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RESEARCH ARTICLE

Association of Sleep Duration and Depression with Periodontitis in Older People Aged 65 Years and Older

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Background: Sleep disorder is a precursor to depression, which is one of the psychological factors associated with periodontal disease that, in turn, affects general and periodontal health. This study aimed to investigate the relationship between sleep duration, depression, and periodontitis in older people aged over 65 years.

Methods: A total of 2,002 older adults aged 65 years or older were included in the study. Their general and health aspects, including smoking, drinking, diabetes, hypertension, and depression, were investigated. Periodontitis was examined using the Community Periodontal Index (CPI). Data were analyzed through a complex sampling design method. Frequency and crossover analyses were conducted to investigate the relationship between depression and periodontitis. To investigate the effect of depression on periodontitis, a logistic regression analysis was performed.

Results: Regarding depression and participants' general characteristics, statistically significant differences were found in sex, economic activity, smoking habit, and CPI ($p<0.05$). In the presence of depression, the odds ratio for periodontitis was 1.84, and the adjusted odds ratio for age, sex, economic activity, residence type, household income, education level, smoking habit, drinking, hypertension, and diabetes was 1.72, representing a significant difference ($p<0.05$).

Conclusion: This study examined the relationship between depression and periodontitis in older persons and confirmed a significant correlation. As the population of older adults increases, we should pay attention to their mental and oral health as well as systemic diseases. Various programs for the health promotion of older persons need to be implemented to improve the quality of life of older people.

Key Words: Depression, Older persons, Periodontitis, Sleep

Introduction

The health of older persons may be affected by the physical and psychological factors that appear with the decline of physiological functions as they age and their social and economic activities decrease[1)]. As the roles of older persons decrease, their income decreases, and their health problems worsen. Supporting older persons appears to be a social problem, the resolution of which has been a focus of a number of studies[2)].

Sleep is a basic physiological activity in human life and has a positive effect on the maintenance of one's health and the improvement of quality of life, including recovery of physical functions and mental recharge[3)]. With age, the number of suprachiasmatic nuclei cells, which are involved in sleep, decreases, and the signals that control sleep and neurological activity weakens[4)]. In particular, many changes in sleep for older persons are recognized as components of the process of aging; about half of the population of older adults complain of insomnia[5)]. Changes in sleep patterns lead to decreased social confidence and social activities owing to increased frequency of naps and sleep deprivation[6)]. Older persons who do not sleep enough are 1.12 times more likely to die early even if they do not

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have any other diseases[7], and less than six hours of sleep is associated with an increased morbidity rate in all chronic diseases, compared with seven to eight hours of sleep[8]. Kong and Han[9] investigated the association between sleep duration and periodontal disease, a chronic disease, but found no significant correlation.

Sleep disorders that keep patients from getting deep sleep are a precursor to depression[10]. Older adults often experience depression with sleep disorders owing to physical senescence, financial difficulties, and loneliness in the aftermath of the death of a spouse. Depression is also associated with suicide and impaired cognitive function[11]. The depression rate of older persons aged 65 years or older in Korea has increased from 14.8% in 2013 and 16.2% in 2015 to 16.9% in 2017[12]. Depression is more likely to occur in older adults with physical or sensory impairments owing to negative emotional reactions; however, they can be treated with proper interventions[13,14].

The prevalence of periodontal disease, a chronic disease in which the dental plaque attached to the surface of the tooth causes tooth loss in older persons[15], increases with age and is associated with sex, smoking, general health, and psychological factors[16]. Depression, a common disease in psychiatry, is also one of the psychological factors associated with periodontal disease[17]. Depression can alter a patient's immune response and adversely affect general as well as periodontal health[18]. Depression is also associated with factors that increase the risk of periodontal disease, such as smoking and drinking alcohol[19].

This study was designed to investigate the correlation between sleep duration, depression, and periodontitis in older persons aged 65 years or older in Korea. Studies that have explored the relation between sleep duration or depression and oral health in older adults on a large-scale in Korea are limited. Therefore, we hope that this study will help promote oral health in older persons with depression or sleep disorders.

Materials and Methods

1. Participants

This study was conducted using the second and third raw data of 2015 and 2016 from the sixth National Health and Nutrition Survey data collected through health questionnaires and clinical reports. The data were analyzed by calculating the variance estimator, address numbers of the survey areas, and weight of the questionnaire; subsequently, a plan file was produced. The total number of initial subjects was 14,930. Among them, 3,134 participants were aged 65 years or older; of them, 1,132 participants, who did not respond to the oral health examination and questionnaire, were excluded. The final number of participants was 2,002.

2. Method

The general variables were sex, age, economic activity, type of housing, household income, education level, smoking and drinking habits, hypertension, and diabetes. The psychological factors were sleep duration and depression; the mean sleep duration per day was categorized into "less than six hours," "six to eight hours," and "nine hours or longer," whereas depression was classified into "yes" and "no"[20].

Dentists examined periodontal health status using the Community Periodontal Index (CPI) for the oral health variables[21]. The CPI is used to examine the periodontal pockets of the standard teeth in the six segments in the oral cavity, or the first and second molars on the upper right, lower right, upper left, and lower left jaw, the upper right central incisor, and the lower left central incisor, using periodontal probes. The score was 0 if the periodontal tissue was healthy, 1 point if it was bleeding, 2 points if it had calculus tartar, 3 points if the periodontal pocket was shallow (4～5 mm), and 4 points if the periodontal pocket was deep (6 mm or more). The maximum score of each segment was selected as the representative score, and scores of 0～2 points were classified into the "normal" group, whereas scores of 3 points or higher were classified into the "periodontitis" group.

3. Data analysis

Complex sample analysis was performed, and frequency and cross analysis were carried out for the general characteristics of the oral health status. Sleep duration and depression according to general characteristics were

Table 1. Characteristics of the Subjects according to Oral Health Condition

Variable	Total (n=2,002)	Community Periodontal Index		p-value
		Healthy	Periodontitis	
Age (y)				0.274
65～69	760 (37.5)	380 (35.6)	380 (39.4)	
70～74	630 (29.0)	331 (29.4)	299 (28.6)	
≥75	612 (33.5)	330 (35.0)	282 (32.0)	
Sex				<0.001[a]
Male	872 (43.0)	394 (37.0)	478 (49.3)	
Female	1,130 (57.0)	647 (63.0)	483 (50.7)	
Economic activity				0.007[a]
Worker	663 (32.2)	305 (28.9)	358 (35.7)	
Non-worker	1,339 (67.8)	736 (71.1)	603 (64.3)	
Residence type				0.057
Alone	421 (18.8)	220 (18.9)	201 (18.7)	
Spouse	887 (40.7)	430 (38.1)	457 (43.5)	
Others	694 (40.5)	391 (43.0)	303 (37.8)	
Income (home)				0.377
Low	906 (45.9)	462 (45.3)	444 (46.5)	
Middle-low	581 (27.8)	300 (27.4)	281 (28.3)	
Middle-high	308 (15.9)	157 (15.5)	151 (16.4)	
High	207 (10.4)	122 (11.8)	85 (8.8)	
Education				0.189
Elementary	1,204 (61.9)	639 (63.2)	565 (60.4)	
Middle	290 (13.7)	142 (12.8)	148 (14.6)	
High	346 (16.8)	171 (15.4)	175 (18.3)	
≥College	162 (7.7)	89 (8.6)	73 (6.7)	
Smoking				<0.001[a]
Done or do	757 (37.7)	344 (33.0)	413 (42.7)	
None	1,245 (62.3)	697 (67.0)	548 (57.3)	
Alcohol				0.461
Yes	1,484 (73.7)	762 (72.9)	722 (74.6)	
No	518 (26.3)	279 (27.1)	239 (25.4)	
Hypertension				0.031[a]
Yes	928 (46.6)	493 (49.2)	435 (43.9)	
No	1,074 (53.4)	548 (50.8)	526 (56.1)	
Diabetes				0.919
Yes	400 (20.7)	198 (20.6)	202 (20.8)	
No	1,602 (79.3)	843 (79.4)	759 (79.2)	
Sleep time				0.040[a]
<6	541 (26.3)	303 (28.6)	238 (23.8)	
6～8	1,274 (64.3)	653 (63.3)	621 (65.4)	
≥9	187 (9.4)	85 (8.1)	102 (10.8)	
Depression				0.010[a]
Yes	78 (3.6)	49 (4.6)	29 (2.6)	
No	1,924 (96.4)	992 (95.4)	932 (97.4)	

Values are presented as n (%).
The data were analyzed by reflecting complex weighted sample design ($p<0.05$).
[a]Chi-square test.

Table 2. Characteristics of the Subjects according to Sleep Time and Depression

Variable	Sleep time			p-value	Depression		p-value
	<6	6~8	≥9		Yes	No	
Age (y)				0.011[a]			0.536
65~69	180 (34.8)	521 (39.5)	59 (30.9)		33 (42.6)	727 (37.3)	
70~74	192 (32.0)	383 (28.5)	55 (23.8)		27 (29.2)	603 (29.0)	
≥ 75	169 (33.2)	370 (31.8)	73 (45.3)		18 (28.2)	594 (33.7)	
Sex				<0.001[a]			0.017[a]
Male	160 (28.8)	628 (48.4)	84 (45.5)		20 (25.3)	852 (43.6)	
Female	381 (71.2)	646 (51.6)	103 (54.5)		58 (74.7)	1,072 (56.4)	
Economic activity				0.096			0.049[a]
Worker	150 (28.6)	451 (34.1)	62 (29.1)		13 (20.3)	650 (32.6)	
Non-worker	391 (71.4)	823 (65.9)	125 (70.9)		65 (79.7)	1,274 (67.4)	
Residence type				<0.001[a]			0.554
Alone	157 (26.7)	224 (15.5)	40 (19.5)		20 (22.0)	401 (18.7)	
Spouse	207 (33.9)	597 (43.2)	83 (42.9)		29 (34.9)	858 (41.0)	
Others	177 (39.4)	453 (41.3)	64 (37.7)		29 (43.1)	665 (40.3)	
Income (home)				0.131			0.343
Low	277 (50.3)	538 (43.1)	91 (52.6)		40 (54.36)	866 (45.6)	
Middle-low	141 (25.4)	384 (28.8)	58 (27.7)		22 (28.4)	559 (27.8)	
Middle-high	76 (14.8)	207 (17.0)	25 (11.9)		9 (10.6)	299 (16.1)	
High	47 (9.5)	147 (11.1)	13 (7.9)		7 (6.7)	200 (10.5)	
Education				<0.001[a]			0.135
Elementary	368 (69.1)	697 (57.0)	139 (74.9)		54 (74.5)	1,150 (61.3)	
Middle	62 (10.2)	204 (15.4)	24 (11.7)		10 (8.1)	280 (13.9)	
High	81 (15.2)	247 (18.5)	18 (9.8)		10 (12.3)	336 (17.0)	
≥College	30 (5.5)	126 (9.1)	6 (3.6)		4 (5.1)	158 (7.8)	
Smoking habit				<0.001[a]			0.005[a]
Done or do	156 (28.3)	259 (41.3)	72 (39.7)		20 (22.0)	737 (383)	
None	385 (71.7)	745 (58.7)	115 (60.3)		58 (78.0)	1,187 (61.7)	
Alcohol				0.010[a]			0.836
Yes	384 (70.2)	970 (76.2)	130 (65.9)		19 (27.7)	499 (26.3)	
No	157 (29.8)	304 (23.8)	57 (34.1)		59 (72.3)	1,425 (73.7)	
Hypertension				0.068			0.373
Yes	301 (56.8)	663 (51.4)	110 (58.7)		45 (59.2)	1,029 (53.1)	
No	240 (43.7)	611 (48.6)	77 (41.3)		33 (40.8)	895 (46.9)	
Diabetes				0.170			0.348
Yes	105 (20.7)	246 (19.8)	49 (27.0)		20 (25.4)	380 (20.5)	
No	436 (79.3)	1,028 (80.2)	138 (73.0)		58 (74.6)	1,544 (79.5)	
CPI				0.040[a]			0.010[a]
Healthy	303 (56.1)	653 (50.9)	85 (44.6)		49 (65.7)	992 (51.1)	
Periodontitis	238 (43.9)	621 (49.1)	961 (48.3)		29 (34.3)	932 (48.9)	

Values are presented as n (%).
The data were analyzed by reflecting complex weighted sample design ($p<0.05$).
[a]Chi-square test.
CPI: Community Periodontal Index.

cross-analyzed, and a logistic regression analysis was performed to investigate the effect of depression on CPI. SPSS 25.0 for Windows (IBM Corp., Armonk, NY, USA) was used, and the statistical significance level was set to 0.05.

Results

1. Differences in Community Periodontal Index according to general characteristics

Of the 2,002 participants aged 65 years and over, 872 were male and 1,130, female; 663 (32.2%) were economically active, and 1,339 (67.8%) were not economically active; 757 (37.7%) had a history of smoking, and 1,245 (62.3%) did not. Regarding mean sleeping duration, 541 (26.3%) had less than six hours, 1,274 (64.3%) had six to eight hours, and 187 (9.4%) had nine hours or longer. Lastly, 78 (3.6%) were depressed. When examining the general characteristics using CPI, statistically significant differences were observed in sex and economic activity between the two groups of "normal" and "periodontitis" ($p < 0.05$). Those who had a history of smoking, had high blood pressure, or had depression showed statistically significant differences, compared with those who did not have either of the above; sleep duration also showed significant differences ($p < 0.05$; Table 1).

Table 3. Logistic Regression Analysis for Association between Depression and CPI

Variable	Category	CPI	
		Crude OR (95% CI)	Adjusted OR (95% CI)
Sleep time	6～8	1	1
	＜6	0.81 (0.65～1.01)	0.87 (0.68～1.10)
	≥9	1.28 (0.90～1.84)	1.29 (0.89～1.87)
Depression	No	1	1
	Yes	1.84 (1.15～2.93)*	1.72 (1.06～2.79)*
Age (y)	65～69		1
	70～74		1.07 (0.82～1.39)
	≥ 75		1.26 (0.97～1.63)
Sex	Male		1
	Female		1.69 (1.23～2.31)*
Economic activity	Worker		1
	Non-worker		1.21 (0.95～1.53)
Residence type	Others		1
	Spouse		1.16 (0.91～1.47)
	Alone		1.23 (0.91～1.67)
Income (home)	High		1
	Middle-high		1.41 (0.88～2.26)
	Middle-low		1.27 (0.83～1.95)
	Low		1.36 (0.87～2.13)
Education	≥College		1
	High		1.43 (0.93～2.19)
	Middle		1.40 (0.89～2.18)
	Elementary		1.38 (0.91～2.10)
Smoking habit	Non-smoking		1
	Smoking		0.96 (0.71～1.29)
Alcohol	No		1
	Yes		1.14 (0.88～1.49)
Hypertension	No		1
	Yes		0.75 (0.61～0.92)
Diabetes	No		1
	Yes		1.02 (0.78～1.34)

Mean±standard deviation were analyzed by reflecting complex weighted sample design. Linear regression.
The data were analyzed by reflecting complex weighted sample design. Logistic regression.
Adjusted for age, gender, economic activity, Residence type, income (home), education, Smoking habit, alcohol, hypertension, diabetes.
CPI: Community Periodontal Index, OR: odds ratio, CI: confidence interval.
*$p < 0.05$.

2. Differences between sleep duration and depression according to general characteristics

There were significant differences in the three categories of sleep duration (less than six hours, six to eight hours, and nine hours or more) by age, sex, type of living, education level, smoking and drinking habit, and CPI ($p < 0.05$). Those who had depression showed statistically significant differences in the following general characteristics: sex, economic activity, smoking habit, and periodontal infection according to CPI ($p < 0.05$; Table 2).

3. Effects of sleep duration and depression on Community Periodontal Index

Table 3 shows the association between sleep duration or depression and CPI. For those who had a mean sleep duration of six to eight hours, the risk ratio of periodontitis was 1.29 times lower than that for those who had a mean sleep duration of more than nine hours, but there was no statistically significant difference ($p > 0.05$). The risk ratio of periodontitis was 1.84 times higher among those who had depression, and after adjusting for age, sex, economic activity, type of housing, household income, education level, smoking habit, drinking, high blood pressure, and diabetes, the risk ratio was 1.72 times (1.06～2.79) higher, compared with those who did not have depression, to a statistically significant degree ($p < 0.05$).

Discussion

According to the 2014 National Health and Nutrition Survey, the average sleep duration of Koreans aged 65 years or older was 6.3 hours per day. Sufficient sleep is important for normal functioning of the body and brain[22]. Sleep impacts the immune system and is responsible for the latter's proper functioning[23]. Lee et al.[24] reported that poor sleep quality decreases high density lipoprotein cholesterol and increases inflammatory leukocytes, which may act as a risk factor for cardiovascular diseases. Moreover, sleep deprivation and sleep disorders have been reported to be closely related to periodontitis, a chronic inflammatory disease[22]. Sleep deprivation leads to extreme fatigue, stress, and poor oral health behavior, leading to poor oral hygiene, which can cause periodontitis[25]. Hong[26] concluded that the risk of periodontitis is 1.37 times higher in the group with less than six hours of sleep per day, whereas Do and Lee[27] reported that those who slept less than seven hours per day have a higher risk of periodontitis, compared with those who slept seven hours or more per day. The present study showed that CPI was 1.29 times higher in those whose mean sleep duration was nine hours or more, but no significant difference was found ($p > 0.05$).

There are not many studies on the biological mechanisms related with periodontal disease and sleep duration, and there is also a limit in explaining direct causality. Therefore, more research has to be conducted. Lee[6] reported that the amount of physical activity and sleep duration are correlated; specifically, the overall activity of older persons is 30.3% lower compared with younger adults, especially in the afternoons. Older persons should be encouraged more to participate in programs provided by individuals as well as the community to increase their physical activity and to help them achieve adequate sleep duration. Sleep duration is also closely related to depression in older persons. Depression can be predicted from sleep disorders, and the prevalence of sleep disorders increases as depression becomes severe[28].

According to Chun and Jung[29], the prevalence of depression in Koreans aged 65 years and older is 20.1%; it has increased as the number of family members living together decreased. However, in the current study, no difference was observed. Jeon and Kim[30] found that the job satisfaction of older persons has the greatest impact on depression. In our study, statistically significant differences in depression were found in the groups with and without economic activity ($p < 0.05$). Rosania et al.[31] reported that stress or depression is related to the destruction of the periodontal tissue through behavioral patterns or psychological mechanisms. Kwon and Yoon[32] found that perceived oral health tends to be poor among patients with depression. In our study, the risk ratio of periodontitis during depression was 1.72 times higher. This finding indicates that depression is associated with periodontal disease, and that it is necessary to prevent oral diseases and maintain healthy oral activity in these patients. Meanwhile, Kim and Won[17] did not find statistically significant associations between depression and periodontal disease. However, if depression

becomes severe, patients are less likely to take care of their oral health and receive dental care; therefore, they require support in paying attention to their own oral health.

In this cross-sectional study, one limitation was that only 78 participants (3.6%) reported having depression. Nonetheless, this study was meaningful because it examined older person aged 65 years and older using data from the National Health and Nutrition Survey, which has a large sample size. Another limitation of this study was that the oral examination was conducted using CPI. Although it is good for examining large populations, researchers have suggested that the clinical attachment loss, along with the depth of periodontal pockets, should be used for more accurate diagnoses of periodontitis in future.

This study examined the relation between depression and periodontitis in older persons and found statistically significant differences across the studied groups. As the population of older persons grows, their mental and oral health, as well as general health, should be given more attention. Various programs need to be developed to improve and maintain their quality of life more systemically and holistically.

Notes

Conflict of interest

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

Ethical approval

This study was approved by Institutional Review Board of the Kyungpook National University (KNU-2019-0121).

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