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RESEARCH ARTICLE

Differences in Oral Health Status between Rural and Urban Populations of Korean Elders: A Population-Based Study from the Korean National Health and Nutrition Examination Survey VI (2013~2015)

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Background: Edentulism is associated with socioeconomic status, rural residence, and chronic disease, but no studies have investigated edentulism and residence factors together. All information that drives a better understanding of the factors related to edentulism plays an important role in the planning and delivery of appropriate dental services for the elderly by national and oral health professionals. This study was designed to investigate the prevalence of edentulism in adults aged over 60 years in Korea and to examine whether there are differences in dentate status between people living in urban and rural areas after controlling for sociodemographic and other related factors.

Methods: The data for this study were collected from 2013 to 2015 as part of the Korea National Health and Nutrition Examination Survey VI, those individuals aged over 60 years and who had complete datasets were included (5,071). The number of teeth and residence status were categorized into two groups: edentate and dentate (1 or more); urban and rural. Multiple multivariate logistic regression analyses were sequentially applied to assess the association between dentate status and residence status after adjusting for potential confounders.

Results: Rural areas, lower household income, and lower education levels were associated with a higher edentate rate. The number of teeth was lower in rural areas than in urban areas. After adjusting for various factors, statistically significant associations were present for women, low household income, low education level, poor perceived health status, and alcohol consumption in participants.

Conclusion: Elders living in rural areas had poorer oral health than elders living in urban areas. The government will need to provide effective systems for promoting oral health for elders living in rural areas.

Key Words: Aged, Oral health, Residence characteristics

Introduction

Edentulism is the loss of all of one's natural teeth. It is considered a poor health result for oral health as well as for systemic health and can significantly reduce the quality of life[1-3]. Many researchers have pointed out that edentulism can have serious negative effects on mental and physical health. In addition, previous studies have reported that tooth loss among patients without teeth is associated with behavioral changes due to lake of self-esteem, disliked appearance, intimate relationships and close relationships and loss of behavior[4]. Another study found that the greater the number of missing teeth, regardless of age, gender, or education, the more daily life met the reduced behavior[5].

The proportion of edentulism is decreasing as health concerns and policies are increasing worldwide. In 1976, 66% of people over 65 years old were dentulous, and in 1995, the prevalence had decreased to 42%[6]. In the US, edentulism among persons 45~54 years of age decreased from 20% in 1960~1962 to approximately 9% in 1988~

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1994. In 1999～2002, the Centers for Disease Control and Prevention (CDC) reported that 8% of US adults 20 years of age and older were completely edentulous[7,8]. However, a previous study on edentulism showed that the proportion of edentulous adults was reduced across the country, but in rural areas, the proportion of edentulous adults was higher and the rate of decline was slower than that of large cities[9]. The current oral disease patterns reflect the implementation of plans for improving life conditions, behavioral and environmental factors, oral health systems, and living conditions[10]. The biggest burden of oral disease is poor people worldwide. People living in rural areas can face many shortcomings associated with edentulousness. Nonmetropolitan populations are expected to be disadvantaged because of their low level of overall education, high poverty rates, high morbidity and mortality rates, and fewer dentists and other oral health professionals[11-13]. Not surprisingly, many of the rural dwellers have been found to be more condition than urban dwellers[14].

Analyzing the causes of loss of teeth by individual case is a complex and multifactorial process involving subjective factors and less important factors, such as cultural factors, sociocultural status, diagnoses, and ethnicity, as well as many objective data, such as tooth decay, periodontal disease, and trauma[15]. Edentulism is associated with socioeconomic status, rural residence, and chronic disease, but no studies have investigated these factors with edentulism together. All information that leads to better understanding of the factors associated with edentulism plays an important role in the planning and delivery of appropriate dental services for the rural area dwellers by national and oral health professionals[16].

Thus, this study was designed to investigate the prevalence of edentulism in adults aged over 60 years in Korea and to examine whether there are differences in dentate status between people living in urban and rural areas after controlling for sociodemographic and other related factors.

Materials and Methods

1. Sampling procedures

The data for this study were collected from 2013 to 2015 as part of the Korea National Health and Nutrition Examination Survey (KNHANES), which is periodically carried out by the Korean Centers for Disease Control and Prevention (KCDC). The sampling protocol included a complex, stratified, multistage, probability-based design with proportional allocation, as well as a cluster survey of a representative sample of the noninstitutionalized civilian population in Korea. The Korean Ministry of Health and Welfare performed the survey. The target population of the survey included all noninstitutionalized civilian Korean individuals aged 1 year or older. The 2005 National Census Registry randomly selected the participants from various geographic areas, ages, and gender groups.

The survey consisted of questions about overall health (household survey, health interview survey, and health behavior survey), a nutrition survey (dietary behavior, dietary supplements, nutrition knowledge, food intake, and food stability), and oral and health examinations (physical measurement, blood and urine tests, blood pressure and pulse measurements, pulmonary function tests, visual acuity and refraction tests, color vision tests, and hearing tests). Face-to-face interviews were performed using a structured questionnaire by trained interviewers. The health interviews and health examinations were conducted by trained medical professionals and interviewers, and the oral examinations were performed by dentists and medical professionals. Before participating in the study, all participants signed an informed consent form.

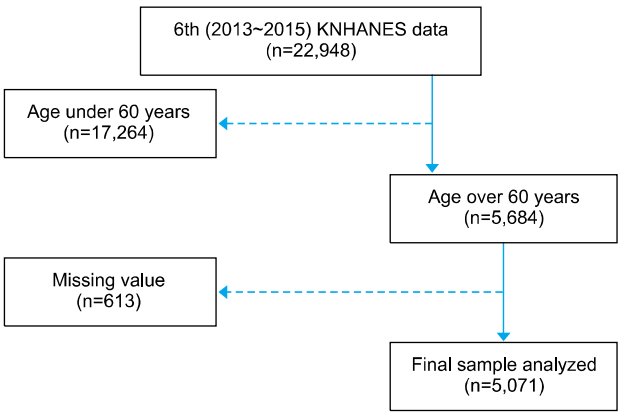

Fig. 1. Overview of the study samples. KNHANES: the Korea National Health and Nutrition Examination Survey.

2. Eligibility and exclusion criteria

Out of the 22,948 subjects who participated in the KNHANES, only those individuals aged over 60 years and who had complete datasets were included in this analysis. The final sample included 5,071 participants (2,194 men and 2,877 women). Detailed descriptions of the sampling methods and survey contents are described in previous studies (Fig. 1)[17-19].

3. Assessment of the number of teeth and categorization of edentate and dentate

Trained dentists conducted the oral examinations of the participants and recorded their oral health status. Missing teeth, impacted teeth or implants, and third molars were excluded when counting the number of teeth[20]. The number of teeth was categorized into two groups: edentate (0) and dentate (1 or more).

4. Classification of residence

The residence status was categorized into two groups: urban and rural. An area was classified as 'urban' if the population was over 50,000 in the administrative district, and an area was classified as 'rural' if the population was less than 50,000 in the administrative district.

5. Assessment of potential confounders

Information on sociodemographic factors, oral health status and behaviors, and general health status and behaviors was collected from the participants' responses to a standardized questionnaire through personal interviews. Participants were categorized into three age groups: 60～69, 70～79, and 80 years and over. Household income was the family income adjusted for the number of family members. It was categorized into quartiles: less than 25%, 25～50%, 50～75% and over 75%. The highest diploma earned was used to assess a participant's education level.

The general health behaviors and status information included hypertension, diabetes mellitus, perceived health status, smoking status, and alcohol consumption. Hypertension was defined as an average systolic blood pressure over 140 mmHg or diastolic blood pressure over 90 mmHg. Diabetes mellitus was defined as a fasting glucose level over 126 mg/dl. Participants were categorized as normal (body mass index [BMI], 18.5 to <25 kg/m^2), underweight (BMI <18.5 kg/m^2), or obese (BMI ≥ 25.0 kg/m^2)[21]. The self-reported perceived health status was divided into three categories: good, ordinary, and poor. Regarding smoking status and alcohol consumption, the subjects were divided into two groups: yes and no.

6. Statistical analysis

The integrated weights were calculated and applied when integrating data for each year from 2013 to 2015. All analytical procedures were performed in accordance with the Guidelines for the Use of KNHANES[22].

In the analysis, the outcome variable was dentate status, and the main explanatory variable was residence status. Statistically significant differences in the characteristics of participants' dentate status were examined using frequency chi-square tests. All data are presented as weighted percentages and standard errors.

Multiple multivariate logistic regression analyses were sequentially applied to assess the association between dentate status and residence status after adjusting for potential confounders. A multivariate logistic regression was used to compute unadjusted and adjusted odds ratios (AORs) and confidence intervals (CIs). The AORs, CIs, and trend p-values for multicategory variables were used. Subgroup analyses by age and gender were also performed to identify risk groups. All statistical analyses were performed using IBM SPSS Statistics for Windows/Macintosh, ver. 21.0 (IBM Corp., Armonk, NY, USA). Statistical significance was set at a value of $p<0.05$.

Results

Of the 5,071 participants, the prevalence of edentulism was estimated to be 14.9%. Tables 1 and 2 show the characteristics of the study participants according to the results of dentate status and residence status. As participants get older, the proportion of edentulism increases. Rural areas, lower household income, and lower education levels were associated with a higher edentate rate (rural residence: 34.5%, household income <25%: 56.0%, and primary school education level: 71.1%; data was now shown). The edentate rate was high when the perceived health status

Table 1. Characteristics of the Participants according to Dentate Status (n=5,071)

Variable	Total	Edentate (n=340)		Dentate (n=4,731)		p-value[b]
		n	% (95% CI)[a]	n	% (95% CI)[a]	
Age (y)						<0.001
60～69	2,642	76	2.7 (2.1～3.5)	2,566	97.3 (96.5～97.9)	
70～79	1,960	167	8.9 (7.4～10.6)	1,793	91.1 (89.4～92.6)	
80 and over	469	97	18.8 (15.3～22.9)	372	81.2 (77.1～84.7)	
Gender						0.132
Men	2,194	170	7.2 (6.1～8.5)	2,024	92.8 (91.5～93.9)	
Women	2,877	170	6.0 (5.0～7.1)	2,707	94.0 (92.9～95.0)	
Residence						<0.001
Urban	3,774	206	5.6 (4.8～6.6)	3,568	94.4 (93.4～95.2)	
Rural	1,297	134	9.3 (7.6～11.2)	1,163	90.7 (88.8～92.4)	
Household income (%)[c]						<0.001
<25	2,049	199	9.2 (7.8～11.0)	1,850	90.8 (89.0～92.2)	
25～50	1,415	76	5.5 (4.3～7.0)	1,339	94.5 (93.0～95.7)	
50～75	919	44	4.8 (3.4～6.7)	875	95.2 (93.3～96.6)	
>75	688	21	3.2 (2.0～4.9)	667	96.8 (95.1～98.0)	
Education level						<0.001
Primary school	2,874	242	8.2 (7.0～9.5)	2,632	91.8 (90.5～93.0)	
Middle school	748	31	4.8 (3.2～7.0)	717	95.2 (93.0～96.8)	
High school	945	51	4.9 (3.5～6.6)	894	95.1 (93.4～96.5)	
University or college	504	16	2.7 (1.6～4.6)	488	97.3 (95.4～98.4)	
Perceived health status						0.003
Good	1,153	67	5.1 (3.9～6.6)	1,086	94.9 (93.4～96.1)	
Ordinary	2,422	150	6.0 (4.9～7.2)	2,272	94.0 (92.8～95.1)	
Poor	1,496	123	8.5 (7.0～10.4)	1,373	91.5 (89.6～93.0)	
Smoking						<0.001
No	3,094	160	5.2 (4.3～6.3)	2,934	94.8 (93.7～95.7)	
Yes	1,977	180	8.5 (7.2～9.9)	1,797	91.5 (90.1～92.8)	
Alcohol consumption						0.001
No	1,216	105	8.9 (7.1～11.1)	1,111	91.1 (88.9～92.9)	
Yes	3,855	235	5.8 (5.0～6.6)	3,620	94.2 (93.4～95.0)	
Hypertension						0.805
No	2,519	168	6.4 (5.4～7.6)	2,351	93.6 (92.4～94.6)	
Yes	2,552	172	6.6 (5.6～7.8)	2,380	93.4 (92.2～94.4)	
Diabetes mellitus						0.299
No	4,056	262	6.3 (5.5～7.3)	3,794	93.7 (92.7～94.5)	
Yes	1,015	78	7.3 (5.7～9.4)	937	92.7 (90.6～94.3)	

[a]Weighted percent, 95% confidence interval (CI). [b]p-value obtained from chi-square test. [c]Monthly average household income ($\sqrt{}$: the number of household members).

was poor (8.5%) and when participants smoked (8.5%; $p<0.05$). Table 2 shows the number of teeth according to the residence area. Overall, the number of teeth was lower in rural areas than in urban areas. The lower the income level, the lower the education level, and as age increased, the number of teeth was lower in rural areas than in urban areas. When the subjective health status was poor and when the participants smoked and consumed alcohol, the number of teeth was lower in rural areas than in urban areas.

Compared with urban areas, the odds ratios for becoming edentulous when living in rural areas are shown in Table 3. Based on the results in Table 3, after adjusting for sociodemographic factors and general health and behavior status factors, statistically significant associations were present for women (AOR=2.1, 95% CI=1.42～3.09), low

Table 2. Number of Teeth Present in a Population Aged 60 Years and Older according to Residence, by Variable (n=5,071)

Variable	Urban (n=3,774)		Rural (n=1,297)		p-value
	Mean teeth present	(95% CI)	Mean teeth present	(95% CI)	
Age (y)					
60～69	20.54	20.00～21.08	20.11	19.25～20.97	0.08
70～79	17.07[a]	16.39～17.76	14.85	13.83～15.87	<0.001
80 and over	13.06[a]	11.80～14.31	10.28	8.49～12.06	0.301
Gender					
Men	16.97	16.18～17.76	16.05	14.99～17.09	0.025
Women	16.81	16.04～17.57	14.12	12.91～15.32	<0.001
Household income (%)[b]					
<25	15.86[a]	15.11～16.62	14.69	13.54～15.85	0.12
25～50	16.76[a]	15.95～17.57	14.58	13.20～15.95	0.14
50～75	16.88[a]	16.04～17.73	15.65	14.33～16.97	0.24
>75	18.04	17.23～18.86	15.38	13.37～17.40	0.01
Education level					
Primary school	15.80	15.10～16.50	13.45	12.41～14.49	<0.001
Middle school	16.23	15.30～17.16	15.11	13.59～16.64	0.29
High school	16.94	16.14～17.74	15.40	13.75～17.06	0.39
University or college	18.58	17.70～19.47	16.34	14.64～18.04	0.45
Perceived health status					
Good	17.32	16.54～18.10	15.17	13.99～16.35	0.03
Ordinary	16.78	16.09～17.47	15.25	14.11～16.40	<0.001
Poor	16.56	15.77～17.36	14.81	13.55～16.06	0.08
Smoking					
No	18.18	17.45～18.92	16.82	15.80～17.85	0.08
Yes	15.59[a]	14.82～16.37	13.33	12.06～14.60	<0.001
Alcohol consumption					
No	17.24	16.69～17.78	15.65	14.69～16.62	<0.001
Yes	16.54	15.69～17.39	14.50	13.29～15.71	0.06
Hypertension					
No	16.54	15.84～17.25	14.54	13.42～15.65	0.12
Yes	17.23[a]	16.60～17.87	15.62	14.59～16.64	<0.001
Diabetes mellitus					
No	17.43	16.83～18.02	15.46	14.56～16.34	0.47
Yes	16.35[a]	15.54～17.16	14.70	13.30～16.10	<0.001

Mean number of existing teeth, 95% confidence interval (CI), and p-value obtained from chi-square test.
The data were analyzed by the complex samples general linear model.
[a]Statistical significance test with, age: 60～69, gender: men, household income: >75%, education level: university, smoking, alcohol, hypertension, diabetes mellitus: no, perceived health status: good, at $p<0.05$. [b]Monthly average household income ($\sqrt{}$: the number of household members).

household income (AOR=1.5, 95% CI=1.02～2.20 for <25%, AOR=1.71, 95% CI=1.01～2.89 for 25～50%), low education level (AOR=1.81, 95% CI=1.30～2.52 for primary school), poor perceived health status (AOR=1.78, 95% CI=1.56～2.73 for ordinary, AOR=1.58, 95% CI=1.01～2.46 for poor), and alcohol consumption (AOR=1.72, 95% CI=0.27～2.33) in participants.

Discussion

Health inequalities mean differences, diversity and disparities in health outcomes between individuals and groups[10]. This health imbalance is an inevitable and unfair demographic health difference in terms of social justice, ethics and human rights[23]. While oral health has improved significantly over the past few decades, the social gradient

Table 3. Sociodemographic Characteristic Associated with Edentulism and Residence Status (Reference=Urban Area)

Variable	Adjusted odds ratio	95% confidence interval	p-value
	Rural		
Age (y)			
60~69	1.17	0.69～1.97	0.562
70~79	1.76	1.19～2.60	0.004
80 and over	1.35	0.80～2.28	0.256
Gender			
Men	1.37	0.95～1.96	0.091
Women	2.10	1.42～3.09	＜0.001
Household income (%)			
＜25	1.50	1.02～2.20	0.038
25~50	1.71	1.01～2.89	0.047
50~75	1.04	0.48～2.27	0.914
＞75	2.66	0.95～7.42	0.062
Education level			
Primary school	1.81	1.30～2.52	0.001
Middle school	0.52	0.20～1.33	0.172
High school	1.22	0.57～2.61	0.822
≥University or college	1.44	0.23～6.92	0.701
Perceived health status			
Good	1.69	0.95～3.00	0.072
Ordinary	1.78	1.56～2.73	0.009
Poor	1.58	1.01～2.46	0.043
Smoking			
No	2.12	1.24～3.18	＜0.001
Yes	1.40	0.97～2.01	0.071
Alcohol consumption			
No	1.64	0.99～2.70	0.051
Yes	1.72	0.27～2.33	0.001
Hypertension			
No	1.64	1.15～2.33	0.006
Yes	1.79	1.21～2.66	0.004
Diabetes mellitus			
No	1.33	0.71～2.61	0.345
Yes	1.87	1.35～2.50	＜0.001

Models were adjusted for age, gender, household income, education, perceived health status, smoking, alcohol consumption, hypertension, and diabetes mellitus except the stratum.
Determined by multivariate logistic regression.

of oral health stands out in the prevention and treatment of disease, and inequality still remains[24]. The greatest burden of oral disease worldwide appears in disadvantaged and poor populations[25]. There are significant differences in oral health service distribution, utilization and outcomes between developing and developed countries and urban and rural areas[26,27]. Thus, the results of this study show clear and distinct social gradient in clinical and subjective oral health indicators based on residence status after adjusting for age, gender, household income, education level, smoking status, alcohol consumption, hypertension, and diabetes mellitus. There are no reports on oral health behavior and the lack of social epidemiological data on oral disease in urban and rural areas. To the best of our knowledge, this study provides the first evidence to compare oral health status among urban and rural dwellers from a Korean population using a nationally representative data sample.

The reported prevalence of edentulism currently varies from country to country, ranging from 6% to 78% of the population[28]. According to the results of this study, 14.9% of elders over 60 years of age were edentate, which is a lower figure than that of a Spanish population survey (20.7%)[16] but higher than that of Chinese national data (8.64%)[29]. Many studies have identified a strong association between demographic and socioeconomic factors and edentulism[30-32]. The study also found age, residence area, education and economic level to be related to edentulism. The association between aging and increased tooth loss has been clearly demonstrated by previous studies. Our results agreed with this finding: as age increased, the proportion of edentate participants decreased significantly. As with other studies[31,33], high economic status and education level are inversely related to the likelihood of tooth loss. In this study, the proportion of edentulous people was higher when the residence area was rural, the economic level was low, and the education level was low. This can be explained by the lack of oral health knowledge and behavior as well as lack of access of these groups to dentistry. There was an important association between residence status and oral status, which may be partly due to the relative difficulty of rural residents in accessing dental care. Many systemic diseases have been reported to be associated with tooth loss[34-36]; our study showed similar results as previous studies. Several previous studies have shown that smokers lose more teeth than nonsmokers due to the adverse effects of tobacco on oral health and dental caries[32,33]. Our study also showed results consistent with previous studies. There was a significant increase in edentulous elders in the group that smoked compared to the group that did not smoke.

After adjusting for well-known potential confounders in the fully adjusted model, it showed a dose effect trend. In rural areas, when the prevalence odds ratio of edentulism is analyzed by socioeconomic status by adjusting all variables compared with urban areas, the odds ratios are more than twice as high for women. When the household income and education levels are low and when participants smoke and consume alcohol, a high prevalence odds ratio of edentulism is seen. These our knowledge, no other study results have been reported results similar to our results, so it is difficult to compare to this study. However, this edentulism prevalence odds ratio seems to be high because the elders in rural areas are vulnerable to various socioeconomic conditions.

Tooth loss is thought to be an early marker of decline and weakness[37]. Edentulism is independently associated with the onset of physical disability[38]. Complete tooth loss is associated with slower walking speeds and physical and cognitive decline in a previous study[37]. As a result, functional decline can cause difficulties in performing oral hygiene practices and using dental services; thus, the elderly may be at risk of dental disease and tooth loss. In addition, a decline in masticatory function due to a large amount of tooth loss can lead to poor nutrition, which can lead to systemic diseases such as diabetes, cardiovascular diseases and dementia[39]. It is extremely important to encourage preventive oral health services for elderly living in rural areas where health services are not available. Implementing appropriate dental services and national programs for these older people will help reduce edentulism. This is especially important in rural and remote areas to which dental professionals have limited access.

Some limitations should be considered when interpreting our findings. First, due to the restriction of the cross-sectional design, the causality of the association between oral health status and dwelling status is unclear. Second, among the survey methods used in this study, the questionnaire method was used, and the risk of recall bias could have occurred because the participants could have experienced memory errors.

Nevertheless, this study has several strengths. A large-scale nationally representative sample of the Korean population was used in this study. Moreover, the quality evaluation of all steps (data collection, data processing, survey administration, and laboratory analysis) of this sample was performed by the KCDC[22]. In addition, a trained dentist assessed periodontal and oral health status, and a professional examiner conducted and documented all general health screenings. In addition, it was uncertain whether socioeconomic status would affect oral health status. To overcome this limitation, we analyzed various adjustments in the logistic regression model. The current study results provide evidence for an association between residential area and socioeconomic status and oral health status in Korean elders.

This study was conducted to provide information on the oral health of urban and rural populations, and the results will help plan and evaluate the national oral health program. Elders living in rural areas had poorer oral health than elders living in urban areas. As a result, the government will need to provide effective systems for promoting oral health for elders living in rural areas. It will also be important to include oral care items in the various existing health services of each country. Of course, new precautionary policies for elders in rural areas are also important, but it government include oral care in existing health services, it will get good results. In addition, rural areas, where dental visit are not easy to visit, will need to visit health centers to promote health center-linked programs and make efforts for more effective oral care by expanding on-site oral health care programs.

Notes

Conflict of interest

No potential conflict of interest relevant to this article was reported.

Ethical approval

The sixth KNHANES was a cross-sectional survey conducted by the Korea Center for Disease Control and Prevention (KCDCP) from 2012 to 2015. The KNHANES was approved by the KCDC Institutional Review Board (2013-07CON-03-4C, 2013-12EXP-03-5C, and 2015-01-02-6C).

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