

## Association between Oral Health and Cognitive Function among Korean Older Population

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### ABSTRACT

The purpose of this study is to investigate the association between oral health and cognitive function in the population aged 55 and older in Korea. Using data from the 2018 Korean longitudinal Study of Aging (KLoSA), a total of 5,578 participants were analyzed after excluding missing values. Chi-square tests, complex sample design, and multiple linear regression were conducted to assess the relationship between oral health status and cognitive function. For each one-unit increase in the Geriatric Oral Health Assessment Index (GOHAI), the Korean Mini-Mental State Examination (K-MMSE) score increased statistically significantly by 0.004 points. Stratified analysis by gender and age revealed that both female and male groups showed statistically significant associations between the Elderly Oral Health Assessment Index and K-MMSE score. Particularly, a strong association between the Elderly Oral Health Assessment Index and K-MMSE score was found in the group aged 65 and above. Based on the findings of this study, there is a need to improve oral health in the population aged 65 and above to achieve maximum cognitive function improvement with a one-unit increase in the Elderly Oral Health Assessment Index. However, there is still room for improvement. Therefore, this study aims to provide foundational data for establishing the importance of oral health management and specific management strategies for this group.

## 1. Introduction

According to the <Dementia Status in South Korea 2021> published by the Central Dementia Center, the average life expectancy and the proportion of elderly population are increasing worldwide. In 2020, the number of dementia patients aged 65 and older was 840,000. However, it is estimated

to increase to 1.36 million in 2030, 2.17 million in 2040, and exceed 3 million in 2050. The rapidly increasing number of dementia patients is also exacerbating the socio-economic burden. The annual total national dementia management cost for 2020 was 1.73 trillion KRW, accounting for approximately 0.9% of the GDP (Central Dementia Center, 2021). The annual management cost per dementia patient was 20.61 million KRW in 2020, and it was more than twice as high for severe cases. Furthermore, in the estimation of future dementia care burden, the national-level dementia management cost, which was approximately 1.73 trillion KRW in 2020, is projected to reach approximately 5.69 trillion KRW for the target population of 2.17 million in 2040 (Central Dementia Center, 2021). In addition to these direct and indirect management costs, the burden of dementia, including caregiving and dependency, is increasing even more. In 2018, the caregiving burden was 2.0 persons, and the dependency burden was 29.6 persons. However, in 2060, it is estimated to be 16.3 persons for caregiving and 6.2 persons for dependency (Central Dementia Center, 2019).

Various factors affect dementia, including low education level, lack of physical activity, age, economic activity, and high-risk nutritional status. According to a leading domestic study, the risk of dementia increases with age, and the risk also increases when reading ability is impaired and education level is low (Korean Society of Preventive Medicine, 2002). In a study published by the Korean Geriatrics Society on “Factors related to cognitive impairment in Korean elderly by gender,” common factors such as high-risk nutritional status, hearing discomfort, and economic activity were found for both men and women. For men, myocardial infarction was a factor, while for women, education level and living alone played a role in cognitive impairment (Lee, 2021). In addition, smoking status, presence of relatives and friends, social relationships, diabetes status, and depression were found to have an impact on cognitive impairment in the elderly (Park, 2016). Furthermore, oral health in the elderly is a significant factor in determining their quality of life (Shin, 2018). A study analyzing the oral health gap of 3,405 elderly individuals aged 65 and older based on income level and residential area found that the average number of teeth differed by over 5 between those in the lowest 1st income quintile and those in the highest 5th income quintile. Additionally, the proportion of elderly individuals with fewer than 20 teeth and edentulous individuals showed a difference of about 2 times (Lee, 2020).

Moreover, research has shown that oral health in the elderly has a significant impact on dementia. In a previous study, it was found that as oral health worsened and difficulty in chewing increased, the experience of cognitive impairment and undergoing dementia screening were significantly higher (Park, 2020). In a preceding study that examined the relationship between dementia and oral health in some elderly individuals in Daejeon, the group with lower cognitive scores had more dental caries and missing teeth compared to the group with higher cognitive scores, and they also had higher rates of periodontal disease. While oral health may not directly impact cognitive function, it was observed that key functions such as chewing ability and the number of remaining teeth had an influence on cognitive function (Korean Journal of Dental Hygiene Science, 2016). In a preceding study on the impact of overall and oral health status on dementia in some local elderly individuals, dental caries and periodontal disease were found to be higher in the suspected dementia group compared to the normal group, indicating that oral health can influence cognitive

impairment (Kim, 2021).

Therefore, this study aimed to analyze the relationship between oral health in the elderly and cognitive impairment and dementia and provide foundational data for elderly oral health management and policy and institutional measures for preventing and managing dementia.

This study examines the correlation between oral health status and cognitive function in the elderly population in Korea. In contrast to other studies, the research aimed to objectively assess the oral health status using the GOHAI index and employed the globally recognized MMSE index to measure cognitive function. This aspect strengthens the validity of the study, providing a unique perspective on the relationship between oral health and cognitive function in the Korean elderly population.

## **2. Methods**

### *2.1 Material and study model*

This study utilized data from the 2018 Korean Longitudinal Study of Aging (KLoSA), a panel survey on aging. The sample was selected using a systematic sampling method, where administrative codes were sorted according to the allocated sample size for each region. A 20% reserve sample was combined with the main sample to account for any changes in the sample due to fluctuations. From this combined sample, 20% was further classified into the main sample and the reserve sample using a systematic sampling method.

Following this approach, 1,000 sample clusters were designated, and households were randomly selected using the household roster from the 2005 Population and Housing Census. If a household had a member aged 45 years or older, they were considered eligible for the survey, and a face-to-face interview was conducted.

The survey targeted individuals born before 1962 residing outside of Jeju Island, South Korea, with the goal of obtaining a sample size of approximately 10,000 individuals. Ultimately, a panel of 10,253 individuals was established. In 2014, an additional 920 individuals born between 1962 and 1953 were included. These participants were interviewed using a Computer-Assisted Personal Interview (CAPI) method, and for special surveys, appropriate methods were determined based on the survey content and items.

### *2.2 Independent variables*

The independent variable in this study, the Geriatric Oral Health Assessment Index (GOHAI), was newly created by adding 12 items related to oral function, pain, discomfort, and psychosocial factors to assess determinants of health in the elderly population. These 12 items were measured on a 6-point scale (ranging from 0 to 5 points), and the scores were summed for calculation. A higher GOHAI score indicates a presence of positive oral health-related health determinants.

GOHAI (Geriatric Oral Health Assessment Index) has 12 survey items as follows:

1. Have you been limited in the amount or kind of food you can eat because of problems with your teeth or dentures?
2. Have you had trouble biting or chewing any kind of food, such as apples or meat?
3. Have you felt comfortable eating in front of other people?
4. Have your teeth or dentures kept you from speaking or pronouncing words the way you would like?
5. Have you been able to eat foods with pleasure?
6. Have problems with your teeth or dentures caused you to cut down on your social activities?
7. Have you felt good about the appearance of your teeth, gums, or dentures?
8. Have you used medications for oral discomfort or pain in your mouth?
9. Have you worried about the problems with your teeth, gums, or dentures?
10. Have you felt tense or uneasy about your teeth, gums, or dentures?
11. Have you been embarrassed about the way your teeth, gums, or dentures look?
12. Have your teeth or gums been sensitive to hot, cold, or sweets?

### *2.3 Dependent variables*

The Korean Mini-Mental State Examination (K-MMSE) included 11 items in 7 categories of cognitive functions, including orientation for time and place, registration, attention & calculation, recall, language, and visual construction. The total score of the measure ranges from 0 to 30; higher the score, better the cognitive function. The validity of the K-MMSE was reported elsewhere (Kang, 1997).

### *2.4 Control variables*

#### *2.4.1 Socioeconomic variables*

In this study, sociodemographic variables were selected from the predefined data of the 2018 KLoSA. “Gender” was categorized as ‘Male’ and ‘Female’. “Age group” was classified into three categories: ‘55-64 years’, ‘65-74 years’, and ‘75 years and older’. “Marital status” was categorized as ‘Never married’, ‘Married’, and ‘Widowed’. “Educational level” was classified as ‘Elementary school graduate or below’, ‘Middle school graduate’, ‘High school graduate’, and ‘College graduate or higher’. “Type of health insurance” was classified as ‘National Health Insurance’ and ‘Medical Aid recipient’.

#### *2.4.2 Health condition factor*

In this study, the health status variable was selected from the predefined data of the 2018 KLoSA. “Subjective health status” was categorized into three groups: ‘Good’, ‘Fair’, and ‘Poor’.

### *2.4.3 Health behavior factor*

In this study, the health behavior factors variables were selected from the predefined data of the 2018 KLoSA. “Work limitation” and “Alcohol consumption” were categorized into ‘Yes’ and ‘No’. The number of chronic diseases was classified into three categories: ‘None’, ‘One’, and ‘Two or more’. Chronic diseases were limited to Hypertension, diabetes, cancer, chronic obstructive pulmonary disease, liver disease, cardiovascular disease, cerebrovascular disease, arthritis.

### *2.5 Analytical approach and statistics*

The statistical analysis methods used in this study included T-tests, ANOVA (Analysis of Variance), and multiple linear regression analysis. After controlling for age, education level, gender, marital status, work limitation, alcohol consumption, health insurance status, number of chronic diseases, and subjective health status variables of the study subjects, the associations were analyzed. Additionally, detailed analyses were conducted based on gender and age to assess the risk. Data collection, organization, and statistical analyses were performed using SAS ver. 9.4 (SAS Institute Inc., Cary, NC, USA), and statistical significance was tested at a 5% level of significance.

## **3. Results**

Table 1 presents the general characteristics of the study participants, analyzing the association between the GOHAI and the Mini-Mental State Examination (K-MMSE). Based on responses from a total of 5,578 participants in the baseline survey, the mean GOHAI score was 39.55 (SD: 8.49), and the mean K-MMSE score was 26.03 (SD: 4.82). When stratified by age, 55-64 year-olds accounted for 41.3% of the total with 2,305 participants. The mean GOHAI score for this group was 42.55 (SD: 7.7), which was higher than the mean GOHAI score of 35.60 (SD: 8.40) for those aged 65 and older. Regarding K-MMSE scores, the 55-64 age group had a mean of 27.95 (SD: 2.76), while the 75 and older age group had a mean of 22.89 (SD: 6.22), indicating that the younger age group had a higher mean K-MMSE score compared to the older age group.

When categorized by gender, the mean GOHAI score for males was 39.76 (SD: 8.44), and their mean K-MMSE score was 26.75 (SD: 4.14). For females, the mean GOHAI score was 39.39 (SD: 8.53), and the mean K-MMSE score was 25.47 (SD: 5.22).

When classifying by subjective health status, the group with good subjective health had a mean GOHAI score of 42.02 (SD: 8.01) and a mean K-MMSE score of 27.77 (SD: 3.21). In contrast, the group with poor subjective health showed lower mean scores for both GOHAI (34.38, SD: 8.98) and K-MMSE (22.60, SD: 6.40) compared to the group with good subjective health.

**Table 1.** General characteristics of subjects included for analysis (2018)

	Total		GOHAI			MMSE		
	N	%	Mean	SD	P-value	Mean	SD	P-value
<b>Age</b>					<.0001			<.0001
55-64	2,305	41.3	42.55	7.70		27.95	2.76	
65-74	1,679	30.1	39.19	8.01		26.39	3.94	
≥ 65	1,594	28.6	35.60	8.40		22.89	6.22	
<b>Education level</b>					<.0001			<.0001
≤ Elementary school	1,930	34.6	36.34	8.64		23.31	5.90	
Middle school	966	17.3	39.56	7.75		26.52	3.95	
High school	1,915	34.3	41.74	7.97		27.67	3.16	
≥ College	767	13.8	42.17	7.65		28.19	2.59	
<b>Gender</b>					0.033			<.0001
Male	2,443	43.8	39.76	8.44		26.75	4.14	
Female	3,135	56.2	39.39	8.53		25.47	5.22	
<b>Marital status</b>					0.001			0.00
Married	4,379	78.5	40.32	8.24		26.64	4.16	
Separated, divorced	1,159	20.8	36.65	8.80		23.72	6.27	
Single	40	0.7	39.05	8.71		26.68	4.38	
<b>Working restriction</b>					<.0001			<.0001
Yes	1,694	30.4	35.68	8.61		24.21	5.88	
No	3,884	69.6	41.24	7.87		26.83	4.03	
<b>Alcohol consumption</b>					0.032			<.0001
Yes	1,972	35.4	40.87	8.26		27.25	3.50	
No	3,606	64.7	38.83	8.54		25.37	5.29	
<b>Health insurance</b>					0.001			<.0001
National Health Insurance	5,395	96.7	39.70	8.42		26.12	4.76	
Medical aid	183	3.3	35.08	9.41		23.33	5.84	
<b>Number of chronic diseases*</b>					0.511			0.21
0	5,091	91.3	39.61	8.46		26.06	4.82	
1	456	8.2	38.96	8.82		25.68	4.87	
≥ 2	31	0.6	38.84	8.77		26.39	4.26	
<b>Self-rated health</b>					<.0001			<.0001
Good	1,804	32.3	42.02	8.01		27.77	3.21	
Moderate	2,658	47.7	40.05	7.65		26.29	4.19	
Bad	1,116	20.0	34.38	8.98		22.60	6.40	
<b>Total</b>	5,578	100.0	39.55	8.49		26.03	4.82	

\* Hypertension, diabetes, cancer, chronic obstructive pulmonary disease, liver disease, cardiovascular disease, cerebrovascular disease, arthritis

Table 2 presents the analysis of the relationship between GOHAI and K-MMSE after controlling for covariates. The analysis showed that for each one-unit increase in GOHAI, K-MMSE increased statistically significantly by 0.004 points (B: 0.004, 95% CI: 0.003-0.004, P-value: .001).

**Table 2.** Association between GOHAI and MMSE

	MMSE			
	B	95% CI		P-value
GOHAI	0.004	0.003	0.004	<.0001
<b>Age</b>				
55-64	ref			
65-74	-0.009	-0.019	0.001	0.092
≥65	-0.091	-0.104	-0.078	<.0001
<b>Education level</b>				
≤ Elementary school	-0.087	-0.101	-0.072	<.0001
Middle school	-0.022	-0.036	-0.008	0.003
High school	-0.009	-0.021	0.003	0.143
≥ College	ref			
<b>Gender</b>				
Male	ref			
Female	-0.012	-0.021	-0.002	0.015
<b>Marital status</b>				
Married	ref			
Separated, divorced	-0.018	-0.030	-0.007	0.002
Single	0.001	-0.046	0.048	0.963
<b>Working restriction</b>				
Yes	-0.003	-0.013	0.008	0.600
No	ref			
<b>Alcohol consumption</b>				
Yes	ref			
No	-0.012	-0.021	-0.003	0.012
<b>Health insurance</b>				
National Health Insurance	ref			
Medical aid	-0.024	-0.049	0.002	0.072
<b>Number of chronic diseases</b>				
0	ref			
1	0.017	0.002	0.032	0.027
≥2	0.059	0.005	0.112	0.031
<b>Self-rated health</b>				
Good	0.095	0.081	0.109	<.0001
Moderate	0.079	0.066	0.092	<.0001
Bad	ref			

Table 3 analyzes the relationship between GOHAI and K-MMSE by gender and age. The results showed that for males, a one-unit increase in GOHAI was associated with a statistically significant increase of 0.003 points in K-MMSE (B: 0.003, 95% CI: 0.002-0.004, P-value: <0.001). Similarly,

for females, a one-unit increase in GOHAI was associated with a statistically significant increase of 0.004 points in K-MMSE (B: 0.004, 95% CI: 0.003-0.005, P-value: <0.001). Among participants aged 64 and under, a one-unit increase in GOHAI was associated with a statistically significant increase of 0.002 points in K-MMSE (B: 0.002, 95% CI: 0.015-0.0025, P-value: <0.001). For those aged 65 and older, a one-unit increase in GOHAI was associated with a statistically significant increase of 0.005 points in K-MMSE (B: 0.005, 95% CI: 0.004-0.006, P-value: <0.001).

**Table 3.** Association between GOHAI and MMSE stratified by sex and age

	MMSE		
	B	95% CI	P-value
GOHAI	<b>Male</b>		
	0.003	0.002	0.004
	<b>Female</b>		
	0.004	0.003	0.005
	<b>≤ 64 years</b>		
	0.002	0.0015	0.0025
<b>≥ 65 years</b>			
0.005	0.004	0.006	

\*adjusted for all variables

#### 4. Discussion

This study aimed to investigate the association between the GOHAI and the K-MMSE in order to explore methods for promoting oral health in the elderly and preventing dementia onset. Addressing limitations in previous studies, which often had small and limited study populations, this study utilized data from the 7th wave of the KLoSA, including a total of 5,578 elderly participants nationwide, to overcome these constraints. Also, in this study, the research was conducted targeting individuals aged 55 and older, aligning with the minimum age of 55 for the Korean version of GOHAI measurement.

The results of this study, conducted on 5,578 elderly individuals aged 55 and above using the GOHAI and K-MMSE, can be summarized as follows: As the GOHAI score increased by one unit, the K-MMSE score also increased. When stratified by gender, an increase in GOHAI score was associated with a corresponding increase in K-MMSE score in both male and female groups. Additionally, in the group aged 65 and above, a strong correlation was observed between an increase in GOHAI score and K-MMSE.

Factors influencing the quality of life in the elderly include overall health, with oral health being equally significant. It has been shown that higher cognitive function is associated with better performance in activities of daily living (Kim, 2015), and cognitive impairment can be a significant predictor of dementia (Jo, 2017). Oral health components such as masticatory function and the number of

remaining teeth have been found to influence cognitive function (Korean Journal of Dental Hygiene, 2016). In fact, oral health in Alzheimer's patients was found to be poorer, with fewer remaining teeth compared to healthy individuals (Elsig, 2015). A previous domestic study also found significant differences in oral health according to the number of remaining teeth (Jo, 2017). The current study's use of the GOHAI yielded results consistent with previous research, further affirming the relationship between oral health and cognition (Jo, 2017).

Moreover, a strong correlation between GOHAI and K-MMSE was found in the female group compared to the male group in this study. This result can be explained by several preceding studies. In Korea, there is a higher incidence of Alzheimer's disease in females compared to males, and the prevalence of vascular risk factors such as hypertension and stroke is significantly higher in females (Ko, 2007). Differences in K-MMSE scores by gender can be interpreted as stemming from differences in social roles and socio-demographic variables (Woo, 1996). This indicates that women tend to have a higher incidence of Alzheimer's and are more affected by vascular risk factors. Additionally, educational level was a significant factor in this study. Lower education levels were associated with lower K-MMSE scores, and previous research has shown that there are differences in oral health according to cognitive function, with a higher incidence of dementia in elderly individuals with lower education levels (Kim, 2015). Those with higher education levels are more likely to have higher social status and safer occupations, leading to economic stability and proactive diagnosis and treatment for dementia (Jo, 2007). This could explain why in this study, an increase in GOHAI was associated with a higher increase in K-MMSE scores in females compared to males.

Lastly, this study's finding of a strong correlation between GOHAI and K-MMSE in the elderly group is consistent with previous research. Many previous studies have shown an increased risk of dementia with age (Kim, 2002). In this study, for those aged 64 and under, an increase in GOHAI by one unit was associated with an increase of 0.002 in K-MMSE, and for those aged 65 and older, the increase was 0.005, indicating a 2.5 times higher risk. Age, as a biological factor, is an important risk factor not only for dementia onset but also for mortality (Park, 2007). Therefore, considering the static correlation between geriatric oral health assessment and K-MMSE through biological factors like age, as well as socio-demographic factors like education level and subjective health status, it is crucial to recognize the significance of elderly oral health as a potential cause of dementia, emphasizing the importance of its management.

However, compared to an international average GOHAI score of 46.2 (Kundapur, 2017), the Korean elderly population's GOHAI score of 37.4 (Lee, 2015) is relatively low. This fundamental discrepancy can be attributed to a lack of policy measures for managing elderly oral health in Korea. To enhance the effectiveness of oral health policies, it is crucial for policy objectives to be clearly communicated so that beneficiaries actively participate (Park, 2017). However, according to previous domestic studies, awareness of the "Elderly Dentures and Implant Health Insurance Coverage" program, which aims to promote elderly oral health, varied depending on the region, with influences from factors like region, age, and education level (Jo, 2015). This necessitates active promotion and information dissemination, along with policies to reduce regional disparities. Furthermore, beneficiaries need to have an interest in oral health and make individual efforts, such

as using oral care products and undergoing regular check-ups. According to prior domestic research, higher oral health knowledge is associated with better dental care and receiving regular check-ups and scaling. This leads to significant differences in oral health based on education and economic level (Lee, 2022). However, due to economic burdens and disruptions in social activities, vulnerable populations have limited opportunities for information acquisition, leading to worsened oral health among this group (Park, 2017).

Therefore, this study ultimately emphasizes the need for more proactive support programs and a continuous management system for elderly oral health to elevate the oral health status of the elderly, ultimately reducing the economic burden of dementia care and societal economic burden. As for the limitations of this study, firstly, the KLoSA used for research data included respondents' opinions, introducing potential subjective bias. Secondly, although this study utilized the KLoSA, which can be generalized to the middle-aged and elderly population in Korea, the analysis was conducted on 5,578 individuals after excluding missing data, limiting the generalizability to the broader Korean middle-aged and elderly population. Thirdly, it should be noted that the study cannot establish a clear causal relationship between geriatric oral health assessment and K-MMSE scores. However, despite these limitations, this study has several strengths. Firstly, it is significant in that it used a systematically developed GOHAI to derive oral health scores. Secondly, by conducting stratified analysis based on gender and age, it was possible to confirm a strong correlation between geriatric oral health assessment and K-MMSE, particularly in females and the group aged 65 and above.

## **5. Conclusion**

This study analyzed the association between the GOHAI and the K-MMSE in a population of individuals aged 55 and above. The research findings indicate that, on average, with each one-unit increase in the GOHAI, there was a corresponding increase in K-MMSE scores. Particularly, a strong correlation was observed in the female group and the group aged 65 and above.

Therefore, based on the results of this study, providing programs and initiatives for oral health specifically targeting females and the population aged 65 and above may lead to a greater improvement in cognitive function compared to other groups. In particular, policy measures should be developed to reduce the societal burden of oral health education and treatment for this group, who may experience difficulties in personal health management as they enter this phase of life.

## **Conflicts of Interest**

The authors declare no conflict of interest.

## References

- Cho, H. (2015). *Study on awareness of the 'dentures and implants health insurance coverage' for the elderly* (Master's thesis, Dankook University).
- Cho, M. (2017). *The relationship between oral health indicators and MMSE in the elderly* (Doctoral dissertation, Kyungpook National University).
- Cho, Y. T., & Kim, M. H. (2007). Sociological approach to the causes of dementia. *Journal of Health Studies*, 44(2), 155-163.
- Go, H. B., Kim, M. G., Kim, J. Y., Kim, H. S., Park, Y. S., Seo, S. H., & Hwang, S. J. (2016). Relationship between dementia and oral health in some elderly in Daejeon. *Journal of Dental Hygiene Science*, 16(6), 481-487.
- Go, S. A., Yoon, J. Y., & Jung, J. H. (2007). Gender differences in risk factors for alzheimer's disease and cognitive function: Ewha dental clinic. *Dementia and Neurocognitive Disorders*, 6(2), 34-37.
- Ham, J. (2019). *Study on oral health and quality of life related to health in the elderly* (Master's thesis, Kyung Hee University).
- Kang, Y. W., Na, D. L., & Hahn, S. H. (1997). A validity study on the Korean mini-mental state examination (K-MMSE) in dementia patients. *Journal of the Korean Neurological Association*, 15(2), 300-308.
- Kim, E. S., & Hong, M. H. (2015). Survey on oral health awareness according to cognitive function in some dementia and suspected dementia patients. *Journal of Korean Society of Dental Hygiene*, 15(2), 217-223.
- Kim, J. S., Chun, B. C., Cho, E. S., & Jeong, I. S. (2002). Cross-sectional study on risk factors for dementia in urban elderly. *Journal of Preventive Medicine and Public Health*, 35(4), 313-321.
- Kim, Y. R., Heo, S. E., Jang, K. A., & Kang, H. K. (2021). The impact of systemic health and oral health status on dementia in some local elderly. *Journal of Dental Hygiene Science*, 21(2), 151-158.
- Kundapur, V., Hegde, R., Shetty, M., Mankar, S., Hilal, M., & Prasad A, H. (2017). Association between dental loss and overall quality of life using the geriatric oral health assessment index (GOHAI) among rural elderly residents. *International Journal of Behavioral Sciences*, 13(1), 6-12.
- Lee, G. Y., Cho, Y. S., & Lim, S. Y. (2015). Quality of life related to oral health and related factors in elderly beneficiaries of visiting healthcare service. *Journal of Dental Hygiene Science*, 15(3), 325-332.
- Lee, H., & Kim, J. S. (2021). Factors related to cognitive impairment in Korean seniors according to gender: Secondary data analysis. *Korean Journal of Gerontology*, 41(6), 1073-1095.
- Lee, J. H. (2022). *Oral health knowledge, oral health behavior, and oral health status according to oral health knowledge and behavior in elderly in Daegu* (Master's thesis, Yeungnam University).
- Park, J. S., & Han, Y. S. (2017). A study on oral health assessment index (GOHAI) and life satisfaction of the state of oral health project of the elderly in Jeonbuk Korea. *Wonkwang*

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- Park, S. H. (2020). Study on oral health and cognitive impairment in the elderly. *Journal of the Society of Convergence Industry Promotion*, 12(2), 169-175.
- Park, S., Lee, J. Y., Suh, G. H., Chang, S. M., & Cho, M. J. (2007). Death rate and risk factors for dementia in a local community. *Journal of Korean Neuropsychiatric Association*, 11(1), 25-28.
- Shin, H. E., Chang, I. J., Cho, M. J., Song, K. B., & Choi, Y. H. (2018). Structural equation modeling of intellectual ability, oral health-related quality of life, and cognitive function in some elderly urban residents. *Journal of the Korean Academy of Oral Health*, 42(4), 159-166.