



Original Article

# Study on characteristics and related factors related to dental implant and partial denture retention rate in the elderly

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## ABSTRACT

**Objectives:** This study aimed to compare the characteristics of partial dentures supported by dental implants and to analyze related factors to provide data. This data can serve as a basis for oral health-related insurance policies for the elderly. **Methods:** Using data from the 8th National Health and Nutrition Survey, we analyzed the data from 4,304 individuals aged  $\geq 65$  years. Based on the Andersen behavioral model, we set the antecedent, possible, and necessary factors as independent variables. We performed logistic regression analysis with dental implants and partial dentures as dependent variables. **Results:** Implant possession was affected by male sex, younger age, higher education, income levels, and healthy lifestyle habits. In contrast, partial denture possession was affected by older age, lower education and income levels, unhealthy lifestyle habits, and chewing discomfort. **Conclusions:** The factors affecting the possession rates of dental implants and partial dentures demonstrated opposite trends. Implants were more affected by health behaviors, whereas partial dentures were more affected by socioeconomic factors. Therefore, a policy to expand the dental coverage must establish a differentiated strategy that considers the characteristics of each type of prosthesis.

**Key Words:** Aged, Dental implants, Oral health, Partial denture, Socioeconomic factors

## Introduction

As the global population continues to age, the proportion of individuals aged 65 and over is rapidly increasing, projected to reach approximately 16% by 2050 [1]. This demographic shift is manifesting various social issues, particularly in the healthcare sector [2], with oral health among the elderly emerging as a significant concern [3]. Oral health is a crucial factor affecting the quality of life for seniors [4]; accumulated oral health issues can lead to tooth loss in old age, resulting in decreased masticatory ability, nutritional imbalance, and social isolation, which negatively impact the overall quality of life for the elderly [5]. Therefore, it is important to restore tooth loss at an appropriate time using fixed or removable dentures.

In response, the government began subsidizing complete dentures for those aged 75 and over with resin material in 2012, expanding eligibility to those aged 65 and over in 2016 and reducing personal costs to 30%, thereby increasing coverage [6]. However, in some cases, removable dentures may result in lower functionality and patient satisfaction, as they can cause poor support and pain [7]. This has led to growing demand and interest in dental implants, which can address and minimize these drawbacks. Consequently, the government has implemented various policies to address these oral health issues among the elderly [8,9], and in 2014, Korea became the first country to incorporate dental implants into its national health insurance. The implementation of

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dental implant coverage began in 2014 for those aged 75 and over with a 50% co-payment, expanded to include those aged 65 and over in 2016, and further reduced the co-payment to 30% in 2018, strengthening coverage incrementally [10]. As a result, the number of dental implant patients has increased approximately 33.6 times since the onset of insurance coverage in 2014 [11].

However, continuous reflection is necessary to determine whether this dental implant coverage aligns with the direction of health insurance aimed at ensuring universal health, and whether it is being adequately provided to the demographics in need. Choi et al. [12] analyzed socioeconomic levels based on the dental retention status of the elderly, confirming that poorer oral conditions were associated with lower economic levels. Thus, they argued that the provision of a maximum of two implants throughout a lifetime poses substantial limitations in improving oral health among vulnerable populations, suggesting the need for expanding the number of subsidies and eligible recipients. Additionally, Oh and Jin [13] found that patients with relatively higher social status were more likely to opt for implants when visiting dental clinics. Kang [14] conducted an analysis based on the socioeconomic factors affecting the use of dental implants among the elderly in our country, finding that the increase in single-person elderly households was associated with a decrease in the utilization of dental implant services. These findings from previous studies present significant implications regarding whether subsidized dental implants align with the minimum oral health needs of the elderly and whether medical resources are being distributed adequately. Therefore, continuous observation is needed to determine if the subsidy policy is being appropriately provided in alignment with policy directions, although such studies are currently lacking. Moreover, it is necessary to consider that oral health status and behaviors may differ according to gender among the elderly [15].

Consequently, this study aims to provide fundamental data that can serve as evidence for guiding oral health-related coverage policy directions for the elderly by comparing the characteristics of partial dentures, a similar subsidized prosthetic item, with dental implants according to gender, and by analyzing related factors.

## Methods

### 1. Study subjects

This study analyzed data using the raw data from the eighth National Health and Nutrition Examination Survey (2019-2021) conducted annually with approval from the Institutional Review Board of the Korea Centers for Disease Control and Prevention (IRB No. 2018-01-03-5C-A) to identify the status and related factors of dental implant possession among the elderly aged 65 and over. The sample for the eighth survey phase was stratified based on city/province, urban/rural areas, and housing types (general houses, apartments), with intrinsic stratification criteria like housing area ratio and household head's education level. The final survey areas were 192 for the first year, 180 for the second year, due to suspension from the COVID-19 pandemic, and 192 for the third. A total of 10,409 households participated, with 22,559 participants, showing a participation rate of 74.0%. For this study, 4,304 individuals aged 65 and above were selected as the final subjects to examine characteristics related to dental implant and partial denture possession, accounting for 23.8% of the entire survey population. Discrepancies in frequencies are due to missing data. This study was conducted with waiver approval from the Kyunghee University Institutional Review Board in 2021 (KHSIRB-21-337(EA)).

### 2. Study instruments

The study structured its variables based on Andersen's behavioral model, a representative model for healthcare service utilization, encompassing demographic, psychosocial, and socioeconomic perspectives [16]. This model consists of predisposing factors, enabling factors, and needs factors. Predisposing factors refer to demographic and sociological characteristics inherent to an individual, independent of personal intention. Enabling factors are means or abilities that facilitate the use of healthcare services, while needs factors are those that directly influence the use of healthcare services.

## 1) Independent variables

### (1) Predisposing factors

These include gender, age, and educational level. Age was reclassified from a continuous variable into categories: 65-69 years, 70-74 years, 75-79 years, and 80 years or older. Educational levels were re-categorized into completion of elementary school or less, and completion of middle school or higher.

### (2) Enabling factors

This was determined by income level. Income level was divided into five groups based on the average monthly household equivalent income: low, lower-middle, middle, upper-middle, and high.

### (3) Needs factors

These include the presence of chronic diseases, high-risk drinking, current smoking status, aerobic physical activity, brushing teeth at least twice a day, use of dental care services in the past year, self-reported chewing problem, and private health insurance enrollment. The presence of chronic diseases was classified based on the World Health Organization's International Statistical Classification of Diseases and Related Health Problems 10th Revision (ICD-10), categorizing individuals with hypertension, dyslipidemia, cardiovascular diseases (such as stroke, myocardial infarction, or angina), diabetes, renal failure, and obesity as having chronic diseases. High-risk drinking was classified as consuming an average of 7 or more drinks per session for men or 5 or more for women, with frequency twice a week or more. Smoking status was categorized based on having smoked 100 or more cigarettes in a lifetime and current smoking habits. Physical activity was classified by performing at least 2 hours and 30 minutes of moderate-intensity activities, or 1 hour and 15 minutes of vigorous-intensity activities weekly, or an equivalent mix of moderate and vigorous activities (considering 1 minute of vigorous activity as 2 minutes of moderate activity). Brushing teeth at least twice a day and having an oral examination in the past year were based on whether these practices were followed. Chewing problem was classified based on current issues with teeth, dentures, gums, or other oral problems. Lastly, private health insurance enrollment was classified based on whether one was enrolled in private health insurance.

## 2) Outcome variables

The dental implant retention rate among subjects aged 65 and above was calculated by determining the proportion possessing implant prosthetics in the upper or lower jaw. The partial denture retention rate was determined by calculating the proportion of those possessing only partial dentures in the upper or lower jaw or having both fixed and partial dentures.

## 3. Data analysis

### 1) Integrated weight calculation

The sample design of the raw data from the eighth National Health and Nutrition Examination Survey employed a two-stage stratified cluster sampling method, allowing for complex sample analysis techniques. In this process, during the preparation of the analysis plan file, the stratification variable within the planned variables utilized a 'variance estimation layer' that combined design layers for variance estimation purposes, along with the 'population aged 65 and over'. The cluster variable corresponded to the 'survey area', which was the primary extraction unit in the sample design. The weights were computed using the 'oral health survey integrated weight', which was calculated separately. Notably, considering that the second year of the eighth survey's raw data was interrupted due to COVID-19, resulting in data collection from only 180 out of 192 survey areas, proportional values were assigned according to the survey period of each year. After calculating the integration ratio, separate integrated weights were derived by multiplying the annual weights by the integration ratio.

## 2) Data analysis

To understand the characteristics of variables within Andersen's behavioral model for the participants, complex sample frequency analysis was conducted. To examine the associations between dental implant possession and the variables within Andersen's behavioral model, complex sample chi-square tests were performed. Additionally, to analyze the effects of individual factors in depth, complex sample logistic regression was conducted, distinguishing between the unadjusted model and the fully adjusted model. All analyses were performed using SPSS program (ver. 26.0; IBM Corp., Armonk, NY, USA), with statistical significance set at  $\alpha=0.05$ .

# Results

## 1. General characteristics of subjects aged 65 and over

A total of 4,304 participants were included in the study, with women making up 54.9% and men 45.1%. The largest age group was 65-69 years at 30.6%, while those aged 80 and over were the smallest at 19.5%. Educationally, 50.9% had completed elementary school or lower, and 49.1% had middle school or higher. Notably, 64.2% of men had middle school education or higher, while 63.9% of women had elementary school education or lower, indicating a significant gender disparity ( $p<0.001$ ). Income was evenly distributed across quintiles for all participants.

In health behaviors, a higher proportion of men displayed unhealthy habits, with high-risk drinking rates 16 times greater and smoking rates six times higher than women ( $p<0.001$ ). Conversely, women engaged in aerobic physical activity 10.0% more than men ( $p<0.001$ ). For oral health behaviors, women brushed their teeth at least twice a day more frequently ( $p<0.001$ ), but visited dental clinics less often ( $p<0.001$ ). Chewing problems were self-reported by 34.5% of participants, with women reporting these issues about 6.0% more than men. The enrollment rate for private health insurance was 52.7% <Table 1>.

**Table 1.** General characteristics of subjects aged 65 years or older

Variables	Division	Total			Male			Female		
		N	%	SE	N	%	SE	N	%	SE
Total	<i>p</i>	0.316								
		4,304	100.0	0.00	1,843	45.1	0.78	2,461	54.9	0.78
Age (yr)	<i>p</i>	<0.001								
	65-69	1,274	30.6	0.97	556	30.5	1.28	718	30.7	1.23
	70-74	1,227	29.2	0.81	546	30.0	1.23	681	28.5	1.11
	75-79	901	20.7	0.75	388	21.3	1.13	513	20.2	0.94
	≥80	902	19.5	0.81	353	18.2	1.03	549	20.6	1.02
Education level	<i>p</i>	<0.001								
	Elementary school	2,051	50.9	1.22	623	35.8	1.49	1,428	63.9	1.44
	Middle school	1,751	49.1	1.22	1,053	64.2	1.49	704	36.1	1.44
Household income	<i>p</i>	0.800								
	1st	869	20.0	0.89	378	20.7	1.21	491	19.4	0.98
	2nd	874	18.8	0.76	376	18.7	1.01	498	18.9	0.93
	3rd	849	19.4	0.73	361	19.5	1.00	488	19.2	0.90
	4th	844	20.1	0.85	360	19.9	1.22	484	20.3	0.97
	5th	831	21.8	1.03	359	21.2	1.27	472	22.3	1.17
Chronic diseases	<i>p</i>	<0.001								
	Yes	3,286	78.9	0.84	1,328	75.1	1.3	1,958	82.0	0.99
	No	862	21.0	0.84	440	24.9	1.3	422	18.0	0.99
High-risk drinking	<i>p</i>	<0.001								
	Yes	210	5.5	0.46	194	11.2	0.93	16	0.69	0.2
	No	4,018	94.5	0.46	1,632	88.8	0.93	2,386	99.31	0.2

**Table 1.** to be continued

Variables	Division	Total			Male			Female		
		N	%	SE	N	%	SE	N	%	SE
Current smoking	<i>p</i>	<0.001								
	Yes	394	10.2	0.64	328	18.6	1.14	66	3.08	0.5
	No	3,825	89.8	0.64	1,495	81.4	1.14	2,330	96.92	0.5
Aerobic physical activity	<i>p</i>	<0.001								
	No	2,607	68.0	0.93	1,071	64.0	1.28	1,536	71.44	1.2
	Yes	1,195	32.0	0.93	603	36.0	1.28	592	28.56	1.2
Tooth brushing per day	<i>p</i>	<0.001								
	Less than twice	543	13.2	0.68	322	18.0	1.05	221	9.30	0.8
	Twice and more	3,498	86.8	0.68	1,408	82.0	1.05	2,090	90.70	0.8
Dental care service use	<i>p</i>	<0.001								
	No	1,671	38.4	0.98	655	34.8	1.36	1,016	41.36	1.3
	Yes	2,543	61.6	0.98	1,165	65.2	1.36	1,378	58.64	1.3
Chewing problem	<i>p</i>	<0.001								
	Yes	1,494	34.5	0.93	589	31.2	1.28	905	37.28	1.1
	No	2,723	65.5	0.93	1,233	68.8	1.28	1,490	62.72	1.1
Private health insurance	<i>p</i>	0.256								
	Yes	2,161	52.7	1.14	933	51.7	1.48	1,228	53.51	1.3
	No	2,094	47.3	1.14	895	48.4	1.48	1,199	46.49	1.3

The data were tested by complex sample frequency analysis and chi-square test.

## 2. Dental implant and partial denture retention rates

The retention rate for dental implants among participants was 38.7%, while that for partial dentures was 24.0%, highlighting that implant retention was approximately 10.0% higher <Table 2>. Men had a slightly higher retention rate for implants ( $p=0.007$ ), whereas no gender difference was observed for partial dentures. In terms of age, the highest implant retention was seen in the 65-69 age group at 43.9%, while the 80 and over group had the highest rate for partial dentures at 38.4%, illustrating opposing trends ( $p<0.001$ ). Education levels showed that individuals with middle school education or higher had a retention rate for implants about 10.0% greater than those who completed elementary school or less. Conversely, partial denture retention was higher among those with elementary school education or less, reflecting similar opposing patterns as with age.

Regarding income, implant retention increased with higher income quintiles ( $p<0.001$ ). Specifically, among women, the retention rate was 19.2% greater in the high-income group versus the low-income group, demonstrating a larger disparity than the 10.2% seen in men ( $p<0.001$ ). For partial dentures, a higher retention rate was present in women with lower income ( $p=0.019$ ).

In health behaviors, women without chronic diseases had an 8.0% higher retention rate for implants compared to those with chronic conditions ( $p=0.018$ ). Regarding oral health practices, those who brushed twice daily had a 13.0% higher retention rate for implants. Regular dental clinic visits in the past year were associated with a 25.0% higher rate, while those without chewing problems had a 14.4% higher rate, and participants with private insurance had a 14.0% higher retention rate ( $p<0.001$ ). For partial dentures, individuals who had not visited a dental clinic in the past year or experienced chewing problems exhibited higher retention rates (approximately 4.0% and 15.6%, respectively), as did those without private insurance (9.8% higher), showcasing contrasting characteristics compared to implants ( $p<0.001$ ).

Though patterns in oral health behaviors were generally consistent across genders, specific characteristics related to brushing twice daily and dental clinic utilization revealed some differences. For brushing, only women showed a significant difference, with those not practicing this behavior having an 8.6% higher rate ( $p=0.032$ ). Overall differences in clinic utilization were noted, but gender-specific variations were not found.

**Table 2.** Dental implant and partial denture retention rate among subjects aged 65 years or older

Variables	Total						Male						Female										
	N		DI†		PD*		N		DI		PD		N		DI		PD						
	N	%	SE	%	SE	%	N	%	SE	%	SE	%	N	%	SE	%	SE	%					
Total	4,304	1,564	0.007	38.68	1.04	0.012	23.97	0.82	1,843	709	40.99	1.35	436	22.55	1.23	2,461	855	36.78	1.25	618	25.14	1.04	
Predisposing factor																							
Age (yr)																							
≥80	902	188	22.38	1.86	336	38.38	1.98	353	89	27.88	2.93	141	40.28	3.09	549	99	18.38	1.99	18.38	1.99	195	36.99	2.37
75-79	901	328	39.28	1.95	254	27.37	1.70	388	149	41.27	2.88	107	25.74	2.51	513	173	37.56	2.63	37.56	2.63	147	28.79	2.37
70-74	1,227	514	43.67	1.75	271	22.08	1.34	546	231	45.94	2.58	114	19.92	1.95	681	283	41.70	2.19	41.70	2.19	157	23.94	1.86
65-69	1,274	534	43.92	1.64	193	14.30	1.16	556	240	43.76	2.46	74	12.33	1.62	718	294	44.05	2.13	44.05	2.13	119	15.91	1.66
Education level																							
Elementary school	2,051	670	34.67	1.30	296	16.53	1.07	623	216	37.75	2.42	191	29.34	2.38	1,428	454	33.18	1.45	33.18	1.45	398	28.00	1.46
Middle school	1,757	781	46.12	1.56	589	28.44	1.24	1,053	461	45.73	1.81	188	16.98	1.32	704	320	46.72	2.33	46.72	2.33	108	15.83	1.68
Enabling factor																							
Household income																							
1st	869	255	31.03	2.03	232	25.47	1.80	378	122	35.94	3.20	94	21.19	2.35	491	133	26.69	2.48	26.69	2.48	138	29.27	2.61
2nd	874	273	32.99	1.93	245	27.25	1.74	376	116	34.12	3.02	103	24.99	2.81	498	157	32.06	2.49	32.06	2.49	142	29.10	2.34
3rd	849	316	41.02	2.02	210	24.22	1.79	361	149	44.04	2.92	89	25.41	2.67	488	167	38.49	2.47	38.49	2.47	121	23.21	2.12
4th	844	346	42.26	2.02	198	22.61	1.61	360	156	44.59	2.95	77	20.63	2.37	484	190	40.19	2.38	40.19	2.38	121	24.21	2.08
5th	831	367	46.00	2.04	157	20.61	1.66	359	164	46.14	2.92	71	21.10	2.55	472	203	45.88	2.72	45.88	2.72	86	20.22	2.28
Needs factor																							
Chronic diseases																							
Yes	3,286	1,196	38.76	1.09	796	23.66	0.95	1,328	531	42.78	1.55	306	21.83	1.39	1,958	665	35.75	1.34	35.75	1.34	490	25.04	1.19
No	862	332	40.92	2.24	210	24.11	1.79	440	162	38.47	2.75	107	23.87	2.59	422	170	43.68	3.19	43.68	3.19	103	24.38	2.51
High-risk drinking																							
Yes	210	90	43.07	3.92	53	24.17	3.39	194	83	42.91	4.16	46	23.20	3.63	16	7	45.29	11.49	45.29	11.49	7	37.22	13.10
No	4,018	1,463	38.76	1.07	973	23.63	0.83	1,632	624	41.00	1.43	384	22.32	1.28	2,386	839	37.08	1.27	37.08	1.27	589	24.61	1.05
Current smoking																							
Yes	394	123	34.90	3.40	109	25.12	2.54	328	106	35.30	3.35	85	23.09	2.71	66	17	32.93	7.85	32.93	7.85	24	35.37	7.22
No	3,825	1,430	39.58	1.08	917	23.59	0.82	1,495	601	42.65	1.45	345	22.31	1.31	2,330	829	37.43	1.28	37.43	1.28	572	24.48	1.04
Aerobic physical activity																							
No	2,607	934	38.56	1.29	638	23.72	0.98	1,071	410	42.26	1.79	255	22.28	1.53	1,536	524	35.71	1.57	35.71	1.57	383	24.84	1.31
Yes	1,195	514	44.04	1.85	246	20.07	1.43	603	265	43.92	2.43	124	19.77	1.93	592	249	44.18	2.52	44.18	2.52	122	20.39	2.05
Tooth brushing per day																							
No	543	149	28.96	2.29	138	25.08	2.34	322	101	32.67	3.02	74	20.42	2.50	221	48	23.06	3.10	23.06	3.10	64	32.50	4.45
Yes	3,498	1,384	41.98	1.14	836	23.18	0.86	1,408	594	44.82	1.57	326	22.17	1.42	2,090	790	39.87	1.35	39.87	1.35	510	23.93	1.06
Dental care service use																							
No	1,671	368	23.73	1.39	445	26.21	1.29	655	137	22.65	2.04	173	25.21	2.13	1,016	231	24.48	1.79	24.48	1.79	272	26.90	1.66
Yes	2,543	1,185	48.73	1.29	579	22.18	1.00	1,165	570	51.28	1.69	256	20.93	1.45	1,378	615	46.36	1.65	46.36	1.65	323	23.33	1.34
Chewing problem																							
Yes	1,494	421	29.72	1.52	500	33.96	1.43	589	166	30.77	2.23	199	33.14	2.24	905	255	28.99	1.86	28.99	1.86	301	34.52	1.86
No	2,723	1,132	44.07	1.20	526	18.37	0.87	1,233	541	46.07	1.60	231	17.61	1.32	1,490	591	42.24	1.54	42.24	1.54	295	19.07	1.12
Private health insurance																							
Yes	2,161	939	45.44	1.43	430	19.30	1.00	933	428	48.22	1.97	174	17.49	1.37	1,228	511	43.22	1.72	43.22	1.72	256	20.74	1.42
No	2,094	613	31.41	1.31	608	29.06	1.23	895	276	33.38	1.75	257	27.91	1.89	1,199	337	29.71	1.68	29.71	1.68	351	30.06	1.51

The data were tested by complex sample chi-square test.

† DI: Dental implant, \* PD: Partial denture

### 3. Analysis of factors influencing dental implant retention rates

Logistic regression analysis was conducted on individual factors according to Andersen's behavioral model <Table 3>. The results indicated that the retention rate for dental implants was higher among men, younger individuals, and those with higher educational attainment ( $p<0.05$ ). Notably, age had the most significant impact on retention rates; compared to individuals aged 80 and over, younger age groups were approximately twice as likely to possess dental implants ( $p<0.001$ ). Higher income levels also correlated with greater retention rates. In terms of needs factors, individuals without chronic diseases, those who engaged in aerobic physical activity, brushed their teeth at least twice a day, visited dental clinics in the past year, reported no chewing problems, or had private insurance were more likely to retain dental implants ( $p<0.01$ ). Specifically, those who utilized dental services exhibited nearly three times the likelihood of having implants ( $p<0.001$ ).

In Model 1, which considered only predisposing factors, younger age and higher education levels were associated with increased dental implant retention ( $p<0.001$ ). Model 2, which included both predisposing and enabling factors, revealed that lower age, higher education, and income levels were associated with greater likelihoods of retaining dental implants; however, the influence of education tended to decrease due to the impact of income ( $p=0.049$ ). Finally, Model 3, which encompassed all factors including needs factors, showed that lower age, higher education and income levels, brushing teeth at least twice a day, utilizing dental clinics in the past year, having no chewing problems, and having private insurance all significantly increased the likelihood of retaining dental implants ( $p<0.05$ ). Especially, those who visited dental clinics were nearly three times more likely to have implants. The Nagelkerke  $R^2$  value for Model 3 was 0.145, indicating that this regression model could explain 14.5% of the variability in dental implant retention rates.

### 4. Analysis of factors influencing partial denture retention rates

Logistic regression analysis was performed on individual factors according to Andersen's behavioral model <Table 4>. The results indicated that retention rates for partial dentures were higher among older individuals and those with lower educational attainment ( $p<0.001$ ). Age exerted the most significant impact; retention probability increased with age, showing higher rates for those above 65-69 years ( $p<0.001$ ). Lower income levels also correlated with increased retention rates. Regarding needs factors, individuals who did not engage in aerobic physical activity, failed to visit dental clinics in the past year, experienced chewing problems, or lacked private insurance were more likely to retain partial dentures ( $p<0.05$ ). Notably, the probability of retention was approximately 2.2 times higher among those with chewing problems ( $p<0.001$ ).

In Model 1, which considered only predisposing factors, higher age and lower education levels were associated with greater partial denture retention ( $p<0.001$ ). Model 2, which included both predisposing and enabling factors, reinforced these results, showing that higher age and lower education levels were associated with increased likelihoods of retaining partial dentures ( $p<0.001$ ). Finally, in Model 3, which encompassed all factors including needs factors, higher age, lower education levels, and the presence of chewing problems were associated with higher retention probabilities ( $p<0.001$ ). Specifically, individuals aged 80 and over were nearly three times as likely to have partial dentures compared to those aged 65-69. The Nagelkerke  $R^2$  value for Model 3 was 0.105, indicating that this regression model could explain 10.5% of the variability in partial denture retention rates.

**Table 3.** Factors affecting dental implant retention rate (unadjusted, model 1, 2, 3)

Variables (Reference)	Unadjusted			Fully adjusted		
	OR	(95% CI)	<i>p</i> *	OR	(95% CI)	<i>p</i> *
<b>Predisposing factor</b>						
Sex (ref. female)	1.00			1.00		
Male	1.19	(1.05-1.36)	0.007	1.09	(0.94-1.28)	0.255
Age (≥80)	1.00			1.00		
75-79	2.24	(1.73-2.91)	<0.001	1.95	(1.48-2.57)	<0.001
70-74	2.69	(2.09-3.46)	<0.001	2.10	(1.60-2.28)	<0.001
65-69	2.72	(2.13-3.46)	<0.001	2.04	(1.57-2.66)	<0.001
Education level (ref. elementary school)	1.00			1.00		
Middle school	1.61	(1.39-1.88)	0.001	1.48	(1.25-1.75)	<0.001
<b>Enabling factor</b>						
Household income (ref. 1st)	1.00			1.00		
2nd	1.09	(0.87-1.38)	0.439	1.04	(0.80-1.34)	0.771
3rd	1.55	(1.22-1.96)	<0.001	1.48	(1.13-1.92)	0.004
4th	1.62	(1.26-2.08)	<0.001	1.48	(1.12-1.95)	0.006
5th	1.89	(1.49-2.41)	<0.001	1.66	(1.26-2.18)	<0.001
<b>Needs factor</b>						
Chronic Diseases (ref. yes)	1.00			1.00		
No	1.15	(1.00-1.33)	0.047	1.02	(0.84-1.24)	0.875
High-risk drinking (ref. yes)	1.00			1.00		
No	0.84	(0.61-1.15)	0.269	0.79	(0.55-1.13)	0.189
Current smoking (ref. yes)	1.00			1.00		
No	1.22	(0.91-1.65)	0.191	1.11	(0.77-1.60)	0.577
Aerobic physical activity (ref. no)	1.00			1.00		
Yes	1.25	(1.06-1.49)	0.009	1.05	(0.88-1.26)	0.567
Tooth brushing per day (ref. less than twice)	1.00			1.00		
More than twice	2.19	(1.77-2.71)	<0.001	1.60	(1.25-2.05)	<0.001
Dental care service use (ref. no)	1.00			1.00		
Yes	3.06	(2.58-3.63)	<0.001	2.89	(2.39-3.49)	<0.001
Chewing problem (ref. yes)	1.00			1.00		
No	1.86	(1.59-2.18)	<0.001	1.61	(1.36-1.91)	<0.001
Private health insurance (ref. no)	1.00			1.00		
Yes	1.82	(1.55-2.13)	<0.001	1.26	(1.03-1.55)	0.028
Nagelkerke R <sup>2</sup>				0.038		0.050

\*by complex sample logistic regression



**Table 4.** Factors affecting the retention rate of partial dentures (unadjusted, model 1, 2, 3)

Variables (Reference)	Unadjusted			Fully adjusted		
	OR	(95% CI)	p*	OR	(95% CI)	p*
	Model 1			Model 2		
	OR	(95% CI)	p*	OR	(95% CI)	p*
<b>Predisposing factor</b>						
Sex (ref. female)	1.00			1.00		
Male	0.87	(0.73-1.03)	0.102	1.03	(0.84-1.27)	0.757
Age (ref. 65-69)	1.00			1.00		
70-74	1.70	(1.33-2.17)	<0.001	1.57	(1.22-2.02)	<0.001
75-79	2.26	(1.77-2.88)	<0.001	1.94	(1.50-2.51)	<0.001
≥80	3.73	(2.92-4.77)	<0.001	3.43	(2.63-4.46)	<0.001
Education level (ref. middle school)	1.00			1.00		
Elementary school	2.01	(1.64-2.45)	<0.001	1.77	(1.42-2.19)	<0.001
<b>Enabling factor</b>						
Household income (ref. 5th)	1.00			1.00		
4th	1.13	(0.86-1.48)	0.398	1.08	(0.80-1.45)	0.616
3rd	1.23	(0.93-1.63)	0.148	1.10	(0.81-1.49)	0.558
2nd	1.44	(1.12-1.86)	0.004	1.20	(0.90-1.59)	0.207
1st	1.32	(1.01-1.72)	0.044	1.18	(0.88-1.59)	0.274
<b>Needs factor</b>						
Chronic diseases (ref. no)	1.00			1.00		
Yes	0.98	(0.78-1.22)	0.829	0.83	(0.66-1.04)	0.104
High-risk drinking (ref. no)	1.00			1.00		
Yes	1.03	(0.71-1.49)	0.875	1.38	(0.90-2.10)	0.140
Current smoking (ref. no)	1.00			1.00		
Yes	1.09	(0.83-1.42)	0.546	1.09	(0.80-1.50)	0.575
Aerobic physical activity (ref. yes)	1.00			1.00		
No	1.24	(1.02-1.51)	0.034	0.99	(0.80-1.22)	0.924
Tooth brushing per day (ref. more than twice)	1.00			1.00		
No	1.20	(0.96-1.49)	0.102	0.88	(0.66-1.17)	0.371
Dental care service use (ref. yes)	1.00			1.00		
No	1.25	(1.05-1.48)	0.011	1.15	(0.95-1.40)	0.214
Chewing problem (ref. no)	1.00			1.00		
Yes	2.29	(1.94-2.69)	<0.001	1.98	(1.65-2.38)	<0.001
Private health insurance (ref. yes)	1.00			1.00		
No	1.71	(1.45-2.03)	<0.001	1.08	(0.88-1.32)	0.485
Nagelkerke R <sup>2</sup>			0.076			0.105

\*by complex sample logistic regression

## Discussion

The aging population worldwide has brought universal health coverage for maintaining a healthy old age to the forefront of discussions. In South Korea, rapid aging has expanded the scope of health coverage, and in 2014, dental implants became the first procedure to be covered by health insurance globally. Consequently, the number of dental implant patients has been increasing rapidly each year; however, research on the characteristics of dental implants remains limited. Therefore, this study aimed to assess the status of dental implant retention, including covered and non-covered procedures, and to explore its characteristics by comparing it with partially covered prosthetic items like partial dentures.

The overall retention rate for dental implants among participants was 38.7%. Higher retention rates were associated with being male, younger age, and higher levels of education and income. This finding aligns with previous studies indicating that dental implants, as a relatively costly treatment, are more likely to be received by individuals from middle and higher socioeconomic backgrounds [13]. Furthermore, better oral health behaviors correlated with higher implant retention rates; previous research [17] suggested that good oral hygiene increases concern for oral health, leading to a greater willingness to restore lost teeth, resulting in higher implant retention rates. The cumulative model results according to the Andersen model also indicated a decline in the influence of predisposing and enabling factors once needs factors were incorporated, suggesting that behavioral characteristics strongly affected implant retention rates. Notably, those who visited dental clinics were about three times more likely to have implants, confirming it as the most significant influence among all variables. According to prior studies, many people seek dental care only when symptoms occur [18], indicating that dental visits likely lead to treatment, thereby positively impacting implant retention. Furthermore, individuals with more severe health issues are often those who visit clinics, which increases the likelihood of receiving implants after extractions. Indeed, patients with periodontal disease are reported to be approximately eight times more likely to qualify for implant treatment [17]. Additionally, over 30% of implant patients cited recommendations from peers as their reason for undergoing surgery, with more than one-third of these recommendations coming from dental professionals. Frequent dental visits may increase the likelihood of receiving advice about implant procedures [19].

On the other hand, the overall retention rate for partial dentures among participants was 24.0%. This rate was higher among older individuals and those with lower educational levels. Specifically, among women, lower income levels were associated with higher retention rates, likely because older women experience higher tooth loss due to poor oral health [20,21], leading to a greater likelihood of choosing partial dentures when multiple teeth are lost. Also, those who did not brush their teeth at least twice a day showed a 7.5% higher retention rate. This may reflect the fact that increasing age often leads to tooth loss due to periodontal disease [22], and when combined with unhealthy behaviors, the retention rate for partial dentures was higher in older women. In the cumulative model according to the Andersen model, a greater gap was observed in retention rates influenced by predisposing and enabling factors compared to needs factors. This indicates that socioeconomic factors strongly influence retention rates for partial dentures, particularly as age increases, with older individuals being nearly three times more likely to retain partial dentures. Research indicates that as seniors age, they lose more permanent teeth, leading to increased need for prosthetics [23]. According to the Health Insurance Review and Assessment Service, the 60-69 age group utilizes dental implants the most, while the 75-79 age group shows higher usage of dentures, aligning with these findings [24].

The limitations of this study and suggestions for future research are as follows. First, the data analyzed in this study are cross-sectional, making it challenging to establish causal relationships. Future studies should consider designing longitudinal research to identify related factors and ascertain causal relationships. Second, while this study compared characteristics of dental implants with partially covered prosthetic items, the considerations for dental implants and partial dentures may differ depending on the location and condition of the defect, patient preferences, and the patient's situation at that moment, necessitating caution in interpretation. Despite these limitations, this study is significant as it analyzed representative data at a national level to identify the characteristics of dental implant and partial denture retention and to comprehensively understand related influencing factors.

## Conclusions

This study analyzed the status of dental implant and partial denture retention among individuals aged 65 and over, using raw data from the eighth National Health and Nutrition Examination Survey (2019-2021), and reached the following conclusions:

1. The analysis of dental implant retention rates among participants aged 65 and over showed that higher rates were associated with being male, younger age, higher education and income levels, and healthier behaviors.
2. The analysis of partial denture retention rates indicated that higher retention was linked to older age, lower education levels, and the presence of chewing discomfort.
3. For dental implants, the influencing factors were primarily associated with enabling factors such as income levels and behavioral needs, while for partial dentures, the disparity was more significantly affected by predisposing socioeconomic factors.

Based on these results, it can be observed that factors influencing dental implant and partial denture retention among individuals aged 65 and over are inversely related. Specifically, dental implant retention is more strongly impacted by health-related behavioral characteristics than socioeconomic factors, whereas partial denture retention is more influenced by seniors' socioeconomic factors. Therefore, in future discussions on expanding dental coverage, it is essential to consider these characteristics to conduct a multifaceted review of the current policies related to implants and dentures.

## Notes

### Author Contributions

Conceptualization: YK Choi, HA Park; Data collection: HA Park; Formal analysis: HA Park; Writing-original draft: YK Choi, HA Park; Writing-review&editing: YK Choi, HA Park

### Conflicts of Interest

The authors declared no conflicts of interest.

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### Ethical Statement

This study was approved by the Institutional Review Board (IRB) of the Kyunghee University (IRB No. KHSIRB-21-337(EA)).

### Data Availability

Data can be obtained from the corresponding author.

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# 65세 이상 노인의 임플란트 및 국소의치 보유율에 따른 특성 및 관련 요인 비교

## 초록

**연구목적:** 본 연구는 치과 임플란트와 국소의치의 특성을 비교하고 관련 요인을 분석하여 노인의 구강 건강 관련 보험 정책의 기초로 활용하고자 하였다. **연구방법:** 제8차 국민건강영양조사 데이터를 이용하여 65세 이상 4,304명의 데이터를 분석하였다. Andersen 행동 모델을 기반으로 선행 요인, 가능한 요인, 필요 요인을 독립 변수로 설정하였으며, 치과 임플란트와 국소 의치를 종속 변수로 하여 로지스틱 회귀분석을 실시하였다. **연구결과:** 치과 임플란트 보유는 남성, 낮은 연령, 높은 교육 수준, 소득 수준 및 건강한 생활 습관에 의해 영향을 받았다. 반면 국소 의치 보유는 높은 연령, 낮은 교육 및 소득 수준, 건강하지 않은 생활 습관, 저작 불편에 의해 영향을 받았다. **결론:** 치과 임플란트와 국소 의치의 보유율에 영향을 미치는 요인은 서로 반대되는 경향이 보였다. 임플란트의 경우 건강한 행태에 더 많은 영향을 받았고, 국소 의치는 사회경제적 요인에 더 많은 영향을 받았다. 따라서 치과 보장성 확대를 위한 정책은 각 보철물 유형의 특성을 고려하여 차별화된 전략으로 수립되어야 한다.

**색인:** 노인, 임플란트, 구강 건강, 부분 틀니, 사회경제적 요인