

The Effect of Depression and Cognitive Function on the Geriatric Oral Health Assessment Index in the Elderly

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Background: Depression and cognitive function have a positive effect on the improvement of quality of life and extension of lifespan in the elderly. In addition, it appears as a major factor influencing oral health status. Therefore, this study looked at the relationship between the Geriatric Oral Health Assessment Index (GOHAI), depression, and cognitive function in the elderly using the Korea Longitudinal Study of Aging.

Methods: In this study, 4,535 elderly people aged 65 years and over were targeted using the 7th data of the 2018 Korea Longitudinal Study of Aging. A t-test and ANOVA analysis were performed to compare GOHAI, depression, and cognitive function by group. In addition, hierarchical multiple linear regression was performed to understand the effect of the elderly's perceived depression scale and cognitive ability on GOHAI.

Results: As a result of adding the depression scale and cognitive function variables to Model 2, the explanatory power was 22%. Educational level, marital status, private health insurance subscription, average monthly allowance, subjective health status, use of dentures, smoking status, economic activity, depression scale, and cognitive function were found to have significant influence ($p < 0.05$). In addition, when controlled and viewed with all factors, depression and cognitive function were found to have an effect on oral health-related quality of life.

Conclusion: The findings indicate that depression and cognitive function are associated with oral health-related quality of life in the Korean elderly. As the age increases, the quality of life declines due to depression and cognitive function problems, in addition to oral discomfort, eating disorders, and physical discomfort.

Key Words: Cognition, Depression, Elderly, Oral health

Introduction

In South Korea, population aging is progressing at an unprecedented speed in the world. According to the future population projections of Statistics Korea, as of 2019, the number of the elderly aged 65 and over was 7.68 million, accounting for 14.9% of the total population, an increase of 1.1% from 13.8% in 2017¹⁾. In addition, it is expected to exceed 20.8% of the total population in 2026 and enter a super-aging society, which is expected to account for more than 40% of the total population by 2045¹⁾. In line with this rapidly increasing aging rate, the government introduced the long-term care insurance system in 2008 to reduce the

national burden. In order to improve the quality of life of the increasing aging population, through institutional reform to adapt to changes in the structure of the population by age, and expansion of community support in the Fifth Health Plan (HP 2030) announced in December 2020²⁾.

With an increasing interest in successful aging and individual efforts to reduce the decline in physical function, function, and mental ability due to aging, the importance of oral health, which has a great influence on masticatory, phonetic, and aesthetic functions, is being highlighted^{3,4)}. According to a previous study, as a result of examining the relationship between objective and

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subjective masticatory abilities and cognitive function in relation to the deterioration of muscle function, which appears first in old age, a correlation between subjective masticatory ability and cognitive function was identified⁵⁾. A study by Jung et al.⁶⁾ also revealed that cognitive function directly or indirectly affected the masticatory ability through face-to-face interviews of the elderly. While there have been studies on oral health and cognitive function in the elderly, such as the studies on the correlation between masticatory and cognitive functions^{5,6)} and that between dementia and the number of remaining teeth⁷⁾, there has been a scarcity of studies on the effect on the Geriatric Oral Health Assessment Index (GOHAI). In addition to cognitive function, in old age, it is difficult to overcome the risk and experience of negative events such as loss of a spouse, retirement, separation from children, and economic anxiety, which affect the psychological factors^{3,8)}. In particular, due to infection anxiety and a heavy social atmosphere around COVID-19, the depression score of the elderly increased to 2.76 points in 2020 after the outbreak from 1.99 points in 2018 before the outbreak of COVID-19⁹⁾. Furthermore, previous studies related to oral health and depression have reported a correlation between the number of remaining teeth and depression⁷⁾, and that the level of depression according to health status was higher in the group with dental discomfort¹⁰⁾.

As such, ‘successful aging’ refers to successfully adapting to a society based on an understanding of one’s own aging process, which requires a harmony of the individual characteristics and physical and mental health status⁷⁾. Although previous studies have reported the relationship between oral health and psychological factors, they could not consider various factors in asking about the experience of depression¹¹⁾, or focused on examining the cognitive function of specific subjects, with limited and insufficient research into depression and cognitive function in the elderly in general¹²⁾. Therefore, based on the data of the Korea Longitudinal Study of Aging (KLoSA), this study investigated the effect of the GOHAI for the elderly on depression and cognitive function.

Materials and Methods

1. Study subjects

In this study, the KLoSA data were used. KLoSA has accumulated basic data through various interdisciplinary studies, measuring and identifying biological phenomena (physical and mental health) in addition to population, social, economic, and psychological phenomena in middle-aged and elderly people in order to use them for effective policy establishment and academic basic research for the middle-aged and elderly. The seventh KLoSA conducted in 2018 included demographic data, family data (children, siblings, and parents), economic data (employment, income, consumption, assets, and pension), and health and medical care data (general health status, subjective expectations, quality of life items, oral health, health behavior, physical function status, and mental health status). In particular, indicators related to the number of natural teeth and oral conditions were added and provided in the health data. Therefore, this study included 4,353 subjects aged 65 using the seventh KLoSA data in 2018 with oral variables added.

2. Research variables

Population, socioeconomic, health behavioral, and oral health-related factor variables were classified based on previous studies using the KLoSA data. GOHAI, designed by Watt et al.¹³⁾, is a quality-of-life measurement scale related to oral health for the elderly that is proposed to measure oral functional factors such as chewing and speaking and health determinants such as pain, discomfort, and psychosocial factors. In the seventh KLoSA, GOHAI items were incorporated by adding 12 items scored on a 6-point Likert scale (0 to 5 points) as newly created variables, where three positive items were inversely scored. The higher the score, the higher the positive oral health-related quality of life.

Cognitive ability Mini-Mental State Examination (MMSE) is an index that helps respondents judge their ability to engage in intellectual activities related to thinking and learning. As a result of calculating the sum of the scores for correct and incorrect answers to the items, a score of 17 or less indicates dementia, a score of 18 to 23 or less

indicates cognitive decline, and a score of 24 or more is considered normal. The higher the score, the better the cognitive function.

The depression scale can be confirmed through the Center for Epidemiological Studies-Depression Scale-10 (CES-D-10), which is an abbreviated and modified variable used for the elderly and chronically ill among the 20 US CES-D questions. According to the criteria, it is divided into '1' and '0,' with the minimum score being 0 and the maximum being 10. A higher score indicates a

higher degree of depression.

3. Analysis methods

In this study, descriptive statistical analysis, independent sample t-test, and one-way ANOVA were applied to confirm group differences in GOHAI index, cognitive ability, and depression scale according to general characteristics by applying the transverse weight values suggested by the seventh KLoSA. Furthermore, hierarchical multiple linear regression was performed to determine the correlation

Table 1. Basic Characteristics of Study Samples

Characteristic	Category	Total (n=4,353)	GOHAI Score	t of F (p-value)
Age (y)	65~74	2,037 (46.80)	38.75±8.27 ^a	170.56 (0.003) ^{a>b>c}
	75~84	1,859 (42.71)	35.18±8.68 ^b	
	≥85	457 (10.50)	31.51±9.25 ^c	
Sex	Male	1,817 (41.74)	37.29±8.73	3.335 (<0.001)
	Female	2,536 (58.26)	35.87±8.93	
Education level	≤Elementary school	2,381 (54.70)	34.72±8.91 ^a	75.10 (<0.001) ^{a>b}
	Middle school	743 (17.07)	37.76±8.05 ^{ab}	
	High school	896 (20.58)	38.79±8.71 ^{ab}	
	≥College	333 (7.65)	39.76±7.98 ^b	
Marital status	Married/cohabitation	2,949 (67.75)	37.52±8.56 ^a	66.11 (<0.05) ^{a>b}
	Single	13 (0.30)	34.30±10.98 ^b	
	Etc (separated, widowed, divorced)	1,391 (31.95)	34.25±9.09 ^a	
Perceived health status	Good	809 (18.58)	39.11±8.12 ^a	285.75 (<0.001) ^{a>b}
	Moderate	1,955 (44.91)	38.61±7.79 ^a	
	Poor	1,589 (36.50)	32.48±9.09 ^b	
Alcohol	Yes	2,003 (46.01)	36.95±8.85	3.335 (0.009)
	No	2,350 (53.99)	36.05±8.88	
Edentulism	Yes	2,761 (63.43)	38.58±8.56	-21.79 (<0.001)
	No	1,592 (36.57)	32.79±8.03	
Smoking	Yes	1,346 (30.92)	36.34±8.96	0.557 (0.577)
	No	3,007 (69.08)	36.51±8.85	
Private health insurance	Yes	699 (16.06)	39.96±7.74	11.549 (<0.001)
	No	3,654 (83.94)	35.79±8.92	
Economic	Yes	1,002 (23.02)	38.94±7.81	10.175 (<0.001)
	No	3,351 (76.98)	35.72±9.04	
Average pocket money quintile	High	818 (18.79)	39.71±8.76 ^a	120.10 (<0.001) ^{a>b>c>d}
	Middle-high	1,184 (27.20)	38.04±8.11 ^b	
	Middle-low	1,162 (26.69)	36.36±7.96 ^c	
	Low	1,189 (27.31)	32.94±9.21 ^d	
Household income quintile	High	529 (12.15)	37.83±8.87 ^a	42.82 (<0.01) ^{a>b>c}
	Middle-high	897 (20.61)	38.55±8.36 ^b	
	Middle-low	1,342 (30.83)	38.55±8.36 ^c	
	Low	1,585 (36.41)	34.70±9.18 ^c	

Values are presented as number (%) or mean±standard deviation.

GOHAI: Geriatric Oral Health Assessment Index.

^{a,b,c,d}The same character shows that there is no statistical significance.

By independent t-test or one-way ANOVA (post-test Scheffe).

between GOHAI, depression scale, and cognitive function, and to determine the effect of the elderly's perceived depression scale and cognitive ability on GOHAI. With GOHAI at the time of the seventh survey as a dependent variable, demographic characteristics and socioeconomic variables were input in step 1. After that, health behavior factors were added in step 2, and the depression scale and cognitive function, which are independent variables, were added in step 3. STATA ver.11.2 (Stata Corp LP, College Station, TX, USA) was used for organizing and statistical analysis of the collected data, with the statistical significance tested at a significance level of 5%.

Results

1. General characteristics of research subjects

Table 1 shows the results of group differences according to demographic characteristics and GOHAI. As a result of examining according to age among the total 4,353 respondents, the age group of 65 to 74 years showed the highest ratio with 2,037 people (46.80%), and it was found that the GOHAI decreased as the age increased. Regarding subjective health status, 'normal' was the highest, with 1,955 people (44.91%). Based on the use of dentures, the GOHAI of the group using dentures was 32.79 (standard deviation [SD]: 8.03), which was significantly lower than that of the group without dentures, 38.58 (SD: 8.56) ($p < 0.001$).

As for the previous year's total household income in the quartile among socio-economic factors, those in the lower ranks accounted for the most, with 1,585 people (36.41%). There was a significant difference in GOHAI between the upper and middle ranks at 37.83 points (SD: 8.87) and 38.55 points (SD: 8.36), respectively ($p < 0.01$). In terms of the average monthly allowance, those in the lower ranks accounted for the most, with 1,189 people (27.31%), showing significant differences in GOHAI with 39.71 points (SD: 8.76) in the upper ranks, 38.04 points (SD: 8.11) in the upper middle ranks, 36.36 points (SD: 7.96) in the lower middle ranks, 32.94 points (SD: 9.21) in the lower ranks ($p < 0.001$).

2. Correlation between depression scale, cognitive function, and GOHAI

Table 2 shows the analysis results for the correlation between the main variables. GOHAI had a positive correlation with GOHAI cognitive function ($r=0.353$, $p < 0.001$), and a negative correlation with the depression scale.

3. Factors affecting GOHAI

Table 3 shows the hierarchical regression analysis results for the effects of the perceived depression scale and cognitive function of the elderly on GOHAI. General characteristics and socioeconomic variables whose significance was confirmed as a result of univariate analysis were set as explanatory variables and applied to hierarchical regression analysis. The variation inflation factor ranged from 1.10 to 2.01, indicating no multicollinearity. As a result of checking the Durbin-Watson statistic to verify the independence of the residuals, it was 1.667, indicating no autocorrelation between errors.

Model 1, which included general characteristics and socioeconomic variables as control variables, showed 12% explanatory power for the dependent variable, GOHAI ($F=94.01$, $p < 0.001$). Age ($\beta = -0.144$, $p < 0.001$), sex ($\beta = 0.049$, $p = 0.007$), level of education ($\beta = 0.099$, $p < 0.001$), marital status ($\beta = -0.066$, $p < 0.001$), private health insurance subscription ($\beta = -0.066$, $p < 0.001$), average monthly allowance ($\beta = 0.167$, $p < 0.001$), and economic activity ($\beta = -0.056$, $p < 0.001$) showed a significant effect.

Model 2, which added health behavioral variables to Model 1, showed 18% explanatory power for GOHAI ($F=84.22$, $p < 0.001$). In addition, age ($\beta = -0.048$, $p =$

Table 2. Correlation between CES-D, MMSE, GOHAI

Item	GOHAI	MMSE	CES-D
GOHAI	1.000		
MMSE	0.353***	1.000	
CES-D	-0.163***	-0.252***	1.000

CES-D: Center for Epidemiological Studies-Depression Scale, MMSE: Mini-Mental State Examination, GOHAI: Geriatric Oral Health Assessment Index.

*** $p < 0.001$, by person's correlation analysis.

Table 3. Hierarchical Regression Analysis of Factors Affecting GOHAI

Category	Model 1			Model 2			Model 3		
	β	p-value	95% CI	β	p-value	95% CI	β	p-value	95% CI
Age (ref. 65 ~ 74 y)	-0.144	< 0.001	-2.361 ~ 1.203	-0.048	0.003	-1.467 ~ 0.601	-0.026	0.217	-0.784 ~ 0.095
Sex (ref. male)	0.049	< 0.007	0.068 ~ 0.366	-0.027	0.253	-0.311 ~ 0.081	-0.016	0.403	-0.263 ~ 0.122
Education level (ref. \leq elementary school)	0.099	< 0.001	0.551 ~ 1.139	0.028	0.001	0.184 ~ 0.750	0.033	0.043	0.084 ~ 0.569
Marital status (ref. married)	-0.066	< 0.001	-1.839 ~ 0.618	-0.035	0.002	-1.510 ~ -0.338	-0.041	0.010	-1.329 ~ 0.177
Private insurance (ref. yes)	-0.066	< 0.001	-2.278 ~ 0.829	-0.063	< 0.001	-2.280 ~ 0.886	-0.062	< 0.001	-2.141 ~ 0.770
Economics (ref. yes)	-0.056	< 0.001	-0.447 ~ 0.130	-0.035	0.020	-0.335 ~ 0.028	-0.029	0.049	-0.300 ~ 0.000
Average pocket money (ref. low)	0.167	< 0.001	1.090 ~ 1.625	0.058	< 0.001	0.493 ~ 1.025	0.063	< 0.001	0.248 ~ 0.776
Perceived health status (ref. good)				-0.175	< 0.001	-2.488 ~ 1.755	-0.133	< 0.001	-1.982 ~ 1.239
Alcohol (ref. yes)				-0.044	< 0.001	-0.338 ~ 0.260	-0.002	0.890	-0.298 ~ 0.289
Edentulism (ref. no)				0.188	< 0.001	0.712 ~ 0.986	0.183	< 0.001	0.690 ~ 0.960
Smoking (ref. non-smoker)				-0.083	< 0.001	-2.295 ~ 0.860	-0.076	< 0.001	-2.155 ~ 0.745
CES-D							-0.044	0.005	-0.329 ~ 0.072
MMSE							0.187	< 0.001	0.213 ~ 0.305
_cons		38.750			42.326			34.638	
F (p)		94.01 (< 0.001)			84.22 (< 0.001)			74.81 (< 0.001)	
R ² (Adjusted R ²)		0.13 (0.12)			0.19 (0.18)			0.23 (0.22)	

GOHAI: Geriatric Oral Health Assessment Index, CI: confidence interval, CES-D: Center for Epidemiological Studies-Depression Scale, MMSE: Mini-Mental State Examination,

0.003), level of education ($\beta=0.028$, $p=0.001$), marital status ($\beta=-0.035$, $p=0.002$), enrollment in private health insurance ($\beta=-0.063$, $p<0.001$), average monthly allowance ($\beta=0.058$, $p<0.001$), subjective health status ($\beta=-0.175$, $p<0.001$), use of dentures ($\beta=0.188$), $p<0.001$), economic activity status ($\beta=-0.035$, $p=0.020$), and smoking status ($\beta=-0.083$, $p<0.001$) were found to have significant effects.

Model 3, which added depression scale and cognitive function variables to Model 2, showed 22% explanatory power. The level of education ($\beta=0.033$, $p=0.043$), marital status ($\beta=-0.041$, $p=0.010$), private health insurance ($\beta=-0.062$, $p<0.001$), average monthly allowance ($\beta=0.063$, $p<0.001$), subjective health status ($\beta=-0.133$, $p<0.001$), use of dentures ($\beta=0.183$, $p<0.001$), smoking status ($\beta=-0.076$, $p<0.001$), and economic activity ($\beta=-0.029$, $p=0.049$), as well as independent variables like depression scale ($\beta=-0.044$, $p=0.005$) and cognitive function ($\beta=0.187$, $p<0.001$), were found to have a

significant effect.

Discussion

This study aimed at understanding the correlation between psychological factors such as depression and cognitive function in the elderly on GOHAI by using the KLoSA data.

In terms of GOHAI according to the general characteristics based on the results of this study, GOHAI decreased as age increased, which was consistent with previous studies¹³⁻¹⁶. As age increases, GOHAI may decrease due to a lack of oral health knowledge, medical expense burden, a decrease in the number of natural teeth, and the need for dentures. Furthermore, the GOHAI of the aged 65 to 74 years old in this study was 38.75 points, similar to 38.75¹⁴) and 37.36 points¹⁶) in the domestic study but lower than 49.7 points¹⁷) in Sweden and 46.77 points¹⁸) in Mexico. As GOHAI is designed according to the situation

in each country, a direct comparison may be difficult, and the nature and scale of the impact may differ depending on socio-demographics, cultural background, economic situation, or provision of dental services^{17,18)}.

In this study, as socioeconomic factors affecting GOHAI (Model 3), average monthly pocket money allowance and economic activity, indicating the ability to pay for dental treatment, affected GOHAI, which was found to be consistent with the findings of Hernández-Palacios RD et al.¹⁸⁾. The results of the study revealed that low income class and low level of education were related to poor GOHAI, suggesting that low-income and low-educated individuals must first meet basic needs such as food, clothing, shelter, and transportation before addressing oral health¹⁹⁻²¹⁾. Therefore, oral health can be considered a relatively low priority for the low-income class and the uneducated elderly. In this study, social and economic factors rather than demographic factors (sex and age) influenced GOHAI, in line with the results of the previous studies¹⁸⁾. Therefore, it is necessary to consider the correlation between socioeconomic factors and GOHAI through future research.

GOHAI was found to significantly decrease with an increase in depression, which was consistent with the results of the study by Eom and Choi²¹⁾. Anttila et al.²²⁾ reported that subjects without depression had more frequent dental visits. As such, previous studies emphasized that the more severe the depression, the higher the risk of a negative oral lifestyle by missing or avoiding oral treatment^{11,23)}. Therefore, in addition to relieving actual pain and treating illness, an approach to empathizing with and understanding the oral discomfort of the elderly is necessary for clinical practice. When developing an oral health program for the elderly in the local community, education regarding depression is necessary.

Furthermore, among factors affecting GOHAI, an increase in the MMSE score, indicating cognitive function, was likely to increase GOHAI. This was found to be consistent with the results of studies by Cho⁷⁾ and Shin et al.²⁴⁾. Such results indicate that low cognitive function was associated with poor oral hygiene and oral health, supporting the studies^{6,7,19)}, reporting a difference in oral health management and oral health awareness according

to cognitive function. In the clinical field, it will be necessary to carefully examine the elderly with low cognitive function and provide sufficient explanation to enable them to take care of their own oral health. Meanwhile, oral health treatment that considers dry mouth, oral muscle function, and psychological factors should be provided to the elderly who are experiencing psychological problems as well as physical changes due to aging, rather than focusing only on the problem of tooth pain.

There are several limitations in interpreting the results of this study. Since a causal relationship cannot be inferred by the use of cross-sectional data, future studies will be required to examine the correlation between cognitive function, depression, and GOHAI longitudinally. Nevertheless, this study has strengths in understanding the relationship with the psychological factors of the elderly using GOHAI, which looks at the oral health quality of life in the elderly. As a result, socioeconomic factors, health behavior factors, and psychological factors, excluding general characteristics, influence the oral health quality of life of the elderly. As age increases, depression and cognitive function affect oral health, in addition to oral discomfort, eating disorders, and physical discomfort. In order to effectively manage the oral health of the elderly in the local community, the use of specific interventions to alleviate depression and effectively prevent cognitive decline, as well as community oral health care resources in connection with the local mental health promotion center, is recommended.

Notes

Conflict of interest

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

Ethical approval

This study was approved by the Wonkwang University Bioethics Review Committee (IRB No. WKIRB-202009-SB-055).

Author contributions

Conceptualization: Young-Im Kim. Formal analysis:

Sun-Mi Kim, Supervision: Young-Im Kim. Writing—original draft: Young-Im Kim and Sun-Mi Kim. Writing—review & editing: Young-Im Kim.

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