Association between Systemic Health Conditions and Self-Reported Oral Health in Korean Elderly

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Systemic health conditions increase with advancing age, and may be linked to poor self-reported oral health. The purpose of this study was to evaluate the association between systemic health conditions and poor self-reported oral health among Korean elderly. The study used a nationally representative sample of Koreans (2012 Korea National Health and Nutrition Examination Survey) aged 65∼98 years (n=1,595). Systemic health conditions in this population were assessed by the presence of one or more of the following conditions: obesity, hypertension, diabetes, and hypercholesterolemia. The relative risk of poor self-reported oral health according to the occurrence of systemic health conditions was estimated by multivariate logistic regression after controlling for several potential confounders (i.e., socio-demographic factors, oral health behaviors, health behaviors, and psychological factors). After adjustment for these confounders, the relative risk of having poor self-reported oral health was greater among the elderly with one or more systemic health conditions than in those without a systemic health condition. The odds ratio of having poor self-reported oral health according to the occurrence of systemic health conditions was 1.51 (95% confidence interval, 1.08∼2.12). Among the Korean elderly, perception of poor oral health was associated with the presence of one or more systemic health conditions. Future studies are needed to examine the detailed causal relation between systemic health conditions and poor oral health longitudinally.

Key Words: Aged, Health, Oral health

Introduction

Korea has the most rapidly aging population worldwide. In 2013, the number of older people in Korea accounted for 12.2% of its entire population. This trend is projected to continue and may result in a super-aged society by 20261. Despite the positive effects of increased life expectancy, an aging population suffering from systemic health conditions can be problematic for the society2. Health care costs related to the treatment and management of systemic health conditions in the elderly are expected to surge, which may deteriorate elderly health-related quality of life3. Poor systemic health conditions can cause blood clots and inflammation, and may lead to serious global
health problems. The association between systemic health conditions and oral health has been examined in many studies. Individuals with systemic health conditions such as obesity, diabetes, hypertension, and hypercholesterolemia were found to have higher risk of developing periodontal disease than those without systemic health conditions. In addition, obesity was associated with tooth loss among elderly aged 70 years and over. Longitudinal studies also revealed a causal relationship that people with obesity were more likely to develop periodontal disease. Although previous studies have examined the association between specific systemic health condition and oral health, this association should be investigated more comprehensively when examining elderly. Comorbidity is more common among elderly, and it has an even bigger impact on oral health due to its association with inflammation. Therefore, examining comorbidity systemic condition and oral health is suggested.

A comprehensive measuring of elderly oral health state is not simple because the effect of previous oral diseases such as dental caries or periodontal disease eventually results in the loss of multiple teeth for the severe cases. A global rating of self-reported oral health has been widely used as a simple and effective subjective measure of general oral health status. Especially for elderly, using self-reported oral health measure is meaningful because the collective evaluation of the history of their oral diseases and treatment accumulated for the whole life can be assessed including missing teeth state and all other oral diseases present. As the self-reported evaluation of perceived oral health status was reported to be significantly related to the objective measurement, perceived oral health status is considered to represent the oral health status of the elderly. Therefore, self-reported oral health can be a comprehensive measure of a person’s complete oral health condition and periodontal disease status.

According to previous studies, demographic factors (e.g., age, gender), socioeconomic factors (e.g., education, income), overall health behaviors (e.g., smoking, drinking, exercise), oral health behaviors (e.g., frequency of daily tooth brushing, use of dental hygiene devices), and psychological factors (e.g., stress) have been reported to have association with individual’s oral health status. Additionally, the overall physical health is closely tied to oral health.

Although systemic health condition is a more urgent and important issue among elderly, studies examining the association between systemic health conditions and self-reported oral health among elderly is scarce. Therefore, the present study utilized the nationally representative sample data from the 2012 Korea National Health and Nutrition Examination Survey (KNHANES) to investigate the potential link between systemic health conditions and self-reported oral health in elderly. The purpose of this study was to evaluate the relationship between systemic health conditions and self-reported oral health among Korean elderly.

**Materials and Methods**

1. Study design and participants

KNHANES is a continuous cross-sectional survey for the non-institutionalized civilian of South Korea. In this survey, we used a complex stratified multistage stochastic sampling design based on age, sex, region to represent the Korean population. KNHANES-IV (2012), coordinated by the Korean Ministry of Health and Welfare, includes items based on oral examination and health interview surveys. This survey was approved by the Institutional Review Board of the Korea Centers for Disease Control and Prevention, and all participants agreed in writing. Our study was approved by the Korea University Institutional Review Board (KU-IRB-16-EX-111-A-1). We analyzed a total of 1,595 subjects aged 65 and over who completed the 2012 KNHANES.

2. Data collection

Dependent variable is self-reported oral health status. “How would you describe the state of your teeth and gums?” The participants were asked to rate their oral health from these five aspects in comparison with their peers using a two-level scale, very good, good, average is ‘good,’ and poor, very poor is ‘poor.’ Besides self-reported oral health conditions.
Systemic health conditions occurrence was assessed with having one or more of the following conditions: obesity, hypertension, diabetes, and hypercholesterolemia. Obesity was assessed with overweight. If the body mass index was greater than or equal to 25 kg/m², respondents were defined as having obesity. Hypertension was assessed with systolic blood pressure (greater than 140 mmHg) or diastolic blood pressure (greater than 90 mmHg), or whether the respondent took blood pressure medication. Diabetes was assessed if respondents had greater than or equal to 126 mg/dl fasting glucose, or took diabetes medication. Hypercholesterolemia was assessed if respondents had greater than or equal to 240 mg/dl fasting total cholesterol, or took cholesterol-lowering medication.

Demographic factors included age (65 ~ 69, 70 ~ 74, 75 and over years) and gender (male, female). Socioeconomic factors included education level (lower than elementary school, middle school, high school, upper university or college) and household income (in quartiles). Health behaviors included smoking (yes, no), drinking alcohol (yes, no), and exercise (yes, no). Oral health behaviors included frequency of daily tooth brushing (≤ 1, 2, ≥ 3), and using a dental hygiene device included dental floss, interdental brush, mouth rinse, electric toothbrush etc. (yes, no). Psychological factors included the level of stress was measured using the question “How much stress do you feel in your normal life?” and was scored on a 4 point scale (little, a little, heavy, extremely heavy).

3. Statistical analysis

The analysis was based on the sampling weights accounting for complex sampling design of KNHANES. Complex sampling method were used to all analysis the data. A bivariate relationship between study participants’ characteristics and self-reported oral health was examined using the chi-square test. A multivariate logistic regression was conducted to investigate the relationship between individual systemic conditions and self-reported oral health adjusted for covariation. Each systemic condition was obesity, hypertension, diabetes, hypercholesterolemia and self-reported oral health adjusted for covariation (Model I ~ IV). A multivariate logistic regression was conducted to investigate the relationship between systemic health

| Variable          | Category               | Unweighted | Weighted |
|-------------------|------------------------|------------|----------|
| Dependent variable| Self-reported oral health status |            |          |
|                   | Good                   | 740 (47.3) |          |
|                   | Poor                   | 816 (52.7) |          |
| Independent variable| Number of systemic health condition |            |          |
|                   | ≥ 1                    | 1,185 (74.6) |          |
|                   | 0                      | 410 (25.4)  |          |
| Obesity           | Yes                    | 523 (32.4)  |          |
|                   | No                     | 1,069 (65.8)|          |
| Hypertension      | Yes                    | 919 (64.7)  |          |
|                   | No                     | 524 (35.3)  |          |
| Diabetes          | Yes                    | 260 (21.4)  |          |
|                   | No                     | 992 (78.6)  |          |
| Hypercholesterolemia| Yes                   | 296 (23.4)  |          |
|                   | No                     | 958 (76.6)  |          |
| Demographics      | Age (y)                | 73.02±0.20 |          |
|                   | 65 ~ 69                | 494 (31.8)  |          |
|                   | 70 ~ 74                | 522 (28.6)  |          |
|                   | ≥ 75                   | 579 (39.6)  |          |
| Gender            | Male                   | 673 (41.2)  |          |
|                   | Female                 | 922 (58.8)  |          |
| Socioeconomic     | Educational level      |            |          |
|                   | ≤ Elementary school    | 903 (66.7)  |          |
|                   | Middle school          | 188 (13.0)  |          |
|                   | High school            | 219 (13.6)  |          |
|                   | ≥ University or college| 121 (6.7)   |          |
| Household income  | Low                    | 763 (51.1)  |          |
|                   | Middle-low             | 441 (28.3)  |          |
|                   | Middle-high            | 215 (12.3)  |          |
|                   | High                   | 145 (8.3)   |          |
| Health behaviors  | Smoking                | 160 (11.7)  |          |
|                   | No                     | 1,270 (88.3)|          |
|                   | Drinking               | 497 (35.1)  |          |
|                   | No                     | 933 (64.9)  |          |
|                   | Exercises              | 98 (5.9)    |          |
|                   | No                     | 1,327 (94.1)|          |
| Oral health behaviors| Frequency of daily tooth brushing |            |          |
|                   | ≤ 1                    | 382 (26.3)  |          |
|                   | 2                      | 636 (38.9)  |          |
|                   | ≥ 3                    | 577 (34.8)  |          |
| Dental hygiene devices| Use                   | 568 (34.2)  |          |
|                   | Not Use                | 1,027 (65.8)|          |
| Psychological     | Level of stress        |            |          |
|                   | Little                 | 440 (30.7)  |          |
|                   | A little               | 690 (48.1)  |          |
|                   | Heavy                  | 232 (16.1)  |          |
|                   | Extremely heavy        | 64 (5.2)    |          |

Values are presented as unweighted n (weighted %) or mean± standard deviation.
Table 2. Bivariate Association between Self-Reported Oral Health Status and Other Related Factors

| Variable                             | Category     | Self-reported oral health | p-value |
|--------------------------------------|--------------|---------------------------|---------|
|                                      |              | Poor                      | Good    |         |
| Independent variable                 |              |                           |         |         |
| Number of systemic health condition  |              |                           |         |         |
| ≥ 1                                  | 630 (55.1)  | 535 (44.9)                | 0.015   |
| 0                                    | 186 (45.7)  | 205 (54.3)                |         |
| Obesity                              | Yes          | 278 (56.6)                | 233 (43.4) | 0.127 |
|                                       | No           | 538 (50.8)                | 506 (49.2) |       |
| Hypertension                         | Yes          | 491 (55.2)                | 415 (44.8) | 0.054 |
|                                       | No           | 251 (48.4)                | 266 (51.6) |       |
| Diabetes                             | Yes          | 152 (57.9)                | 107 (42.1) | 0.058 |
|                                       | No           | 485 (50.2)                | 493 (49.8) |       |
| Hypercholesterolemia                 | Yes          | 140 (45.7)                | 153 (54.3) | 0.111 |
|                                       | No           | 497 (53.4)                | 449 (46.6) |       |
| Demographics                         |              |                           |         |         |
| Age                                  |              |                           |         |         |
| 65 ~ 69                              | 232 (48.9)  | 248 (51.1)                | 0.092   |
| 70 ~ 74                              | 265 (50.5)  | 248 (49.5)                |         |
| ≥ 75                                 | 319 (57.4)  | 244 (42.6)                |         |
| Gender                               |              |                           |         |         |
| Male                                 | 336 (50.4)  | 320 (49.6)                | 0.153   |
| Female                               | 480 (54.3)  | 420 (45.7)                |         |
| Socioeconomic                        |              |                           |         |         |
| Educational level                   |              |                           |         |         |
| ≤ Elementary school                 | 498 (56.3)  | 394 (43.7)                | 0.001   |
| Middle school                        | 88 (50.3)   | 97 (49.7)                 |         |
| High school                          | 104 (45.4)  | 113 (54.6)                |         |
| ≥ University or college             | 45 (34.6)   | 72 (65.4)                 |         |
| Household income                    |              |                           |         |         |
| Low                                  | 420 (56.1)  | 327 (43.9)                | 0.012   |
| Middle-low                           | 222 (53.6)  | 209 (46.4)                |         |
| Middle-high                          | 89 (40.3)   | 119 (59.7)                |         |
| High                                 | 71 (49.4)   | 71 (50.6)                 |         |
| Health behaviors                     |              |                           |         |         |
| Smoking                              | Yes          | 96 (60.6)                 | 61 (39.4) | 0.044 |
|                                       | No           | 637 (51.4)                | 615 (48.6) |       |
| Drinking                             | Yes          | 254 (53.1)                | 236 (46.9) | 0.809 |
|                                       | No           | 479 (52.2)                | 440 (47.8) |       |
| Exercise                             | Yes          | 54 (56.0)                 | 44 (44.0) | 0.587 |
|                                       | No           | 675 (52.2)                | 631 (47.8) |       |
| Oral health behaviors                |              |                           |         |         |
| Frequency of daily tooth brushing    | ≤ 1          | 218 (56.5)                | 157 (43.5) | 0.148 |
|                                       | 2            | 326 (53.6)                | 297 (46.4) |       |
|                                       | ≥ 3          | 272 (48.9)                | 286 (51.1) |       |
| Dental hygiene devices               | Use          | 270 (49.7)                | 278 (50.3) | 0.133 |
|                                       | Not use      | 546 (54.3)                | 462 (45.7) |       |
Table 2. Continued

| Variable   | Category          | Self-reported oral health | p-value |
|------------|-------------------|---------------------------|---------|
| Psychological | Level of stress   |                           |         |
|            | Little            | 190 (42.6)                | 241 (57.4) | < 0.001 |
|            | A little stress   | 362 (54.8)                | 321 (45.2) |
|            | Heavy             | 140 (61.9)                | 88 (38.1)  |
|            | Extremely heavy   | 39 (60.7)                 | 24 (39.3)  |

Values are presented as unweighted n (weighted %).
p-value was by chi-square test.

Table 3. Multivariate Association between Poor Self-Reported Oral Health and Individual Systemic Health Condition under Adjustment for Other Related Factors

| Individual systemic health condition | Poor self-reported oral health | p-value |
|--------------------------------------|--------------------------------|---------|
| Model I Obesity (ref. no)            | Adjusted OR*                   | 1.38    |
| Model II Hypertension (ref. no)      | 1.31                            | 0.99 ~ 1.74 | 0.059 |
| Model III Diabetes (ref. no)         | 1.29                            | 0.92 ~ 1.81 | 0.141 |
| Model IV Hypercholesterolemia (ref. no) | 0.75                          | 0.50 ~ 1.12 | 0.153 |

Dependent variable: self-reported oral health status (ref. good).
OR: odds ratio, CI: confidence interval.
*Adjusted odds ratio taking account for age, gender, education level, household income, smoking, drinking, exercise, frequency of tooth brushing, using dental hygiene devices, and the level of stress.

Results

1. Study participants’ characteristics
The general characteristics of the study subjects by demographics, socioeconomic, health behaviors, oral health behaviors, and psychological factors are presented in Table 1. More than half of the respondents had poor self-reported oral health (52.7%), and a high proportion of individuals (74.6%) reported having one or more systemic health conditions. The distribution of each systemic health condition was as follows hypertension (64.7%), obesity (32.4%), hypercholesterolemia (23.4%), diabetes (21.4%).

The average age of the study subjects was 73.0 years. Of the total 1,595 subjects, women accounted for more than half (58.8%). Regarding education, the majority of study subjects (66.7%) reported having less than an elementary school education. Regarding household income, the majority of subjects (51.1%) responded that they were in the lowest category. High proportions of subjects did not smoke, drink, nor exercise. More than half of the subjects (73.7%) reported brushing their teeth at least twice a day. The majority of subjects (65.8%) reported not using supplementary oral hygiene products. Finally, 48.1% of study subjects reported a moderate level of stress.

2. Study participants’ characteristics and self-reported oral health
Bivariate associations between self-reported oral health and other related factors are shown in Table 2. Systemic health conditions occurrence was significantly associated with poor self-reported oral health (p < 0.05). Regarding socioeconomic factors, educational attainment was associated with good self-reported oral health (p < 0.001), as was household income level (p < 0.05). Among the health behaviors, smoking was associated with poor self-reported oral health (p < 0.01). Finally, stress level was associated with poor self-reported oral health (p < 0.001).
3. Systemic health conditions and self-reported oral health

First, the results presenting the association between each systemic health conditions and self-reported oral health adjusted for covariation are shown in Table 3. All models were Adjusting for age, gender, education level, household income, smoking, drinking, exercise, frequency of tooth brushing, using dental hygiene devices, and the level of stress, a multivariate logistic regression result showed that persons having obesity had significantly higher odds of having poor self-reported oral health compared to persons having no obesity (odds ratio [OR], 1.38; confidence interval [CI], 1.01 ~ 1.87).

Second, the relationship between systemic health conditions occurrence and self-reported oral health adjusted for covariation among older Koreans is shown in Table 4. The result showed that persons with systemic health conditions had significantly higher odds of having poor self-reported oral health compared to persons having no systemic health condition (OR, 1.51; CI, 1.08 ~ 2.12).

### Discussion

As the average human lifespan is prolonged, interest in the quality of life of elderly has increased. Also interests in the general health of the elderly are growing and an

| Table 4. Multivariate Association between Systemic Health Conditions and Poor Self-Reported Oral Health |
|---------------------------------------------------------------|
| **Variable**          | **Category**                        | **Poor self-reported oral health** |
|                      |                                  | **Adjusted OR** | **95% CI**     | **p-value** |
| Independent variable | Number of systemic health condition (ref. 0) | 1.51 | 1.08 ~ 2.12 | 0.017 |
|                      | ≥1                                | 0.70 | 0.47 ~ 1.04 | 0.076 |
|                      | Demographics Age (ref. ≥75)       | 0.78 | 0.53 ~ 1.60 | 0.218 |
|                      | 65 ~ 69                           | 1.16 | 0.83 ~ 1.61 | 0.383 |
|                      | 70 ~ 75                           | 1.03 | 0.63 ~ 1.68 | 0.905 |
|                      | Gender (ref. female)              | 0.65 | 0.40 ~ 1.06 | 0.083 |
|                      | Male                             | 0.97 | 0.67 ~ 1.41 | 0.889 |
|                      | Socioeconomic Educational level (ref. ≤elementary school) | 0.45 | 0.26 ~ 0.79 | 0.005 |
|                      | ≥University or College            | 0.64 | 0.42 ~ 0.97 | 0.036 |
|                      | High school                      | 0.81 | 0.55 ~ 1.21 | 0.308 |
|                      | Middle school                    | 1.03 | 0.63 ~ 1.68 | 0.905 |
|                      | Household income (ref. low)       | 0.65 | 0.40 ~ 1.06 | 0.083 |
|                      | High                             | 0.97 | 0.67 ~ 1.41 | 0.889 |
|                      | Middle-high                      | 1.33 | 0.71 ~ 2.50 | 0.374 |
|                      | Middle-low                       | 1.03 | 0.71 ~ 1.49 | 0.942 |
|                      | Health behaviors Smoking (ref. no) | 1.06 | 0.73 ~ 1.53 | 0.761 |
|                      | Yes                              | 1.33 | 0.71 ~ 2.50 | 0.374 |
|                      | Drinking (ref. no)                | 0.97 | 0.67 ~ 1.41 | 0.889 |
|                      | Yes                              | 1.07 | 0.71 ~ 1.59 | 0.942 |
|                      | Oral health behaviors The frequency of daily tooth brushing (ref. ≤1) | 1.01 | 0.69 ~ 1.49 | 0.889 |
|                      | 2                                | 1.02 | 0.77 ~ 1.36 | 0.885 |
|                      | ≥3                               | 1.79 | 1.35 ~ 2.37 | < 0.001 |
|                      | Dental hygiene devices (ref. not use) Use | 2.06 | 1.38 ~ 3.07 | < 0.001 |
|                      | Psychological Level of stress (ref. little) | 2.10 | 1.11 ~ 4.0  | 0.023 |

Dependent variable: self-reported oral health status (ref. good).
OR: odds ratio, CI: confidence interval.
increasing number of studies are being conducted with an assumption that the susceptibility of elderly to systemic health conditions due to the deterioration of their biological and physical functions is a factor that increases the demand for medical care.

In this study we examined the association between systemic health conditions and self-reported oral health status controlling for other related factors among Korean elderly. We used the representative national data collected in 2012 KNHANES. Our results based on each systemic health condition suggest that obesity to be the significant factor in the association with poor self-reported oral health. In addition, the risk of reporting a poor self-reported oral health status was 1.5 times higher in the presence of systemic health conditions compared to in cases of absence. Our findings are similar to the results of previous studies which have confirmed the relationship between obesity and oral health mostly among adults\(^9\)-\(^{13}\),\(^{17}\).

It has been reported that systemic health condition and oral health in elderly. But, research is relatively scarce on the relationship between related metabolic diseases, metabolic syndrome and oral health in elderly. The Korean longitudinal study reported that there exists positive correlation between the number of systemic health conditions and periodontal disease among elderly\(^{18}\). The Japanese Niigata study researchers found that elderly with systemic health conditions were more likely to develop periodontal disease\(^{14}\). In addition, they found an association between systemic health conditions and the bacterial exposure that causes periodontal\(^{27,29}\). Adding to previous studies, the result from this study supports the association between systemic health conditions and oral health among elderly.

Evidence suggests that systemic health conditions and oral health may share many possible explanations\(^{30}\). Patients with systemic health conditions may tend to have more inflammation in the presence of periodontal pathogens and predispose to periodontal disease. Oxidative stress may add evidence to elucidate the mechanism of the relationship between systemic health conditions and periodontal disease\(^{16}\). Also, changes in environmental factors, eating habits, and life styles that influence obesity may affect the relationship between systemic health conditions and periodontal disease, as a component analysis of each systemic health conditions found abdominal girth in women had the strongest association with periodontal disease\(^{10}\).

We also found that self-reported oral health status of elderly was associated with other personal characteristics, such as education level and the level of stress. The self-reported oral health status was poorer when the education level was low. This is consistent with the results of previous studies in which oral health status was worst for the socioeconomically disadvantaged group\(^{31}\). Therefore, more education and initiatives to promote oral health are needed for the less-educated population. Self-reported oral health status significantly differed according to stress level, too. This result is partially supported by Locker and others\(^{32}\), which showed that self-reported oral health status was correlated with stress level and psychological well-being. The result showing that oral status worsened as the stress level increased demonstrates the association between psychological factors and oral health.

This study has several limitations. First, the results of this study cannot explain the causal relationship because of its cross-sectional survey design. Second, we considered only several systemic health conditions that are reported to be prevalent among elderly. To comprehensively understand the association between systemic health conditions and oral health among elderly, considering various systemic health conditions will be needed.

This study was holds significance as it confirms the relationship between systemic health conditions and oral health among Korean elderly by using data that are representative of the general population of Korea. Further study is needed to examine the detailed causal relations between systemic health conditions and oral health longitudinally. In addition, proper interventions to prevent systemic health conditions and promote oral health should be established for the complete health of elderly. To improve the oral health level of elderly effectively, an integrated oral health management program that comprehensively considers both systemic health conditions and psychological factors such as stress should be implemented.
Summary

This study was to examine the association between systemic health conditions and self-reported oral health among Korean elderly. The study used KNHNES-IV (2012) aged 65–98 years (n=1,595). From frequency analysis, being lower education, lower income, smoking status, high stress level were significantly related to poor self-reported oral health. After adjustment for confounders, the risk of having poor self-reported oral health was greater in elderly with systemic health conditions than those without systemic health conditions. The OR of having poor self-reported oral health according to systemic health conditions occurrence was 1.51 (95% CI, 1.08–2.12). Among Korean elderly, poor self-reported oral health was associated with systemic health conditions. We should be concerned about in health promotion for elderly vulnerable to metabolic condition related systemic health and poor oral health.

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