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Relationship between Oral Health-related Factors and Dementia-related Factors: A Cross-sectional Study

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Objectives: Since dementia and oral health are closely related, we confirmed the relationship between oral health and dementia-related factors.
Methods: This study was analyzed 140 people collected in questionnaires for about a month. Correlation analysis was performed to confirm the relevance of variables.
Results: The oral health knowledge and dementia prevention behavior score were improved in the high group of oral health behavior. Also, oral health behavior was related to oral health knowledge and dementia prevention behavior, and oral health knowledge was related to dementia anxiety and dementia prevention behavior ($p<0.05$).
Conclusions: These results suggest that improving oral health behavior and oral health knowledge is important to improve dementia prevention behaviors.

Keywords Dementia, Health, Health behavior, Knowledge, Oral health

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Ⅰ. Background

Dementia is a lifelong disease that requires national responsibility because the burden on the family of dementia patients is very high. In South Korea, the cost of managing dementia patients was 13.2 trillion KRW (Korean Won) in 2015 and is estimated to balloon to 34.3 trillion KRW in 2030 and 106 trillion KRW in 2050 [1]. Globally, dementia management costs about USD 818 million a year, accounting for 1.1% of the world's gross domestic product (GDP). It has thus become a financial problem worldwide as well as in South Korea [2].

Dementia is classified into Alzheimer's dementia, vascular dementia, or dementia caused by central nervous system disease or physical disease. Alzheimer's dementia accounts for about 70% of all dementia cases, but prevention is most important as there is no cure to date [3]. Dementia is an irreversible disease that can't be cured, so the dementia anxiety increases with age. In South Korea, 4 out of 10 people over 60 years of age reported that they fear dementia the most, more than cancer and cardiovascular diseases like stroke [4]. The United States has reported that adults over 55 years of age fear dementia more than cancer [5], and in France, 59.97% of adults over 18 years of age reported in a survey that they fear dementia [6]. As such, cognitive impairment of dementia devastates the lives of the patients and their families, so dementia anxiety increases as aging progresses.

Cognitive impairment in dementia patients affects their oral hygiene management, becoming a significant impediment to their oral health. The systemic inflammatory responses induced by periodontitis have been reported to increase the risk of developing dementia [7]. Several studies have reported that dementia and oral health are closely related to each other [8]. In particular, in a previous study, as the serum markers of the periodontal pathogen *P. gingivalis* increased, cognitive functions like word memory were lowered. In addition, when 10 dementia patients' brain tissues were examined within 12 hours postmortem, *P. gingivalis*-derived LPS was identified in the brains of 4 dementia patients [9]. The pooled relative risk of dementia in relation to periodontitis from all high quality studies was

1.38 (95%CI 1.01-1.90), in the five cohorts was 1.18 (1.06-1.31) and in the two case-control studies 2.25 (1.48-3.42). It has been reported that the systemic inflammatory response due to periodontal disease increases the risk of cognitive impairment and dementia, and causes poor oral conditions in dementia patients, such as fewer residual teeth due to severe dental caries [10]. In a national cross-sectional study in the United Kingdom, there were 2.6 times more cognitive impairment cases in edentulous patients among people aged 65 years and older [11]. In South Korea, a community-based study also found that dementia progressed 1.61 times faster in people with missing teeth and without dentures [12]. Therefore, to prevent the progression of dementia, promoting oral health practice is very important by making people realize that dementia and oral health are closely associated with each other.

To practice oral health, regular oral check-ups and proper brushing should be made a habit. A longitudinal study over 6 years examining the relationship between oral health care and cognitive function changes reported a significant correlation between low brushing frequency and progression of cognitive impairment [13]. Brushing is the most basic way to maintain oral health, and efforts are needed to improve oral health practice because brushing alone cannot prevent dementia. Therefore, it is necessary to check people's dementia knowledge, anxiety, and prevention behavior according to the degree of their oral health behavior. Most of the relevant studies [7-13,14] to date, however, have confirmed the relationship between dementia and oral disease [7-13], and the relationships among dementia knowledge, dementia anxiety, and dementia prevention behavior in elderly people [14]. Dementia prevention behavior refers to lifestyle and eating habits to prevent dementia. Until now, few studies have confirmed the relationship between oral health behavior and oral health knowledge to improve of dementia prevention behavior and reduce anxiety about dementia. Therefore, the purpose of this study was to confirm the difference between dementia knowledge, dementia anxiety, and dementia prevention behavior according to the level of oral health behavior, and to confirm the relationship between oral health-related factors and dementia-related factors.

Ⅱ. Methods

1. Subjects of study

This study was cross-sectional survey, and conducted by after receiving IRB review from the Institutional Review Board of Silla University (No. 1041449-201912-HR-002). Copies of the questionnaire were distributed to senior citizens aged 50 or older living in South Korea for about a month from January 10, 2020, and were immediately recovered after filling it out. G*Power 3.1 was used to determine the sample size and was set to t-test and two-tails. It with a 0.05 significance level, 80% power, and a 0.5 medium effect size. As a result, the sample size was calculated to be 128, and considering the unclear answers, a total of 140 subjects were determined. For the survey, subjects aged 50 or older were openly recruited, and the purpose of the study was sufficiently explained. As a result, a total of 140 people agreed to participate, and only seven out of 147 people in the study refused to participate (98.2% of the respondents). The exclusion criteria were persons with a diagnosis of mental illness, including dementia and this study followed established guidelines for reporting medical surveys [15]. The Researchers designed the questionnaire by adapting questions from previous surveys [16-20]. A pilot study was conducted among ten patients of similar ages to detect comprehension problems and assess if the questions responded to the research aims. After the pilot study, a few questions were modified, and the implementation phase started. Data were collected with a modified questionnaire. Most subjects filled out the questionnaire themselves, but in the case of subjects who had difficulty understanding the questionnaire, the researcher explained and collected data. Demographic data such as participants' age, gender, medical history, and interval of visits to dentistry were also collected.

2. Study tools

1) Oral health behavior

The questionnaire on oral health behavior consisted of 20 items (2 questions for regular treatment, 13 questions for brushing teeth, 4 questions for eating habits, and 1 question for oral

care products) formulated by referring to the study by Kim et al. [16]. The questionnaire took about 20 minutes, and each item consisted of 'very good', 'good', 'normal', 'bad', and 'very bad'. "very good" is 5 points and "very bad" is 1 point, which means that the better the oral health behavior, the higher the score. In this study, the Cronbach's α was 0.87, and the way to distinguish the high oral health behavior (HOHB) and low oral health behavior (LOHB) are the 'ranking case' of the IBM program. Based on the cumulative percentage of 49.3%, the two groups were classified as LOHB for 85 points or less and HOHB for 86 points or more. The average of LOHB was 73.77, and the average of HOHB was 92.03.

2) Oral health knowledge

The questionnaire on oral health knowledge consisted of 10 items (4 questions of brushing teeth, 1 question of oral disease, 2 questions of eating habits, 1 question of smoking, 1 question of fluoride, 1 question of regular oral examination) formulated by referring to the study by Shin [17]. The questionnaire took about 15 minutes, and a correct answer was scored as 1 point, and an incorrect answer was scored as 0 points. Therefore, the higher the score, the higher the oral health knowledge. In this study, the Cronbach's α was 0.41.

3) Dementia knowledge

The questionnaire on dementia knowledge consisted of 12 items (3 questions of cause of dementia, 3 questions of dementia symptoms and diagnosis, 4 questions of prevention and treatment of dementia, and 2 questions of dementia patient care), all of which were developed by Seoul City [18]. The questionnaire took about 15 minutes, and a correct answer was scored as 1 point, and an incorrect answer was scored as 0 points. Therefore, the higher the score, the higher the dementia knowledge. The Cronbach's α was 0.57 at the time of development, and 0.45 in this study.

4) Dementia anxiety

The questionnaire on dementia anxiety consisted of 5 items formulated by referring to the study by Park et al. [19]. The answers to each question are 'always afraid', 'often afraid', 'sometimes afraid', 'not afraid', and 'not afraid at all'. 5 points for 'always afraid' and 1 point for 'not afraid at all'. A higher score for dementia anxiety means higher fear. The questionnaire took about 5 minutes, and the Cronbach's α was 0.87.

5) Dementia prevention behavior

For dementia prevention behavior, the instrument developed by Lee et al. [20] was used, which consisted of 12 items (4 questions of stress management, 3 questions of disease management, 3 questions of lifestyle habits, and 2 questions of diet). The answers to each question, dementia prevention behaviors are 'always', 'often', 'sometimes', 'don't do it', and 'don't do it at all'. 5 points for 'always' and 1 point for 'don't do it at all'. A high score on the dementia prevention behavior means that the prevention behavior for dementia is good. The questionnaire took about 10 minutes, and the Cronbach's α was 0.72.

3. Statistical analysis

For statistical analysis, IBM SPSS ver. 25.0 (IBM Co., Armonk, NY, USA) was used. The oral health behavior was analyzed through frequency analysis, and the comparison of oral health knowledge and dementia knowledge according to the level of oral health behavior was conducted using chi-square test and independent t-test. The comparison of dementia anxiety and dementia prevention behavior according to the level of oral health behavior was conducted using Mann-Whitney U-test, a non-parametric analysis method. We did correlation analysis to confirm the relevance of oral health knowledge, dementia knowledge, dementia anxiety and dementia prevention behavior and oral health behavior.

Ⅲ. Results

1. Demographic characteristics of subjects

For the results of the demographic characteristics of the subjects, there were more women than men, and 61 years of age or older than those under 61. There were more groups

taking the drug than the non-medication group, and more groups without the disease than the group with the disease. There were more people who visited the dentist only when they had a toothache than those who visited the dentist regularly for oral health management <Table 1>.

2. Oral health behavior

For the results of the examination of the subjects' oral health behavior, item 2 ("I get treatment immediately if I have toothache") had the highest level while item 18 ("I do not eat tough and hard foods as much as possible") had the lowest level as seen in Table 2. In addition, the subjects' oral health behavior scores were 83.03 on average, and based on 85 points, with a cumulative percentage of 49.3%, those who got a score of 85 or less were classified as belonging to the LOHB group, and those who got a score of 86 or higher were classified as belonging to the HOHB group.

3. Oral health knowledge according to the level of oral health behavior

For the results of the examination of the subjects' oral health knowledge according to their oral health behavior level, there were significant differences between the HOHB and LOHB groups in item 3 ("When brushing, place the bristles between your teeth to clean thoroughly."), item 4 ("When brushing your teeth, you should also brush your tongue."), and item 9 ("The use of toothpaste containing fluoride is effective in preventing tooth decay"), and in the total score for oral health knowledge as seen in Table 3. The total score of oral health knowledge is out of 10. The group with LOHB scored 8.42 points, and the group with HOHB scored 9.07. Therefore, oral health knowledge was higher in the HOHB than in the LOHB group ($p<0.05$).

4. Dementia knowledge according to the level of oral health behavior

For the results of the examination of the subjects' dementia knowledge according to their oral health behavior level, there was a significant difference only in item 2 ("Alzheimer's disease is the most common cause of dementia.") as seen in Table 4 ($P<0.01$). The total score of dementia knowledge is out of 12. The group with LOHB scored 7.57 points, and the group

<Table 1> Demographic characteristics

		N	%
Sex	Male	51	36.4
	Female	89	63.6
Age	50-60	51	36.4
	61-70	73	52.1
	71-80	16	11.1
Medication	Don't take medicine	62	44.3
	Take medicine	78	55.7
Disease	No	72	51.4
	High blood pressure	26	18.6
	Diabetes	8	5.7
	Liver disease	1	0.7
	Osteoporosis	9	6.4
	Etc	24	17.1
Dental visit interval	Dental visits every 3-6 moths	19	13.6
	Dental visits every 1 year	47	33.6
	Dental visits every 2-3 years	7	5.0
	Visit the dentist only if I have a toothache	67	47.9

<Table 2> Oral health behavior

Oral health behavior	N=140
1. I have a regular oral health checkup.	3.71± 1.37
2. I get immediate treatment if my teeth hurt.	4.63± 0.92
3. I brush my teeth well to prevent cavities.	4.62± 0.87
4. I brush my teeth more than three times a day.	4.04± 1.27
5. I brush my teeth within three minutes after eating.	3.87± 1.25
6. I brush my teeth for more than 3 minutes.	4.09± 1.15
7. When I brush my teeth, I rotate my toothbrush to do my best.	4.20± 1.19
8. I also brush my gums and tongue when I brush my teeth.	4.55± 1.01
9. I always brush my teeth after a meal, after a snack, before going to bed.	4.01± 1.24
10. When I can't brush my teeth, I rinse it with water.	4.43± 1.05
11. I don't eat anything after brushing my teeth before going to bed.	4.30± 1.04
12. The size of the toothbrush head is adequate for one to two molars.	4.31± 1.21
13. I use a new toothbrush before it bends.	4.56± 1.01
14. I use dental floss or interdental toothbrush as well as toothbrush.	3.57± 1.45
15. I keep my toothbrush head up.	4.51± 1.08
16. I try to eat a lot of milk, fruit, and vegetables.	4.16± 1.12
17. I don't eat too sweet food for snacks.	3.56± 1.48
18. I don't eat tough and hard food as much as I can.	3.32± 1.55
19. I chew food evenly from side to side.	4.31± 1.09
20. I use toothpaste with fluoride.	4.27± 1.19
Subject's average score	83.03±12.65

<Table 3> Comparative on the oral health knowledge correct rate and oral health behavior level

Oral health knowledge	Oral health behavior level		
	LOHB group (N=69)	HOHB group (N=71)	*p*
1. You get cavities when you don't brush your teeth often.	61(88.4)	63(88.7)	.952
2. The cause of periodontitis is the biofilm.	57(82.6)	61(85.9)	.591
3. When brushing, place the bristles between your teeth to clean thoroughly.	61(88.4)	70(98.6)	.014*
4. When brushing your teeth, you should also brush your tongue.	59(85.5)	68(95.8)	.036*
5. You should brush your teeth before going to bed.	49(71.0)	60(84.5)	.055
6. Fruits, milk, and vegetables are foods that help clean teeth.	43(62.3)	53(74.6)	.116
7. Chocolate, cookies, and candy are foods that cause tooth decay.	64(92.8)	65(91.5)	.791
8. Tobacco is harmful to oral health.	63(91.3)	68(95.8)	.281
9. Toothpaste containing fluoride has the effect of preventing cavities.	58(84.1)	67(94.4)	.049*
10. Regular dental checkups are effective in preventing tooth decay.	66(95.7)	69(97.2)	.626
±Subject's average score	8.42±1.43	9.07±1.03	.003*

By chi-square test, ±independent t-test

with HOHB scored 8.08. Therefore, dementia knowledge was higher in the HOHB group than in the LOHB group, but there was no significant difference.

5. Dementia anxiety according to the level of oral health behavior

There were no significant differences in all the items on

<Table 4> Comparative on dementia knowledge correct rate and oral health behavior level

Dementia knowledge		Oral health behavior level		
		LOHB group (N=69)	HOHB group (N=71)	*p*
Causes of dementia	1. As you get older, dementia will inevitably occur.	59(85.5)	58(81.7)	.542
	2. Alzheimer's disease is the most common cause of dementia.	32(46.4)	49(69.0)	.007*
	3. A stroke can cause dementia.	40(58.0)	47(66.2)	.316
Symptoms of dementia	5. Remembering things from a long time ago is not dementia.	38(55.1)	43(60.6)	.511
	6. Dementia can change your personality.	55(79.7)	60(84.5)	.459
	7. Dementia can be seen only if it exhibits strange behavior.	36(52.2)	34(47.9)	.612
Prevention of dementia	4. There is no way to prevent dementia.	49(71.0)	48(67.6)	.662
	8. There is also dementia that can be cured completely.	30(43.5)	36(50.7)	.392
	9. Medication is helpful for dementia.	59(85.5)	65(91.5)	.261
	10. Regular exercise reduces the risk of dementia.	63(91.3)	69(97.2)	.134
Dementia care	11. Dementia makes it impossible to live with family.	31(44.9)	26(36.6)	.317
	12. Dementia patients are not judgmental, so they can be cared for without explaining to the patient.	30(43.5)	39(54.9)	.175
*Subject's average score		7.57±2.14	8.08±1.87	.128

By chi-square test, *independent t-test

<Table 5> Comparative on dementia anxiety and oral health behavior level

Dementia anxiety	Oral health behavior level			
	LOHB group (N=69)	HOHB group (N=71)	*z*	*p*
1. I'm afraid of forgetting myself.	4.48±0.98	4.69±0.67	- .840	.401
2. I'm afraid it would be burdensome for my family to take care of me.	4.59±0.77	4.72±0.61	-1.043	.297
3. I'm afraid there's no one to look after me.	4.25±1.16	4.15±1.29	- .060	.952
4. I'm afraid because dementia is not a curable disease.	4.52±0.87	4.72±0.79	-1.877	.061
5. I am afraid of the cost of nursing.	4.42±1.19	4.54±1.07	- .683	.495
Subject's average score	22.26±4.17	22.82±3.59	- .569	.569

By Mann-Whitney U-test

dementia anxiety according to the level of oral health behavior, showing that the dementia anxiety is very high regardless of oral health behavior as seen in Table 5.

6. Dementia prevention behavior according to the level of oral health behavior

For the results of the examination of the dementia prevention behavior according to the level of oral health behavior, there were significant differences in item 4 (“Do you read newspapers or magazines?”), item 5 (“Do you eat enough vegetables or fruits?”), and item 7 (“Do you manage disease well?”), and in the total score for dementia prevention behavior as seen in Table 6. The group with LOHB scored 46.52 points, and the group with HOHB scored 50.24. Therefore, dementia prevention behavior was higher in the HOHB group than in the LOHB group (P<0.05).

7. Correlations among oral health behavior, oral health knowledge, dementia knowledge, dementia anxiety, and dementia prevention behavior

Table 7 shows the results of confirming the correlation between oral health behavior and oral health knowledge, dementia knowledge, dementia anxiety, and dementia prevention behavior. Oral health behavior was related to oral health knowledge and

<Table 6> Comparative on dementia prevention behavior and oral health behavior level

Dementia prevention behavior	Oral health behavior level			
	LOHB group (N=69)	HOHB group (N=71)	*z*	*p*
1. Do you smoke?	3.96±1.39	4.21±1.34	-1.717	.086
2. Do you drink alcohol?	2.80±1.51	3.23±1.48	-1.628	.103
3. Do you eat regular meals?	4.16±1.07	4.37±0.93	-1.260	.208
4. Do you read newspapers, magazines, etc.?	3.19±1.62	3.79±1.46	-2.165	.030*
5. Do you eat enough vegetables and fruits?	3.88±1.27	4.55±0.65	-3.132	.002*
6. Are you maintaining your usual weight?	4.17±1.09	4.44±0.86	-1.425	.154
7. Do you usually take good care of your disease?	4.19±1.09	4.51±0.86	-1.990	.047*
8. Do you exercise more than 20 minutes a day for a week?	3.86±1.20	4.32±0.99	-2.541	.011*
9. Do you usually relieve stress well?	4.29±1.14	4.44±0.77	- .007	.994
10. Are you trying to live happily?	4.64±0.82	4.65±0.78	- .047	.963
11. Do you often do handwork (embroidery, sewing, etc.)?	3.20±1.51	3.38±1.55	- .728	.467
12. Do you often talk or sing with your friends?	4.19±1.14	4.37±0.93	- .713	.476
Subject's average score	46.52±7.92	50.24±5.63	-2.847	.004*

By Mann-Whitney U-test

<Table 7> The relationship between oral health behavior and oral health knowledge, dementia knowledge, dementia anxiety and dementia prevention behavior

	A	B	C	D	E
A	1				
B	.321**	1			
C	.076	-.137	1		
D	.083	.241**	-.114	1	
E	.324**	.192*	.087	.074	1

A; Oral health behavior, B; Oral health knowledge, C; Dementia knowledge, D; Dementia anxiety, E; Dementia prevention behavior, **p<0.01, *p<0.05. Correlation analysis

dementia prevention behavior, and oral health knowledge was related to dementia anxiety and dementia prevention behavior.

Ⅳ. Discussion

Many studies have shown that dementia is closely related to oral health [7-14], and it is vital to practice oral health to prevent dementia. Most people have high awareness of the importance of oral health but very low oral health behavior [21]. Therefore, examining the relationships among dementia knowledge, dementia anxiety, and dementia prevention behavior in groups with high and low oral health behavior scores is necessary. For the results of the examination of the subjects' oral health knowledge according to their oral health behavior level, the group with HOHB had high oral health knowledge. This is consistent with a study [22] that reported that the higher the interest and knowledge about oral health, the higher the oral health behavior. In this study, the subjects' dementia knowledge was not related to their oral health behavior level, and low scores were obtained in 4 of the 12 items on oral health behavior while high scores were obtained in only 2 of such items. In addition, it was confirmed that the subjects' dementia knowledge was not high, with 7 items having less than 60% correct answers. As such, active education to increase dementia knowledge is necessary.

Compared to the subjects' dementia knowledge, their dementia anxiety was very high, with a score of 4 or higher in all the items. Dementia anxiety refers to an emotional response that recognizes the fear of developing dementia, and the subjects answered that they feared losing their identity due to dementia [23]. The fear of dementia was the family burden [14] or family damage [19] that it may entail or cause. In South Korea, 78.2% of the subjects in a study reported that they feared dementia [19]. As such, dementia anxiety was very high in all the items on such, regardless of the level of oral health behavior. In this study, the relationship between dementia anxiety and dementia prevention behavior was not confirmed, but in the 3-year follow-up study by Mah, Binns, and Steffens [24], the higher the dementia anxiety was, the greater the risk of dementia. In particular, the elderly people with severe anxiety were 2.35 times more likely to develop dementia. As there is a close relationship between dementia anxiety and dementia, in-depth research on dementia anxiety and dementia prevention behavior is expected in the future. This study confirmed that the group with HOHB was more likely to take dementia prevention behaviors than the group with LOHB. These results are consistent with the results of studies [14] suggesting that there is a relationship between the frequency of brushing and cognitive impairment. Therefore, it has been confirmed that oral health behaviors and dementia prevention behaviors are very closely related, so further studies will be needed to confirm causality. In this study, oral health behaviors, oral health knowledge, and dementia prevention behaviors were related, and oral health knowledge, dementia anxiety, and dementia prevention behaviors were also related. Since this study only confirmed the relationship between dementia and oral health, there is a limit to explaining the causal relationship between dementia and oral health. However, this study is considered meaningful because few studies have confirmed the relationship between knowledge, anxiety and preventive behavior of dementia and oral health. The first limitations of this study are that sample size is small, which limits the generalizability of the study results. Second, the reliability of the questionnaire on dementia knowledge and oral health knowledge investigated in this study was low. Third, the criteria for the high and low oral health behavior groups were divided for convenience in order to simply divide them into two groups, so the criteria were ambiguous. As a final limitation, the relationships among oral health behavior, dementia knowledge, dementia anxiety, and dementia prevention behavior cannot be categorized into causal relations; therefore, further research on this should be conducted. Despite these limitations, it is considered to be of sufficient value to provide basic data confirming the relationship between oral health-related factors and dementia-related factors. As a result of this study, it is important to inform the public that the actions to prevent dementia are related to practicing oral health. Effective dissemination of this information will require a collaborative and continuous effort by dementia specialists and oral health care professionals.

V. Conclusions

This study examined the associations among oral health knowledge, dementia knowledge, dementia anxiety, and dementia prevention behavior according to the level of oral health behavior. The study results confirmed that oral health knowledge and dementia prevention behaviors were higher in the group with HOHB than those with LOHB, and that oral health knowledge, dementia anxiety, and dementia prevention behaviors were related. Therefore, to prevent dementia, active education is required on the relationship between dementia and oral health, and efforts should be made to improve people's oral health behavior.

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