



The Association between Dental Implant Treatment Experience and Socioeconomic Factors in Korean Adults: A Cross-Sectional Survey Data Analysis

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Abstract

Background: We examined the Korean adults' experience with dental implants and analyzed its association with various socioeconomic factors.

Methods: This study was based on the participants enrolled in the 2013-2015 KNHANES. Using the variables associated with dental implant treatment experience and other socioeconomic factors, we evaluated the statistical significance and potential associations between the dental implant treatment experience and its related factors. The final analysis in this study was performed on adults aged 20 yr and over. It comprised 4,893 subjects in the year 2013, 4,431 subjects in 2014, and 4,430 subjects in 2015.

Results: An increasing number of individuals had reported undergoing dental implant treatment. An older age was associated with a higher likelihood of undergoing dental implant treatment, particularly in adults aged ≥ 40 years. Additionally, the likelihood was higher in individuals with a greater income level, low-level of educational background, and married status. Factors that were observed to influence dental implant treatment experience included age, education level, income level, marital status.

Conclusion: Our analysis confirmed the growing accessibility to dental implants among Korean adults and an association between dental implant treatment experience and socioeconomic factors. We recommend a healthcare policy on dental implants that considers relevant socioeconomic factors, in order to provide dental implant treatment to individuals who are in absolute need of treatment.

Keywords: Dental implant; Socioeconomic factors; South Korea

Introduction

The history of dental implant surgery in Korea starts in the early 1990s with the procedure be-

coming rapidly widespread in the 2000s. Along with Israel and Italy, Korea has one of the great-



est numbers of dental implants per 10,000 population (1). Teeth loss requires prosthetic treatments including fixed artificial dentures, partial or complete dentures, or dental implants to help patients recover dental functions. The Korea National Evidence-based healthcare Collaborating Agency reported an aging-associated increase in the need for dental implants and prosthetics (2).

While the need for dental prosthetics varies based on the location and the number of lost teeth, dental implants have the advantage of being independently placed without affecting adjacent teeth. Because it is difficult to care for removable and fixed partial prostheses in the area of tooth loss, about 74% of them require new treatment within 15 years (3). Pjetursson et al. found that more than 90% of patients who received dental implant treatments were satisfied with their functionality and aesthetics (4).

In Korea, dental implants were first included in the list of procedures covered by the National Health Insurance in July 2014. During the early stages, coverage was limited to elderly individuals (≥ 75 yr old), And, the scope of subjects gradually expanded to over 70 yr of age in 2015 and to over 65 yr of age in 2016 (5).

Socioeconomic inequality was a factor that influenced the experience of fixed and removable dental prosthetic treatment (6). Age, gender, degree of education, and income have been identified as factors influencing implant treatment decisions (7). The effectiveness of dental health insurance in Korea varies with age and income quintile (8).

The U.S. Medicare system provides health insurance coverage only for certain aspects of dental treatment for the elderly population aged ≥ 65 yr, and the majority of dental care services, including dental implants, are not covered. Thus, the majority of the elderly population in the U.S. relies on private insurance for these uninsured dental care services (9). Meanwhile, the U.K.'s National Health Service provides dental care services but does not include implants (10). Similarly, Japan's Social Health Insurance does not cover orthodontic treatment and dental implants (11). Thus, the coverage for dental implants available in Ko-

rea is a rather unusual practice with respect to the public health insurance programs across the world. Despite the fact that the National Health Insurance in Korea has allowed for remarkable expansion of the beneficiary group for dental implants, the vulnerable population who actually need dental implants, such as individuals with poor oral health and economic status, may not have adequate access to oral health management services because of the 30%-50% deductible payments and restrictions on coverage. Meanwhile, the increase in Korea's implant experience is corroborated by prior research (12,13). Nonetheless, there has been no attempt to examine the differences in the experience with dental implants vis-à-vis socioeconomic status or the association between dental implants and socioeconomic factors in the Korean adult population. This created a severe gap in the evidence supporting the assumption that the vulnerable population and elderly individuals still experienced disadvantages in insurance coverage for dental implants, and resolution of this inequality in oral health management remains elusive.

In Korea, the Ministry of Health and Welfare and the Korea Centers for Disease Control and Prevention (KCDC) annually perform the Korea National Health and Nutrition Examination Survey (KNHANES) to assess the health and nutritional status of the Korean population and produce statistical data for national health policies (14). KNHANES includes the data on the presence of dental implants confirmed via oral examination, along with data on various sociodemographic characteristics. Analysis using this database facilitated adequate assessment of the association between the dental implant treatment experience and socioeconomic factors in Korean adults.

Socioeconomic factors lead to differences in the degree of experience with dental implant treatment. Therefore, we aimed to reveal previously undefined baseline data regarding the correlation between dental implants and socioeconomic factors, in order to improve inequalities in the use of and access to health and medical services during dental implant treatments.

Methods

Data source and study population

The analysis in this study was based on the data obtained from 2013-2015 KNHANES. According to the protocol on data use, raw data were obtained from the KNHANES website. KNHANES, managed by KCDC, performs the assessment and provides the statistics on the participants' health conditions, including smoking and drinking status, physical activities, and obesity-related information, as requested by the WHO and Organization for Economic Cooperation and Development (OECD). Every year, 20 families from 192 districts are selected through random sampling, and approximately 10,000 individuals aged ≥ 1 year from these families are analyzed. The survey is further categorized into health examination, health-related questionnaire, and nutritional examination.

The final analysis in this study was performed on adults aged 20 yr or older who completed an oral examination, a health survey, and a nutrition survey. Moreover, among the total targets, non-response missing values for variables were excluded. Therefore, the sample size was 4,893 subjects in 2013, 4,431 subjects in 2014, and 4,430 subjects in 2015.

Calibration training

Dentists serving as oral epidemiologists undergo appropriate training to become specialists in an oral examination (public health dentistry) prior to participating in KNHANES. The kappa value, showing inter-observer agreement among the investigators who evaluated dental health, ranged from 0.81 to 0.98 (15-17). The kappa value is a statistical indicator measuring the degree of agreement between the two investigators. In the survey conducted by the investigator, the match is checked based on the Gold Standard.

Variable selection

The 6th oral examination survey was performed by the dentists serving as oral epidemiologists.

Oral examination was performed on subjects with dental implants/prosthetics aged one year or over. The examination findings included dental condition and need for treatment, prosthetic condition and the need for treatment, periodontal diseases status, and fluorosis

Patients' implant treatment experience was assessed through an oral examination. Before the examination was initiated, the patient was asked to answer the following questions in order to identify the presence of an implant: "Have you ever had an implant?" and "In which area of the jaw did you receive the implant treatment?" The answers to these questions were taken into consideration during the oral examination. The presence of an implant was assessed by dividing the pre-examination question results into that of the upper and lower jaw (18).

The variable implants status was coded as "zero" or "one or more" for maxillary and mandibular implants. This was recorded to generate the dependent variable implant treatment experience.

Furthermore, various socioeconomic factors including Gender(Male/Female), Age(20-39/40-59/60-79+), Area of residence(City, Rural), Education level(\leq Middle school/ High school/ \geq College), Income level(Low/ Low-Middle/ Middle-High/ High) Marital status(Married/ Unmarried), National health insurance status(National health insurance/ National medical care), Private health insurance status(Yes, No) and Occupation(Manager, professional workers/ Administrative workers/ Service and sales workers/ Workers in agriculture, fishery, and forestry/ Workers in machine-handling skills/ Labor workers/ Homemaker and Inoccupation) were selected as independent variables. Among the independent variables, national health insurance status was coded as "National health insurance" and "National medical care". In Korea, the beneficiaries of medical care usually comprise people in vulnerable groups.

Method of analysis

The 2013-2015 KNHANES data were analyzed using STATA 13.0, a statistical analysis software package. The Chi-Square test was performed to

evaluate if the association between dental implant treatment experience and its related factors was significant. Moreover, to examine further the association between dental implant treatment experience and socioeconomic factors and the effects of related factors in-depth, complex samples logistic regression analysis was performed. The analysis outcomes were shown using the odds ratio and 95% confidence interval.

Ethical review

We utilized data from the 6th (2013-2015) KNHANES, comprising of a series of surveys targeting human participants by the Korean government to promote public welfare. We thus obtained approval for this study from the Institutional Review Board (Approval No. 2013-07CON-03-4C, 2013-12EXP-03-5C).

Results

An increasing number of Korean adults reported a prior experience of undergoing dental implant treatment, with the proportion of individuals increasing from 9.9% in 2013 to 12.2% in 2014 and

13.3% in 2015. One of the variables that followed a similar trend in the 2013-2015 surveys was an age-associated increase in dental implant experience.

From the year 2013-2014, the rate of the dental implant treatment experience for patients in their 40s and 50s was twice that of those in their 20s and 30s. Patients in their 60s or older had three times higher dental implant treatment experience compared to those in their 20s and 30s. In 2015, the rate of treatment for patients in their 40s and 50s was three times higher than those in their 20s and 30s, while that of patients in their 60s and older was four times higher compared to those in their 20s and 30s. Furthermore, the dental implant treatment experience was more common in participants with greater income and lower education levels. Married participants were more likely to receive dental implants as compared to unmarried ones, and those with health insurance coverage were more likely to undergo dental implant treatment than those receiving medical care benefits (Table 1).

Table 1: The distribution of subjects who have experienced dental implant in 2013~2015 year

Classification	N	2013 year			N	2014 year			N	2015 year		
		N	Wt%†	P		N	Wt%†	P		N	Wt%†	P
Total	4,893	524	9.9		4,431	601	12.2		4,430	679	13.3	
Gender												
Male	2,069	251	11.0	*	1,827	258	12.8		1,912	291	12.7	
Female	2,824	273	8.8		2,604	343	11.7		2,518	388	13.9	
Age												
20~39age	1,440	76	5.1	***	1,225	78	6.4	***	1,110	66	5.6	***
40~59age	1,909	219	11.3		1,647	225	13.5		1,723	268	15.7	
60~79+age	1,544	229	15.5		1,559	298	19.9		1,597	345	21.0	
Area of residence												
City	3,914	415	9.7		3,600	499	12.5		3,590	555	13.3	
Rural	979	109	10.4		831	102	10.8		840	124	13.3	
Education level												
≤Middle school	1,679	188	11.0		1,557	217	13.9	*	1,545	262	16.2	**
High school	1,670	172	9.3		1,429	216	12.6		1,416	222	13.0	
≥College	1,544	164	9.6		1,445	168	10.8		1,469	195	11.6	
Income level												
Low	962	82	8.7	***	826	78	8.7	**	819	105	11.9	
Low-Middle	1,278	117	8.1		1,123	146	10.8		1,080	149	12.3	

Middle-High	1,264	134	9.0		1,272	185	13.0		1,215	197	13.0	
High	1,389	191	12.8		1,210	192	14.3		1,316	228	14.9	
Marital status												
Married	4,201	487	11.1	***	3,836	582	14.5	***	3,778	642	15.7	***
Unmarried	692	37	5.1		595	19	3.4		652	37	4.5	
National health insurance status												
National health insurance	4,727	520	10.1	**	4,275	593	12.4		4,261	670	13.6	**
National medical care	166	4	2.7		156	8	5.8		169	9	4.9	
Private health insurance status												
Yes	3,626	396	9.7		3,261	456	12.8		3,317	521	13.6	
No	1,267	128	10.4		1,170	145	9.9		1,113	158	12.3	
Occupation												
Manager, professional workers	607	70	10.5		581	58	9.5		602	73	10.0	*
Administrative workers	455	42	10.1		404	49	10.9		425	65	12.9	
Service and sales workers	640	72	10.5		542	75	12.3		525	68	11.9	
Workers in agriculture, fishery, and forestry	214	31	13.5		244	35	14.2		240	46	18.5	
Workers in machine-handling skills	485	55	11.1		412	51	11.9		425	67	14.6	
Labor workers	453	37	8.0		385	57	14.4		408	58	11.9	
Homemaker/ In-occupation	2,039	217	9.0		1,863	276	13.2		1,805	302	14.7	

* $P < 0.05$, ** $P < 0.01$, *** $P < 0.001$, † Weighted value

Table 2 shows the results of the complex samples logistic regression analysis that examined the associations between dental implant treatment experience in Korean adults and socioeconomic factors. In all surveys from 2013-2015, dental implant treatment experience became significantly more prevalent with an increase in age and higher household income, but this significance

was relatively weaker vis-à-vis education level. And, the difference in dental implant treatment experience narrowed slightly from 2014 to 2015 but remained statistically significant for the marital status. These findings suggested unequal access to dental implant treatments between different groups of the population (Table 2).

Table 2: Odds ratios of dental implant treatment experience among groups categorized by socio-economic factors

Classification	2013 year	2014 year	2015 year
	Odds Ratio (95% CI) †	Odds Ratio (95% CI) †	Odds Ratio (95% CI) †
Age			
20~39age	Ref. 1.000	Ref. 1.000	Ref. 1.000
40~59age	2.476(1.631-3.759)***	1.532(1.096-2.142)**	2.582(1.766-3.776)***
60~79+age	5.136(3.217- 8.199)***	3.603(2.499-5.195)***	4.737(3.099-7.240)***

Education level			
≤Middle school	0.692(0.496- 0.966)*	0.889(0.638-1.240)	0.819(0.601-1.116)
High school	0.889(0.675- 1.170)	1.203(0.911-1.590)	1.021(0.793-1.316)
≥College	Ref. 1.000	Ref. 1.000	Ref. 1.000
Income level			
Low	0.500(0.339-0.738) ***	0.343(0.227-0.518) ***	0.557(0.396-0.783) **
Low-Middle	0.572(0.426-0.769) ***	0.592(0.436-0.803) **	0.696(0.520-0.932) *
Middle-High	0.678(0.516-0.892) **	0.838(0.640-1.096)	0.871(0.672-1.128)
High	Ref. 1.000	Ref. 1.000	Ref. 1.000
Marital status			
Married	Ref. 1.000	Ref. 1.000	Ref. 1.000
Unmarried	0.879(0.524-1.472)	0.310(0.175-0.547) ***	0.550(0.342-0.884) *

* $P < 0.05$, ** $P < 0.01$, *** $P < 0.001$, †Adjusted for Gender, Age, Education level, Income level, Marital status, National health insurance status

Discussion

This analysis aimed at investigating potential associations between dental implant treatment experience and socioeconomic factors in the Korean adult population (≥ 20 yr old) using data from 2013-2015 KNHANES. Our study represents an attempt at providing evidence to better guide the insurance coverage policies for dental implants by analyzing the dental implant treatment experience and the socioeconomic status of Korean individuals who actually underwent dental implant procedures as observed in the KNHANES data.

The analysis demonstrates a steadily increasing proportion of Korean adults with dental implant experience, from 9.9% in 2013 to 12.2% in 2014 and 13.3% in 2015. While this upward trend can partly be attributed to the health insurance coverage for dental implant procedures applicable to the elderly population (≥ 70 yr old), the number of existing teeth was decreasing and the number of extracted teeth was increasing in the population. According to the KNHANES data, the average number of intact natural teeth in the elderly (≥ 65 yr old) Korean population remained steady at approximately 16 teeth in the last 6 yr (mean values in 2013: 16.8 in males and 16.1 in females) (19), but did not meet the standard of 21 natural teeth or more as outlined by WHO(20). On the other hand, the expansion of the dental implant market has probably contributed to the trends in dental care services. According to the market sta-

istics for dental implants published by the Korea Health Industry Development Institute, the annual average rate of growth of Korea's dental implant market has been about 12.9% in recent five years (2012–2016) (21). This rapid expansion of the dental implant market could be the cause of increased dental care due to a wider choice of material. Nonetheless, with the expansion of health insurance coverage, growth of the dental implant market, and rapid population aging, the demand for dental implants in Korea will continue to grow. Adults of the younger generation in their 20s and 30s have less dental implant experience, probably due to their relatively younger age and absence of symptoms of chronic dental diseases (i.e., periodontal diseases). However, the older generation (40-50s and 60-70s) is prone to dental diseases and changes (i.e., tooth loss) due to chronic periodontal diseases or accumulated dental diseases. A previous study (22) has reported a steady increase in outpatients presenting gingivitis and periodontal diseases associated with aging among individuals in their 40s to ≥ 80 s, with the level of this increase most remarkable in the 40s. These findings suggest that dental implant treatment experience is more in individuals aged ≥ 40 yr due to increased incidences of teeth loss. Therefore, it is crucial to identify the age group with greater demand for dental implants and adjust the age-related scope of health insurance coverage appropriately.

Individuals with greater household income were more likely to have undergone dental implant

treatment. This finding was confirmed in a previous study (23) that reported that individuals with greater level of income clearly exhibited more experiences of dental implant procedures. Moreover, the subjects with a lower level of education exhibited more instances of dental implants experience. In the elderly population, there were limits to cost and surgery intervention (24). A previous study (23) associated a higher likelihood of edentulism with a lower level of education, which supports our findings under the assumption that these individuals would require dental implants to replace lost teeth. Moreover, the higher the income level, the higher the use of implants by the elderly in Korea (25). The higher the socioeconomic level, the higher the prevalence of implants in American adults (26). In addition, tooth loss was more prevalent in socially and economically vulnerable people (27). From July 2018, the deductible payment rate for implants has been reduced to 30% (28). Although this change is a positive sign, without policies that consider socioeconomic factors, those individuals with the absolute need for dental implant treatment will probably still be denied treatment.

In Korea, particular efforts were made to reinforce the guarantee of providing prosthetic treatment for the elderly as a public service, in order to provide relief from their poverty problems and restore their oral function. According to the 2017 National Health and Nutrition Examination Survey, the rate of limited oral function among the elderly (aged 65 yr and older) was 45.8% and the rate of chewing discomfort was 42.9%, thereby constituting one in two affected patients (29). While the rate of oral health problems in the elderly is high, some of them are unable to receive essential dental services due to financial and policy issues (30).

As an active countermeasure against tooth loss in the elderly, national health insurance coverage for their dentures and implants was initiated in 2012 and 2014, respectively. However, this health insurance cover is applied uniformly without any differentiation based on socioeconomic characteristics. According to this study, it is necessary to review the policies that can benefit the elderly

population belonging to vulnerable groups in the lower socioeconomic demographic.

We observed differences in the dental implant treatment experience of participants of different socioeconomic statuses. Similar to our findings, socioeconomic factors have been confirmed by several previous studies as an important variable determining the utilization of dental care services (31,32). Additionally, while it was observed that the rate of implant treatment experience increases with age, socioeconomic factors should also be considered in order to enable universal access to medical care.

An in-depth discussion is necessary to address potential problems arising with a “one-size-fits-all” approach of insurance coverage for dental implant treatment, despite its aim of facilitating the recovery and rehabilitation of oral function in elderly individuals without considering their unique socioeconomic characteristics.

Due to the cross-sectional nature of this study and lack of information on the location of dental implants, in-depth analysis for different types of teeth could not be performed. Nevertheless, our study is meaningful in that it examines changes in the adult implant experience in Korea and identifies its relationship with socioeconomic factors. Further research is needed to examine the correlation between the implant experience and tooth incidence rates, and to identify the association between the implant experience and systemic disease-related factors. We recommend that future studies be conducted to assess the correlation between dental implant treatment experience and tooth extraction.

Conclusion

For dental implant insurance policy in South Korea to be beneficial for the majority of the population, it is important to understand the oral conditions of the beneficiaries more carefully and consider their socioeconomic factors. This is the starting point to move towards a well-designed policy.

Ethical considerations

Ethical issues (Including plagiarism, informed consent, misconduct, data fabrication and/or falsification, double publication and/or submission, redundancy, etc.) have been completely observed by the authors.

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Conflict of interest

The authors declare no conflict of interest.

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