



Sleep Disturbances and Depression Associated With Cognitive Function As Well As Activities of Daily Living in Older Adults With Very Mild to Mild Dementia

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Objective: The present study compared cognitive function and the ability to perform daily activities in subjects with very mild to mild dementia, classified by the presence or absence of sleep disturbances and depression. **Methods:** A total of 1,188 psychiatric outpatients (457 males and 731 females, mean age=74.65±5.83 years) were recruited. Sleep disturbances were measured by the Korean version of the Neuropsychiatric Inventory and depression was measured by the Korean Geriatric Depression Scale. Cognitive function was assessed using the Korean version of the Mini-Mental State Examination (K-MMSE), immediate recall, delayed recall, and verbal fluency. The ability to perform daily tasks was measured by the Seoul-Instrumental Activities of Daily Living (S-IADL). **Results:** Participants with both sleep disturbances and depression as well as those with depression only had significantly lower K-MMSE, immediate and delayed recall, and verbal fluency scores and higher S-IADL scores than the normal group. Also, those with both sleep disturbances and depression showed the highest S-IADL scores among groups. However, there were no significant differences between subjects with sleep disturbances only and the normal group in all cognitive functional areas and S-IADL. **Conclusion:** The present study found the differences in cognitive function and the ability to perform daily tasks among patients with mild dementia according to their sleep disturbances and depression. Our findings suggest that depression has stronger associations with cognitive and functional decline in older adults than sleep disturbances.

Keywords: Sleep disorders; Depression; Cognitive function; Activities of daily living

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INTRODUCTION

As the elderly population is increasing significantly worldwide, aging-related problems including cognitive decline have emerged as important social issues to be addressed. In particular, dementia significantly affects one's quality of life, impairing health status as well as the ability to perform daily activities, causing a serious caregiver burden [1]. The ability to perform instrumental activities represents an important aspect of functional independence of the elderly individuals. Maintaining the independence in physical and cognitive activities is critical in improving the health and quality of life among older adults [2]. In this respect,

effective early interventions may be crucial for individuals at risk of serious dementia.

Behavioral and psychological symptoms are common in individuals with mild cognitive impairment and dementia [3-5]. Among them, sleep disturbances are known to be related to poor performance in various cognitive and functional areas. For example, studies have shown that sleep quality affects cognitive functions such as memory, executive function, and processing speed [6-8]. In addition, sleep is essential for health recovery and survival, and insufficient sleep leads to loss of appetite and fatigue, causing obstacles to daily life activities [9]. Sleep quality tends to deteriorate in old age due to shorter sleep hours and increased

sleep disturbances, which can lead to dysfunction in physical activities during the day [10].

Depression is another important factor underlying decline in cognitive functions in older adults. Depressive symptoms have been associated with lower performance on memory, language, and visuospatial and executive function in older population [11,12]. Especially among those with early dementia, depressive symptoms were found to amplify the risk of functional decline [13]. Furthermore, depression is associated with loss of interest in daily activities and increased dependence and attachment, which can result in a decline in the ability to perform instrumental activities independently [14].

Studies have indicated that sleep quality and depression are closely linked to each other, and the connection between them seems to be bidirectional [15,16]. People with chronic sleep disturbances such as insomnia are more likely to develop depression, as chronic insomnia interferes with the activity of the hypothalamic-pituitary-adrenal axis [17,18]. Also, individuals with depression are inclined to have sleep problems, since depression inhibits the secretion of melatonin, disrupting one's circadian rhythm [19]. Considering the mutual relationship between sleep disturbances and depression, it can be predicted that the impact on cognitive function and daily activities of the elderly will be greater when the two issues are concurrent.

Given these lines of evidence, sleep disturbances and depression could collectively as well as individually lead to decline in cognitive function. Thus, the present study attempted to investigate the differences in cognitive function and activities of daily living among groups divided by the presence of sleep disturbances and depression. We hypothesized that people with either sleep disturbances or depression, or both would show greater cognitive decline and impairment of instrumental activities than those with neither. Also, we hypothesized that individuals who suffer from both sleep disturbances and depression would show the lowest performance in cognitive function and daily activities among all groups.

METHODS

Participants

This study involves 1,188 outpatients aged 65 or older (457 males [38.5%] and 731 females [61.5%], mean age=74.65±5.83 years) who visited the Department of Psychiatry at Samsung Medical Center between 2006–2018 for cognitive impairment. The subjects were diagnosed with stages 0.5 (very mild dementia) to 1 (mild dementia) of the Clinical Dementia Rating (CDR) [20]. All participants provided informed consent, and the study protocol was approved by the Institutional Review Board of Samsung Medical Center (IRB file no. 2017-10-018).

Assessment of sleep disturbances

Sleep disturbances were assessed using the sleep disorders item from the Korean version of the Neuropsychiatric Inventory

(NPI) [21]. The caregivers of the patients were interviewed concerning the patients' sleep behaviors. If the caregiver responded that sleep-related difficulties were present in the past month, frequency, severity, and composite scores were rated. The frequency could vary from 1 to 4 (1=less than once a week, 2=about once a week, 3=several times a week, 4=daily or continuously) and the severity is rated from 1 to 3 (1=mild, 2=moderate, 3=severe). The composite score is a product of the frequency and the severity (maximum=12). In accordance with the previous study, those who scored 4 or higher were assigned to sleep-disturbed group [22].

Assessment of depression

Depressive symptoms were assessed using the Korean Geriatric Depression Scale (KGDS), a 30-item questionnaire in a yes or no format that measures symptoms of depression in older adults based on the patients' mood over the previous week. In general, a score of 0–13 is considered normal, 14–18 mild, 19–21 moderate, ≥22 severe depression [23]. As commonly recommended for clinical purposes, a cutoff score of 18 was used to classify depressed group and non-depressed group [24].

Assessment of cognitive function

Cognitive function was assessed using four measures: the Korean version of the Mini-Mental State Examination (K-MMSE), immediate recall, delayed recall, and verbal fluency. The MMSE is a 30-item questionnaire that measures cognitive impairment including domains for orientation, concentration, memory, language, and praxis, with lower scores indicating poorer cognitive functioning [25]. Immediate and delayed recall were derived from the Korean Auditory Verbal Learning Test. Immediate recall score was the number of words the patient recalled immediately after hearing a list of 15 nouns five times, with a total score ranging from 0 to 75. Delayed recall score was the number of words the patient recalled after a 20-minute delay, with a total score ranging from 0 to 15 [26]. Verbal fluency score was the sum of acceptable words the patient produced within 60 seconds from two categories: animals and objects.

Assessment of activities of daily living

Activities of daily living was assessed using the Seoul-Instrumental Activities of Daily Living (S-IADL), which evaluates the patient's ability to perform tasks that he or she needs to manage to live independently in a community. The major domains of S-IADL includes cooking and household chores, using transportation, taking medications, managing finances, keeping appointments, and so on. A higher score represents greater impairment of instrumental activities of daily living, with a total score ranging from 0 to 45 [27].

Statistical analysis

Once the participants were divided into groups based on sleep disturbances and depression, analysis of variance, and chi-square test were performed to compare the differences in sociodemo-

graphic characteristics. Thereafter, analysis of covariance (ANCOVA) was conducted to examine the differences in the mean values of the cognitive function and activities of daily living variables across groups, with age, sex, and years of education as covariates. When the ANCOVA test found a significant difference among the groups, Fisher's least significant difference test was used as a post hoc test. All analyses were conducted using SPSS Statistics Ver. 22.0 (IBM Corp., Armonk, NY, USA).

RESULTS

The participants were categorized into four groups based on the presence of sleep disturbances and depression: 1) normal group without sleep disturbances nor depression (N; n=637, 53.6%), 2) depressed group without sleep disturbances (D; n=301, 25.3%), 3) sleep-disturbed group without depression (SD; n=120, 10.1%), and 4) sleep-disturbed and depressed group (SDD; n=130, 10.9%). The general characteristics of the participants across groups are described in Table 1. A group difference was found in the number of academic years demonstrating that participants in the sleep-disturbed and depressed (SDD) group as well as those in the depressed group without sleep disturbances (D) had significantly lower education than those in the sleep-disturbed group without depression (SD) and those in the normal (N) group ($F=9.42$, $p<0.001$). Moreover, the prevalence of the normal group was found to be the highest in those who were diagnosed as both CDR 0.5 and 1 ($\chi^2=15.12$, $p=0.019$). There were no significant differences in terms of age and sex among groups.

Table 2 presents the results of the ANCOVA comparing the mean scores of cognitive function variables and S-IADL across four groups. The participants with both sleep disturbances and depression showed significantly lower MMSE scores than those with sleep disturbances only ($p=0.002$) and those without sleep disturbances nor depression ($p=0.025$). Similarly, those with depression only showed significantly lower MMSE scores than the sleep-disturbed group ($p<0.001$) and the normal group ($p=0.004$).

Immediate recall and verbal fluency scores demonstrated patterns of mean differences among groups similar to that of MMSE scores. Those with both sleep disturbances and depression had significantly lower immediate recall and verbal fluency scores compared to the group with sleep disturbances only (immediate recall, $p=0.033$; verbal fluency, $p=0.006$) and the normal group (immediate recall, $p=0.010$; verbal fluency, $p=0.001$). Those with depression only also had significantly lower immediate recall and verbal fluency scores compared to the group with sleep disturbances only (immediate recall, $p=0.027$; verbal fluency, $p=0.024$) and the normal group (immediate recall, $p=0.002$; verbal fluency, $p=0.001$). However, the MMSE, immediate recall, and verbal fluency scores of the sleep-disturbed and depressed group were not significantly different from those with depression only.

Compared to the normal group, the sleep-disturbed and depressed group as well as the depressed group without sleep disturbances showed significantly lower delayed recall scores (group SDD, $p=0.017$; group D, $p=0.001$). The delayed recall scores were not significantly different between the group with depression only and the group with both sleep disturbances and depression.

Table 1. Sociodemographic characteristics according to sleep disturbances and depression

	Normal (N) (n = 637)	Depression without sleep disturbances (D) (n = 301)	Sleep disturbances without depression (SD) (n = 120)	Sleep disturbances and depression (SDD) (n = 130)	p-value
Age (yr)	74.98±5.92	74.04±5.72	74.44±5.61	74.62±5.75	0.137
Sex					0.105
Female (n=731)	380 (52.0)	202 (27.6)	68 (9.3)	81 (11.1)	
Male (n=457)	257 (56.2)	99 (21.7)	52 (11.4)	49 (10.7)	
Education (yr)	10.33±5.09	8.74±4.84	10.57±5.05	8.86±4.81	<0.001
CDR					0.019
0.5 (n=872)	491 (56.4)	207 (23.6)	89 (10.2)	85 (9.8)	
1 (n=316)	146 (46.2)	94 (25.3)	31 (10.1)	45 (10.9)	

Data are presented as mean±SD or n (%). CDR, Clinical Dementia Rating

Table 2. Cognitive function and activities of daily living according to sleep disturbances and depression

Cognitive function	Normal (N) (n=662)	Depression without sleep disturbances (D) (n=331)	Sleep disturbances without depression (SD) (n=136)	Sleep disturbances and depression (SDD) (n=149)	F-value	Post hoc analysis
K-MMSE	24.15±4.20	23.31±4.22	24.87±3.60	23.26±4.52	6.14***	SDD=D<N=SD
IR	24.82±9.74	22.85±8.81	25.03±10.40	22.57±8.75	4.85**	SDD=D<N=SD
DR	3.27±3.16	2.58±2.76	3.19±3.06	2.60±2.55	4.90**	SDD=D<N
VF	22.84±8.62	21.01±8.39	22.99±7.43	20.16±7.50	6.55***	SDD=D<N=SD
S-IADL	9.67±7.31	12.78±8.45	10.62±7.61	15.08±9.69	23.94***	N=SD<D<SDD

Data are presented as mean±SD. ** $p<0.01$; *** $p<0.001$. K-MMSE, Korean version of the Mini-Mental State Examination; IR, immediate recall; DR, delayed recall; VF, verbal fluency; S-IADL, Seoul-Instrumental Activities of Daily Living

Furthermore, those with both sleep disturbances and depression showed significantly higher S-IADL scores than the other three groups (group N, $p < 0.001$; group SD, $p < 0.001$; group D, $p = 0.004$). Those with depression only had significantly higher S-IADL scores than the normal group ($p < 0.001$) and the sleep-disturbed group ($p = 0.010$). Meanwhile, the S-IADL scores were not significantly different between the sleep-disturbed group and the normal group.

DISCUSSION

The present study examined general characteristics and the differences in cognitive function and the ability to perform daily tasks in older adults with very mild to mild dementia, classified by the presence or absence of sleep-related problems and depression.

In the current study, 53.6% of the subjects belonged to the normal group, 25.3% to the depressed group without sleep disturbances, 10.9% to the sleep-disturbed and depressed group, and 10.1% to the sleep-disturbed group without depression. The co-prevalence of sleep disturbances and depression in the present analysis is in line with the comorbid nature of sleep disorders and depression in older adults [28]. Among the four groups, the group with both sleep disturbances and depression as well as the group with depression only had lower educational attainment compared to the group with sleep disturbances only and the normal group. This is compatible with previous studies that lower education levels are related to increased risk of depressive symptoms [29].

The participants with both sleep disturbances and depression as well as those with depression only showed significantly lower performance than the normal group in all cognitive functional areas, including K-MMSE, immediate and delayed recall, and verbal fluency. Moreover, subjects with both sleep disturbances and depression as well as those with depression only had higher scores on S-IADL than the normal group, suggesting that poor quality of sleep and depression may hinder one's ability to carry out daily activities independently. These results are consistent with the previous findings that sleep disturbances and depression are associated with cognitive decline and dysfunction in instrumental activities in older adults [6-14].

However, those who had sleep disturbances without depression had no significant differences from the normal group in all cognitive functional areas as well as S-IADL. In other words, in people with sleep disturbances, cognitive functions and the ability to perform instrumental activities independently vary depending on whether they are accompanied with depression. This could suggest that cognitive and functional decline is more pronounced among individuals who suffer from mood symptoms such as depression together with sleep problems than those with sleep disturbances without mood symptoms.

Otherwise, such findings may have been influenced by the way sleep disturbances were measured in this study. It is possible that the NPI used to measure sleep-related problems in this study did not fully reflect the subjects' sleep complaints since it was rated

by their caregivers. Also, variables such as the duration or types of sleep disturbances, which were not measured by the NPI, may have influenced the results as confounding factors.

On the other hand, subjects with depression, whether they are accompanied with sleep disturbances or not, showed significantly lower performance than the normal group in all cognitive functional areas and S-IADL. These findings could imply that intervening in geriatric depression may be a key to maintaining cognitive function and the independence in physical and cognitive activities among older adults. Given that more than two-thirds of the older population with depression experience sleep disorders [30], active interventions for treatment of depression can help reduce sleep disturbances, thereby preventing severe cognitive and functional impairment followed by them.

Finally, as we hypothesized, participants with both sleep disturbances and depression were found to have the lowest ability to perform daily instrumental activities among groups. As shown in previous studies, the relationship between sleep disturbances and depression is bi-directional and reciprocal [15,16], implying that they have deteriorating effect on each other. Therefore, our findings suggest that serious sleep disturbances and depression may be risk factors exacerbating each other, leading to greater decline in the elderly individuals' independence in physical and cognitive activities.

There are several limitations of this study that need to be addressed. First, the subscale of the NPI is subjective and does not fully capture the concept of sleep disturbances. Using more comprehensive measures such as the Pittsburgh Sleep Quality Index would provide more information on the specific aspects of one's sleep disturbances. Secondly, the cognitive tasks assessed in our study may not represent an individual's overall cognitive function. Finally, the cross-sectional design prevents us from verifying the longitudinal effects of sleep disturbances and depression on cognitive function and daily activities of older adults.

In conclusion, the current study revealed the differences in cognitive function and the ability to perform daily tasks among the elderly according to their sleep disturbances and depression. Despite several limitations, our study provides information on risk factors contributing to cognitive and functional decline among the elderly individuals, which could be utilized in promoting more effective intervention strategies, especially for patients with mild dementia. Further studies on the concurrent nature of sleep disturbances and depression would lead to a better understanding of the associations of sleep and depression with the quality of life in the elderly population.

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Conflicts of Interest

The authors have no potential conflicts of interest to disclose.

Availability of Data and Material

The datasets generated or analyzed during the study are available from the corresponding author on reasonable request.

Author Contributions

Conceptualization: Doh Kwan Kim. Data curation: Doh Kwan Kim, Jieun Han. Formal analysis: Doh Kwan Kim, Jieun Han. Funding acquisition: Doh Kwan Kim. Investigation: Doh Kwan Kim, Jieun Han. Methodology: Doh Kwan Kim, Jieun Han. Project administration: Doh Kwan Kim. Resources: Doh Kwan Kim. Software: Doh Kwan Kim, Jieun Han. Supervision: Doh Kwan Kim. Validation: Jieun Han. Visualization: Jieun Han. Writing—original draft: Jieun Han. Writing—review & editing: Doh Kwan Kim.

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