

한국노인의 전신건강상태와 주관적 구강건강 관련성

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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 expect-

tancy, 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

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health problems⁴⁾.

The association between systemic health conditions and oral health has been examined in many studies⁵⁻¹⁹⁾. Individuals with systemic health condition such as obesity, diabetes, hypertension, and hypercholesterolemia were found to have higher risk of developing periodontal disease than those without systemic health conditions⁵⁻¹²⁾. In addition, obesity was associated with tooth loss among elderly aged 70 years and over¹³⁻¹⁵⁾. Longitudinal studies also revealed a causal relationship that people with obesity were more likely to develop periodontal disease^{16,17)}.

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^{18,20,21)}. 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^{13,22)}. 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^{13,23)}. 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^{24,25)}. 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 status²⁶⁾. Additionally, the overall physical health is closely tied to oral health²⁷⁾.

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 surveys²⁸⁾. 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 statue. "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/m^2 , 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 medication¹⁸⁾.

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

Table 1. Study Participants' Characteristics

Variable	Category	Unweighted (weighted)
Dependent variable	Self-reported oral health status	
	Good	740 (47.3)
Independent variable	Poor	816 (52.7)
	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 \pm 0.20
	65 ~ 69	494 (31.8)
	70 ~ 74	522 (28.6)
	≥ 75	579 (39.6)
	Gender	
Socioeconomic	Male	673 (41.2)
	Female	922 (58.8)
	Educational level	
	\leq Elementary school	903 (66.7)
	Middle school	188 (13.0)
	High school	219 (13.6)
	\geq University or college	121 (6.7)
	Household income	
	Low	763 (51.1)
	Middle-low	441 (28.3)
Health behaviors	Middle-high	215 (12.3)
	High	145 (8.3)
	Smoking	
	Yes	160 (11.7)
	No	1,270 (88.3)
	Drinking	
	Yes	497 (35.1)
	No	933 (64.9)
	Exercises	
	Yes	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	
Psychological	Use	568 (34.2)
	Not Use	1,027 (65.8)
	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 \pm 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			
Socioeconomic	Male	336 (50.4)	320 (49.6)	0.153
	Female	480 (54.3)	420 (45.7)	
	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
		Poor	Good	
Psychological	Level of stress			<0.001
	Little	190 (42.6)	241 (57.4)	
	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		
		Adjusted OR ^a	95% CI	p-value
Model I	Obesity (ref. no)	1.38	1.01 ~ 1.87	0.041
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.

^aAdjusted 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.

conditions and self-reported oral health adjusted for covariation. All analyses were performed using PASW Statistics ver. 18.0 (IBM Co., Armonk, NY, USA). The type one error rate was set at the alpha level of 0.05.

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	1.51	1.08 ~ 2.12	0.017
Demographics	Age (ref. ≥ 75)			
	65 ~ 69	0.70	0.47 ~ 1.04	0.076
	70 ~ 75	0.78	0.53 ~ 1.60	0.218
	Gender (ref. female)			
	Male	1.16	0.83 ~ 1.61	0.383
Socioeconomic	Educational level (ref. ≤ elementary school)			
	≥ University or College	0.45	0.26 ~ 0.79	0.005
	High school	0.64	0.42 ~ 0.97	0.036
	Middle school	0.81	0.55 ~ 1.21	0.308
	Household income (ref. low)			
	High	1.03	0.63 ~ 1.68	0.905
	Middle-high	0.65	0.40 ~ 1.06	0.083
	Middle-low	0.97	0.67 ~ 1.41	0.889
Health behaviors	Smoking (ref. no)			
	Yes	1.43	0.90 ~ 2.27	0.129
	Drinking (ref. no)			
	Yes	1.06	0.73 ~ 1.53	0.761
	Exercises (ref. no)			
	Yes	1.33	0.71 ~ 2.50	0.374
Oral health behaviors	The frequency of daily tooth brushing (ref. ≤ 1)			
	2	1.03	0.71 ~ 1.49	0.942
	≥ 3	1.01	0.69 ~ 1.49	0.889
	Dental hygiene devices (ref. not use)			
	Use	1.02	0.77 ~ 1.36	0.885
Psychological	Level of stress (ref. little)			
	A little	1.79	1.35 ~ 2.37	< 0.001
	Extremely heavy	2.06	1.38 ~ 3.07	< 0.001
	Heavy	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 elderly¹⁸. The Japanese Niigata study researchers found that elderly with systemic health conditions were more likely to develop periodontal disease¹⁴. 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 explanations³⁰. 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 disease¹⁶. Also, changes in environmental factors, eating habits, and life styles that influence obesity may affect the relationship between systemic health con-

ditions and periodontal disease, as a component analysis of each systemic health conditions found abdominal girth in women had the strongest association with periodontal disease¹⁰.

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 group³¹. 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 others³², 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 elder 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.

References

1. Statistical Report on the Aged: National health and nutrition survey Korea, 2013. Retrieved August 25, 2016, from http://www.kostat.go.kr/portal/korea/kor_nw/2/1/index.board?bmode=read&aSeq=252623(2011, December 7).
2. Rowe JW, Kahn RL: Human aging: usual and successful. *Science* 237: 143-149, 1987.
3. Dennison C, Prasad M, Lloyd A, Bhattacharyya SK, Dhawan R, Coyne K: The health-related quality of life and economic burden of constipation. *Pharmacoeconomics* 23: 461-476, 2005.
4. Grundy SM: Hypertriglyceridemia, insulin resistance, and the metabolic syndrome. *Am J Cardiol* 83: 25F-29F, 1999.
5. Kuo LC, Polson AM, Kang T: Associations between periodontal diseases and systemic diseases: a review of the inter-relationships and interactions with diabetes, respiratory diseases, cardiovascular diseases and osteoporosis. *Public Health* 122: 417-433, 2008.
6. Jung JO: Effects of metabolic syndrome on periodontal diseases in Korean adults. *J Dent Hyg Sci* 12: 245-252, 2012.
7. Kang HJ: A study on periodontal disease and tooth loss in metabolic syndrome patient. *J Dent Hyg Sci* 15: 445-456, 2015.
8. Kong YM, Han GS: Relationships between obesity types and periodontitis according to characteristics of subjects. *J Dent Hyg Sci* 12: 279-286, 2012.
9. Khader Y, Khassawneh B, Obeidat B, et al.: Periodontal status of patients with metabolic syndrome compared to those without metabolic syndrome. *J Periodontol* 79: 2048-2053, 2008.
10. Andriankaja OM, Sreenivasa S, Dunford R, DeNardin E: Association between metabolic syndrome and periodontal disease. *Aust Dent J* 55: 252-259, 2010.
11. Han DH, Lim S, Paek D, Kim HD: Periodontitis could be related factors on metabolic syndrome among Koreans: a case-control study. *J Clin Periodontol* 39: 30-37, 2012.
12. Kwon YE, Ha JE, Paik DI, Jin BH, Bae KH: The relationship between periodontitis and metabolic syndrome among a Korean nationally representative sample of adults. *J Clin Periodontol* 38: 781-786, 2011.
13. Lee PH, McGrath CP, Kong AY, Lam TH: Self-report poor oral health and chronic diseases: the Hong Kong family project. *Community Dent Oral Epidemiol* 41: 451-458, 2013.
14. Holmlund A, Hulthe J, Lind L: Tooth loss is related to the presence of metabolic syndrome and inflammation in elderly subjects: a prospective study of the vasculature in Uppsala seniors (PIVUS). *Oral Health Prev Dent* 5: 125-130, 2007.
15. Elsig F, Schimmel M, Duvernay E, et al.: Tooth loss, chewing efficiency and cognitive impairment in geriatric patients. *Gerodontology* 32: 149-156, 2015.
16. Iwasaki M, Sato M, Minagawa K, Manz MC, Yoshihara A, Miyazaki H: Longitudinal relationship between metabolic syndrome and periodontal disease among Japanese adults aged ≥ 70 years: the Niigata Study. *J Periodontol* 86: 491-498, 2015.
17. Nesbitt MJ, Reynolds MA, Shiao H, Choe K, Simonsick EM, Ferrucci L: Association of periodontitis and metabolic syndrome in the Baltimore longitudinal study of aging. *Aging Clin Exp Res* 22: 238-242, 2010.
18. Lee KS, Kim EK, Kim JW, et al.: The relationship between metabolic conditions and prevalence of periodontal disease in rural Korean elderly. *Arch Gerontol Geriatr* 58: 125-129, 2014.
19. Morita T, Yamazaki Y, Mita A, et al.: A cohort study on the association between periodontal disease and the development of metabolic syndrome. *J Periodontol* 81: 512-519, 2010.

20. Valderas JM, Starfield B, Sibbald B, Salisbury C, Roland M: Defining comorbidity: implications for understanding health and health services. *Ann Fam Med* 7: 357-363, 2009.
21. Kritchevsky SB, Cesari M, Pahor M: Inflammatory markers and cardiovascular health in older adults. *Cardiovasc Res* 66: 265-275, 2005.
22. Kim HY, Patton LL, Park YD: Assessment of predictors of global self-ratings of oral health among Korean adults aged 18-95 years. *J Public Health Dent* 70: 241-244, 2010.
23. Kim HY, Patton LL: Intra-category determinants of global self-rating of oral health among the elderly. *Community Dent Oral Epidemiol* 38: 68-76, 2010.
24. Douglass CW, Berlin J, Tennstedt S: The validity of self-reported oral health status in the elderly. *J Public Health Dent* 51: 220-222, 1991.
25. Reisine ST, Bailit HL: Clinical oral health status and adult perceptions of oral health. *Soc Sci Med Med Psychol Med Sociol* 14A: 597-605, 1980.
26. Beck JD, Slade GD: Epidemiology of periodontal diseases. *Curr Opin Periodontol* 3: 3-9, 1996.
27. Linden GJ, Lyons A, Scannapieco FA: Periodontal systemic associations: review of the evidence. *J Clin Periodontol* 40 Suppl 14: S8-S19, 2013.
28. Korean Ministry of Health and Welfare: National Health and Nutrition Examination 2010-2012. Retrieved August 25, 2016, from <https://knhanes.cdc.go.kr/knhanes/index.do> (2015, February 24).
29. Garcia RI, Henshaw MM, Krall EA: Relationship between periodontal disease and systemic health. *Periodontol* 2000 25: 21-36, 2001.
30. Watanabe K, Cho YD: Periodontal disease and metabolic syndrome: a qualitative critical review of their association. *Arch Oral Biol* 59: 855-870, 2014.
31. Heft MW, Gilbert GH, Shelton BJ, Duncan RP: Relationship of dental status, sociodemographic status, and oral symptoms to perceived need for dental care. *Community Dent Oral Epidemiol* 31: 351-360, 2003.
32. Locker D, Clarke M, Payne B: Self-perceived oral health status, psychological well-being, and life satisfaction in an older adult population. *J Dent Res* 79: 970-975, 2000.