Gender, n (%) | | | | | | |
| Male | 6,341 (89.9) | 714 (10.1) | **.032** | 6881 (97.5) | 174 (2.5) | **.001** |
| Female | 8,531 (88.8) | 1,072 (11.2) | | 9277 (96.6) | 326 (3.4) | |
| Income, n (%) | | | | | | |
| IV (highest) | 3,739 (89.7) | 431 (10.3) | .546 | 4,051 (97.1) | 119 (2.9) | .883 |
| III | 3,729 (89.3) | 445 (10.7) | | 4,051 (97.1) | 123 (2.9) | |
| II | 3,677 (88.7) | 468 (11.3) | | 4,017 (96.9) | 128 (3.1) | |
| I (lowest) | 3,727 (89.4) | 442 (10.6) | | 4,039 (96.9) | 130 (3.1) | |
| Education, n (%) | | | | | | |
| ≥ College | 3,687 (86.6) | 570 (13.4) | < **.001** | 4,122 (96.8) | 135 (3.2) | **.006** |
| High school | 5,036 (87.5) | 719 (12.5) | | 5,563 (96.7) | 192 (3.3) | |
| Middle school | 1,727 (92.7) | 136 (7.3) | | 1,830 (98.2) | 33 (1.8) | |
| ≤ Primary school | 4,422 (92.4) | 361 (7.6) | | 4,643 (97.1) | 140 (2.9) | |
| Occupation, n (%) | | | | | | |
| White collar | 2,644 (86.7) | 404 (13.3) | < **.001** | 2,955 (96.9) | 93 (3.1) | .596 |
| Blue collar | 4,157 (90.2) | 449 (9.8) | | 4,481 (97.3) | 125 (2.7) | |
| Pink collar | 1,833 (88.1) | 247 (11.9) | | 2,016 (96.9) | 64 (3.1) | |
| Others | 6,238 (90.1) | 686 (9.9) | | 6,706 (96.9) | 218 (3.1) | |
| Marital status, n (%) | | | | | | |
| Married | 10,856 (90.4) | 1,153 (9.6) | < **.001** | 11,680 (97.3) | 329 (2.7) | **.001** |
| Single | 4,016 (86.4) | 633 (13.6) | | 4,478 (96.3) | 171 (3.7) | |
| Smoking, n (%) | | | | | | |
| Never smoker | 9,054 (89.0) | 1,116 (11.0) | **.008** | 9,846 (96.8) | 324 (3.2) | .283 |
| Ex-smoker | 2,597 (90.7) | 267 (9.3) | | 2,791 (97.5) | 73 (2.5) | |
| Current smoker < 1 pack/day | 1,771 (87.9) | 244 (12.1) | | 1,955 (97.0) | 60 (3.0) | |
| Current smoker ≥ 1 pack/day | 1,450 (90.1) | 159 (9.9) | | 1,566 (97.3) | 43 (2.7) | |
| Binge drinking, n (%) | | | | | | |
| No | 12,044 (89.5) | 1,408 (10.5) | **.030** | 13,043 (97.0) | 409 (3.0) | .547 |
| Yes | 2,828 (88.2) | 378 (11.8) | | 3,115 (97.2) | 91 (2.8) | |
| Cancer history, n (%) | | | | | | |
| No | 14,424 (89.2) | 1,744 (10.8) | .118 | 15,685 (96.5) | 483 (3.5) | .538 |
| Yes | 448 (91.4) | 42 (8.6) | | 473 (95.9) | 17 (4.1) | |

*Obtained from chi-square test.
†Obtained from independent *t* test.
Bold denotes statistical significance at $P < .05$.

**Table 3 Series of Adjusted Prevalence Ratios (95% confidence intervals) of Total TMD, Severe TMD, and EQ-PD (n = 16,658)**

| | Total TMD | *P* value | Severe TMD | *P* value | EQ–PD | *P* value |
|---|---|---|---|---|---|---|
| Total | | | | | | |
| Model 2 | 1.28 (1.17–1.40) | < **.001** | 1.40 (1.21–1.61) | < **.001** | 1.76 (1.65–1.89) | < **.001** |
| Model 3 | 1.26 (1.15–1.37) | < **.001** | 1.35 (1.19–1.54) | < **.001** | 1.75 (1.64–1.87) | < **.001** |
| Model 4 | 1.26 (1.16–1.38) | < **.001** | 1.35 (1.19–1.54) | < **.001** | 1.75 (1.64–1.87) | < **.001** |
| No cancer history | | | | | | |
| Model 1 | 1.30 (1.18–1.43) | < **.001** | 1.43 (1.23–1.67) | < **.001** | 1.89 (1.76–2.02) | < **.001** |
| Model 2 | 1.25 (1.14–1.38) | < **.001** | 1.37 (1.18–1.59) | < **.001** | 1.75 (1.63–1.88) | < **.001** |
| Model 3 | 1.24 (1.13–1.36) | < **.001** | 1.32 (1.15–1.51) | < **.001** | 1.74 (1.62–1.86) | < **.001** |
| Cancer history | | | | | | |
| Model 1 | 1.72 (1.18–2.51) | **.005** | 1.73 (1.03–2.88) | **.037** | 2.27 (1.63–3.15) | < **.001** |
| Model 2 | 1.98 (1.36–2.88) | < **.001** | 2.18 (1.30–3.65) | **.003** | 2.13 (1.50–3.01) | < **.001** |
| Model 3 | 2.02 (1.38–2.95) | < **.001** | 2.20 (1.31–3.69) | **.003** | 2.16 (1.53–3.07) | < **.001** |

Model 1 was adjusted for age and gender. Model 2 was adjusted for age, gender, income, education, occupation, and marital status. Model 3 was adjusted for age, gender, income, education, occupation, marital status, smoking, and binge drinking. Model 4 was adjusted for age, income, education, occupation, marital status, smoking, binge drinking, and cancer history. Bold denotes statistical significance at $P < .05$.

| | EQ-PD | | |
|---|---|---|---|
| | No | Yes | *P* value* |
| | 45.8 (15.6) | 57.1 (16.2) | < **.001**† |
| | | | |
| | 5,577 (79.1) | 1,478 (20.9) | < **.001** |
| | 6,397 (66.6) | 3,206 (33.4) | |
| | | | |
| | 3,177 (76.2) | 993 (23.8) | < **.001** |
| | 3,054 (73.2) | 1,120 (26.8) | |
| | 2,930 (70.7) | 1,215 (29.3) | |
| | 2,813 (67.5) | 1,356 (32.5) | |
| | | | |
| | 3,615 (84.9) | 642 (15.1) | < **.001** |
| | 4,630 (80.5) | 1,125 (19.5) | |
| | 1,297 (69.6) | 566 (30.4) | |
| | 2,432 (50.8) | 2,351 (49.2) | |
| | | | |
| | 2,624 (86.1) | 424 (13.9) | < **.001** |
| | 3,203 (69.5) | 1,403 (30.5) | |
| | 1,661 (79.9) | 419 (20.1) | |
| | 4,486 (64.8) | 2,438 (35.2) | |
| | | | |
| | 8,799 (73.3) | 3,210 (26.7) | < **.001** |
| | 3,175 (68.3) | 1,474 (31.7) | |
| | | | |
| | 7,040 (69.2) | 3,130 (30.8) | < **.001** |
| | 2,094 (73.1) | 770 (26.9) | |
| | 1,574 (78.1) | 441 (21.9) | |
| | 1,266 (78.7) | 343 (21.3) | |
| | | | |
| | 9,377 (69.7) | 4,075 (30.3) | < **.001** |
| | 2,597 (81.0) | 609 (19.0) | |
| | | | |
| | 11,678 (72.2) | 4,490 (27.8) | < **.001** |
| | 296 (60.4) | 194 (39.6) | |

Table 3 shows a series of PRs for SI after incremental adjustment. The analysis results revealed that total TMD, severe TMD, and EQ-PD had a significant PR in the sociodemographic factors-adjusted model (PR = 1.28 in total TMD, 1.40 in severe TMD, and 1.76 in EQ-PD). The magnitudes of the PRs were attenuated with the adjustment of health behavior but not by cancer history. In the fully adjusted model (model 4 in Table 3), the associations between pain conditions and SI were still significant (PR = 1.26 for total TMD, PR = 1.35 for severe TMD, and PR = 1.75 for EQ-PD). Although the interaction terms between cancer history and total TMD (*P* = .103), severe TMD (*P* = .117), and EQ-PD (*P* = .112) were not significant, PRs were explored within strata defined by cancer history. In the subgroup analyses by cancer history, the age- and gender-adjusted PRs of total TMD, severe TMD, and EQ-PD among cancer history were higher than those among no cancer history. The PRs of total TMD and of severe TMD among cancer history were increased with incremental socioeconomic factor and health behavior adjustment (from 1.72 to 2.02 in total TMD, from 1.73 to 2.20 in severe TMD), whereas the PRs of the EQ-PD were attenuated with incremental adjustment (from 2.27 to 2.16).

## Discussion

This study sought to examine the associations of pain conditions with SI in a large representative sample of South Koreans. General pain (as measured by the EQ-PD), severe TMD, and total TMD were associated with an increased PR for SI after controlling for demographic characteristics. All these pain measures maintained a statistically significant association with SI after additional adjustment for socioeconomic factors and cancer history. PR for SI was greatest for individuals with EQ-PD, followed by severe TMD and total TMD.

The results of this study revealed that TMD symptoms could be an aggravating factor for SI when they are coupled with cancer history. This is the first large-scale investigation of this topic. The majority of people who had experienced cancer reported no suicide-related behavior, but those who were experiencing suicidal thoughts are a serious concern. Although SI is only one aspect of the spectrum for suicidal symptoms, it is important to understand because SI is a significant risk factor for self-destructive behaviors and is itself an indicator of emotional suffering.[29,30]

By demonstrating that SI is associated with severe TMD, the findings add to the understanding of the relationship between severe TMD of cancer survivors and risk for SI. Severe TMD was associated with SI, even after adjusting for sociodemographic covariates. This is consistent with reports that pain and chronic medical conditions are a significant risk factor for suicide and SI.[13–15,31,32]

The relationships of smoking, excessive alcohol drinking, and cancer history with SI are well established. Results from numerous epidemiologic studies have consistently documented a strong association between cigarette smoking and suicide-related outcomes among adults in the community.[33,34] There are a number of plausible explanations for this association. One possibility is that smoking leads to increased depression that then increases the risk of suicide-related outcomes. Alcoholism is also associated with increased suicide risk. Heavy alcohol drinking predisposes individuals to suicidal thoughts or precipitates such thoughts through its depressogenic effects; in

addition, it has an association with adverse life events, impairment of problem-solving skills, and aggravation of impulsivity, possibly through its effects on serotonergic neurotransmission.[35] Previous reports have also indicated that patients with cancer have more than a 2.0-fold higher risk of suicide completion than patients without cancer.[7–9,11] Scandinavian registry studies, for example, have reported standardized mortality ratios for suicide deaths in cancer patients that range from 1.55 to 2.5 for males and 1.35 to 2.9 for females, compared with the general population.[7,11] Cancer patients must face several forms of distress, which might lead them to feel depressed or experience anxiety.[36]

Prior studies have demonstrated that nonpersistent suicidal thoughts are frequent in cancer patients, and long-lasting SI, although less common, is still high. In a large cross-sectional survey of cancer patients, 7.8% reported thoughts that they would be better off dead or thoughts of hurting themselves.[37] The prevalence of SI in a cohort of adult survivors of pediatric cancers was 7.8% compared to 4.6% of the controls.[38] Moreover, 17.7% of family caregivers with cancer patients reported SI, and 2.8% had attempted suicide during the previous year.[39] Cancer patients with pain conditions may be more likely to feel hopelessness and to have impairments in occupational or social functioning that could lead more directly to suicidal thoughts. Negative expectations about one's ability to manage or treat pain effectively could lead to SI, and these effects might be greatest for certain conditions, such as severe TMD, that do not have clear and/or effective treatments. Exposure to painful stimuli over time also has been hypothesized to increase an individual's acquired capacity to engage in suicidal behaviors in the presence of stressors and/or suicidal thoughts. Therefore, cancer survivors with pain conditions such as severe TMD might have more risk for SI than individuals suffering from pain only. The importance of carefully observing the mental status of patients with cancer cannot be emphasized enough, especially for those cases involving pain including TMD pain. The presence of cancer accompanied by TMD pain may be especially closely related to SI.

A notable limitation of this study was the use of a single item to assess recent SI. Suicidal symptoms can vary over short periods of time, making prevalence estimates from a single time point somewhat limited. A more complete understanding of the nature of suicide in a Korean population will require detailed assessment of suicidal thoughts and behavior. Specifically, onset, duration, and intensity of suicidal thoughts as well as suicidal impulses, plans, or attempts will be critical for a better understanding of the effect of SI on survivors' adaptation and functioning, as well as their risk for self-harm or suicide completion. Reliance on self-reported health outcomes is another limitation, because reports of these conditions may be affected by emotional states in a manner that could potentially bias the results. The inclusion criteria for the TMD in this study were temporomandibular joint clicking, pain, and mouth-opening limitations. Pain of the masticatory system is often related to pain conditions elsewhere in the body, eg, lower back pain or pain of the cervical spine and the surrounding musculature. It is possible that both types of pain coexist independently because of a common origin. On the other hand, one disorder might have causal significance for the other, and TMD could be a symptom of the general condition. There could also be selection bias. To evaluate selection bias, it is important to compare a population that agreed to participate with those who did not. Although the number of subjects who refused to participate in the survey was very small, information on the nonrespondents could not be collected. Therefore, some caution should be taken when interpreting the data. Moreover, an interpretation of the causal pathway of some of the associations described in the cross-sectional study is not obvious because the temporal sequence of the appearance of TMD and SI is unclear. A well-designed retrospective or prospective cohort or a nested case-control study could disentangle these complex relations. Finally, this study investigated people with any history of cancer, not necessarily current cancer patients.

Despite these limitations, the study findings are consistent with the growing literature on SI in cancer patients and survivors[7–11,37,38] and have important implications for identifying and intervening in cancer patients most at risk. Medical variables, such as physical pain and TMD, are typically available from medical records or patient-completed forms and could be used to stratify a person who has experienced cancer for targeted screening, particularly in situations where universal screening is not practical. Finally, the association of TMD with SI is a reminder of the importance of a comprehensive biopsychosocial perspective on cancer patient care. Helping those with a history of cancer find appropriate medical and dental care for their treatment-related effects is a priority for improving the physical health of survivors and may be essential for improving their emotional health as well.

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