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Original Article

Factors Influencing Sleep Duration and Sleep Difficulty in People with Chronic Obstructive Pulmonary Disease

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Abstract

Background: Although sleep problems are prevalent among people with chronic obstructive pulmonary disease (COPD), many research gaps exist in this area. The aims of this study were to identify sleep duration and sleep difficulty in people with COPD and to determine factors influencing these sleep variables.

Methods: This cross-sectional study employed data from the 8th Korea National Health and Nutrition Examination Survey (KNHANES) performed in 2019. A total of 408 people with COPD were included in the study. Individuals' sociodemographic, COPD-related, and psychological characteristics were examined to determine factors affecting their sleep duration and sleep difficulty.

Results: Of 408 study subjects, almost 95% had mild or moderate COPD. The mean sleep duration of the subjects was 6.73 hours per day, indicating short sleep duration. Subjects with elementary school or no education, middle individual income, unmarried status, or depression were more likely to have shorter sleep duration than those with middle or high school education, low individual income, married status, or no depression. In addition, over 54% of subjects experienced mild to severe sleep difficulty. Female gender, low family income, and more perceived stress were significantly associated with greater sleep difficulty.

Conclusion: Among the study subjects, over 40% had short sleep duration or mild to severe sleep difficulty. Although COPD severity was not significantly associated with sleep duration or sleep difficulty, sociodemographic disparities in sleep health were observed.

Keywords: Chronic obstructive pulmonary disease; Sleep difficulty; Sleep duration

Introduction

Sleep plays an important role in physical and mental growth, healing, immune function, cardiopulmonary function, and metabolism (1). However, in people with chronic obstructive pulmonary disease (COPD), sleep may place physiological stress on the respiratory system, and such stress can reduce gas exchange and oxygen saturation (2,3). Consequently, most people with COPD suffer from sleep difficulty, sleep disturbance, or poor sleep quality (4).

Sleep duration refers to total sleep time during the night. According to the National Sleep Foundation's updated sleep duration recommendations (5), 7 to 9 hours of sleep duration is recommended for adults between 26 and 64 years old, and 7 to 8 hours is recommended for older adults aged 65 and above. Although there is no sleep duration

guideline for people with COPD (6), such individuals commonly report less than 7 hours of sleep duration (7,8). Furthermore, people with COPD reported sleep difficulty, including problems with falling asleep and staying asleep, frequent nocturnal awakenings, and unrefreshing sleep despite adequate sleep time (3,9,10).

Although understanding and managing sleep problems in people with COPD are priorities, the research in this area has been limited in various ways (3). First, despite the high prevalence of sleep problems in the COPD population, little sleep research focusing on this population has been performed in Asian countries or in national studies. Because sleep exhibits much variability that is affected by the environment and sociocultural structures, examination of sleep and its influencing factors in the Korean COPD population could improve understanding of their sleep problems. Moreover, as no Korean national studies have identified factors associated with sleep in people with COPD, epidemiologic data are critically needed to predict the future impacts of COPD. Second, although significant disparities in sleep health exist depending on age, gender, race/ethnicity, and socioeconomic status (SES) (11), little is known about such disparities in the COPD population. As sleep is a universal phenomenon, social structures such as demographic characteristics and SES have incentivized insufficient sleep and resulted in sleep difficulty (11). In people with COPD, the influence of health disparities and SES on disease etiology and outcomes is especially evident (12). As previous research has shown a strong relationship between COPD and SES (12), identification of sleep disparities among people with COPD may reveal modifiable factors that can be targeted for intervention.

This study was conducted to characterize sleep duration and sleep difficulty in people with COPD and to determine factors significantly associated with these sleep variables using data from a population-based study conducted in South Korea. This article was prepared in accordance with the STROBE reporting checklist.

Methods

Participants

This cross-sectional study involved analysis of data from the 8th Korea National Health and Nutrition Examination Survey (KNHANES) conducted between January and December 2019. The KNHANES is a nationally representative annual survey targeting noninstitutionalized Korean citizens residing in the Republic of Korea. The survey data are collected by the Division of Chronic Disease Surveillance, Korea Centers for Disease Control and Prevention (KCDC).

The inclusion and exclusion criteria

Among the 8,110 participants in the 2019 KNHANES, people with COPD were identified using the ratio of forced expiratory volume in 1 second (FEV_1) to forced vital capacity (FVC) measured by pulmonary function test. A total of 527 individuals were identified as having COPD based on a ratio of $FEV_1/FVC < 0.7$ according to the Global Initiative for Chronic Obstructive Lung Disease (GOLD) criteria (13). Under the exclusion criteria, 72 people having a history of or current pulmonary disease other than COPD (i.e., asthma, pulmonary tuberculosis, or lung cancer) were excluded. In addition, 47 people who completed only their demographic survey were excluded. Finally, 408 people with COPD were included.

Participant characteristics

Variables for sociodemographic, COPD-related, and psychological factors were included as predictors in this study. For sociodemographic variables, data on age, gender, education, employment, individual income, family income, history of receiving welfare, marital status, and history of smoking were collected using clinical questionnaires.

The COPD-related variables included COPD severity, sputum, and cough. COPD severity was classified into four groups using FEV_1 percent predicted (FEV_1pp) values based on the COPD GOLD criteria: mild (≥80%), moderate (50-79%), severe (30–49%), and very severe (<30%) (13). For both sputum and cough, participants were

asked to respond "yes" if they had experienced the symptom almost every day for more than 3 consecutive months in the previous year or "no" if not. The psychological variables were depression, perceived stress, and suicide plan. In the question on depression, participants were asked to respond "yes" if they had felt depressed during more than 2 consecutive weeks. Regarding perceived stress, participants who perceived that they experienced stress "a lot" or "fairly often" were categorized as having "more" perceived stress, while those who perceived that they experienced stress "a little" or "rarely" were categorized as "less." For the suicide plan variable, participants were asked to answer "yes" if they had ever planned to commit suicide during the previous year or "no" if not.

Sleep duration and sleep difficulty

Sleep duration was calculated as mean sleep duration values for weekdays and weekends. Participants were asked to separately provide their mean hours of sleep duration during weekdays (working days) and weekends (non-working days).

Sleep difficulty was measured using one of the eight items of the Korean Health-related Quality of Life Instrument (HINT-8), which has been shown to be valid and reliable (14). This instrument was developed to assess the health-related quality of life of Koreans while reflecting Korean culture. Participants were asked to rate their sleep difficulty during the previous week on a Likert scale ranging from 1 to 4 points: "none at all" (1 point), "mild" (2 points), "moderate" (3 points), and "severe" (4 points). Higher scores indicated greater sleep difficulty.

Ethical approval

The KCDC Institutional Review Board (IRB) approved the KNHANES survey (No. 2018-01-03-C-A). The present study was exempted from the informed consent requirement by the IRB of Semyung University (IRB No. SMU-EX-2021-07-002).

Statistical analysis

The data were analyzed using the Stata/IC 16.1 (StataCorp, College Station, Texas, USA) statistical program. Descriptive statistics such as means, standard deviations (SDs), frequencies, and percentages were used to assess the characteristics, sleep duration, and sleep difficulty of people with COPD. To examine differences between participants' characteristics and sleep duration, a t-test or analysis of variance (ANOVA) was performed. To evaluate relationships between participants' characteristics and sleep difficulty, a Fisher's exact test was used because of the small cell values for the severe sleep difficulty category.

To determine factors associated with sleep duration, multiple linear regression analysis was performed. In addition, multiple ordinal logistic regression analysis was performed to identify factors associated with sleep difficulty. The proportional odds assumption for the multiple ordinal logistic regression was tested using the likelihood-ratio test. The results of this regression were reported as odds ratios (OR) and corresponding 95% confidence intervals (CI). In all analyses, the level of statistical significance was considered to be $p<.05$ for a two-tailed test.

Results

A total of 408 people with COPD were included in this study, and their characteristics are summarized in Table 1. Their ages averaged 66.5 years (range: 40-80), and 65.9% (n=269) of the people were male. About 95% (n=387) of the people had mild or moderate COPD, and over 7% (n=31) had experienced either sputum or cough for more than 3 consecutive months in the previous year. As for psychological factors, 8.1% (n=33) had experienced depression for more than 2 consecutive weeks, and 16.4% (n=67) perceived that they experienced more stress.

The mean sleep duration of the 408 people with COPD was 6.73 hours (SD=1.34). With respect to sleep difficulty, 45.8% of people with COPD reported no sleep difficulty, while 43.4% reported mild sleep difficulty. A total of 10.7% reported moderate or severe sleep difficulty.

Table 1: Characteristics of study subjects

Variable	*n (%)*
Sociodemographic factors	
Age (yr)	
40-64	168 (41.2)
65-80	240 (58.8)
Gender	
Male	269 (65.9)
Female	139 (34.1)
Education	
None or elementary school	135 (33.2)
Middle school	62 (15.2)
High school	128 (31.4)
College	82 (20.1)
Employment	
No	204 (50.2)
Yes	202 (49.8)
Income, individual	
Low	81 (20)
Middle	234 (57.8)
High	90 (22.2)
Income, family	
Low	105 (25.9)
Middle	234 (57.8)
High	66 (16.3)
History of receiving welfare	
No	381 (93.4)
Yes	27 (6.6)
Marital status	
Unmarried	7 (1.7)
Married	401 (98.3)
History of smoking	
No	148 (36.3)
Yes	260 (63.7)
COPD-related factors	
COPD severity	
Mild	167 (41.1)
Moderate	220 (54.2)
Severe	16 (3.9)
Very severe	3 (0.7)
Sputum	
No	377 (92.4)
Yes	31 (7.6)
Cough	
No	378 (92.6)
Yes	30 (7.4)
Psychological factors	
Depression	
No	375 (91.9)
Yes	33 (8.1)
Perceived stress	
Less	341 (83.6)
More	67 (16.4)
Suicide plan	
No	402 (98.5)
Yes	6 (1.5)
Sleep duration (hours)	6.73±1.34 (Mean±SD)
Sleep difficulty	
None at all	187 (45.8)
Mild	177 (43.4)
Moderate	41 (10)
Severe	3 (0.7)

Note. COPD, chronic obstructive pulmonary disease; SD, standard deviation

Differences in sleep duration according to participant characteristics are presented in Table 2. Sleep duration significantly differed by gender, education, individual income, marital status, history of smoking, and depression. According to Fisher's exact test results (Table 2), sleep difficulty was significantly associated with age, gender, employment, family income, history of receiving welfare, depression, perceived stress, and suicide plan.

Table 2: Sleep duration and sleep difficulty according to participant characteristics

Variable	*Sleep duration*			*Sleep difficulty*	
	Mean±SD	**t or F**	***P***	**Fisher's exact**	***P***
Sociodemographic factors					
Age (yr)		1.57	0.117	8.61	0.032*
40-64	6.85±1.25				
65-80	6.64±1.40				
Gender		2.99	0.003*	18.05	<0.001*
Male	6.87±1.29				
Female	6.45±1.39				
Education		9.79	0.020*	12.96	0.161
None or elementary school	6.42±1.48				
Middle school	6.97±1.27				
High school	6.84±1.32				
College	6.84±1.08				
Employment		0.91	0.364	9.85	0.013*
No	6.67±1.37				
Yes	6.79±1.41				
Income, individual		6.10	0.003*	8.10	0.156
Low	7.13±1.47				
Middle	6.55±1.32				
High	6.83±1.26				
Income, family		0.65	0.522	17.95	0.006*
Low	6.69±1.53				
Middle	6.71±1.33				
High	6.90±1.04				
History of receiving welfare		-1.66	0.098	8.76	0.038*
No	6.76±1.35				
Yes	6.31±1.17				
Marital status		2.90	0.004*	0.95	0.553
Unmarried	5.29±1.29				
Married	6.75±1.33				
History of smoking		-2.99	0.003*	3.50	0.281
No	6.88±1.31				
Yes	6.47±1.36				
COPD-related factors					
COPD severity		2.25	0.082	5.49	0.571
Mild	6.84±1.30				
Moderate	6.61±1.33				
Severe	7.34±1.72				
Very severe	6.17±0.29				
Sputum		0.35	0.725	5.61	0.098
No	6.73±1.32				
Yes	6.65±1.60				
Cough		-0.03	0.978	3.66	0.260
No	6.73±1.46				
Yes	6.73±1.33				
Psychological factors					
Depression		-3.15	0.002*	13.16	0.003*
No	6.79±1.33				
Yes	6.03±1.31				
Perceived Stress		1.27	0.206	8.97	0.017*
Less	6.76±1.35				
More	6.54±1.27				
Suicide plan		0.20	0.845	12.38	0.012*
No	6.73±1.33				
Yes	6.83±2.14				

Note. COPD, chronic obstructive pulmonary disease; SD, standard deviation. *P<0.05

Results of the multiple linear regression analysis are shown in Table 3. Factors significantly associated with sleep duration were education, individual income, marital status, and depression. More specifically, people with COPD who completed high school or middle school were more likely to have longer sleep duration (by 0.14 and 0.15 hour) than those who had no education or completed elementary school, respectively. Moreover, people who had a mid-level individual income were more likely to have shorter sleep duration (by 0.2 hour) than those with low individual income. Lastly, married people were more likely to have longer sleep duration (by 0.13 hour) than unmarried people, and people with depression were more likely to have shorter sleep duration (by 0.16 hour) than those with no depression.

Table 3: Factors associated with sleep duration and sleep difficulty

	Sleep duration			
Variable	**Estimate**	**SE**	***t***	***P***
Education				
None or elementary school†				
Middle school	0.145	0.498	2.73	0.007*
High school	0.138	0.161	2.46	0.014*
Over college	0.088	0.191	1.54	0.124
Income, individual				
Low†				
Middle	-0.205	0.167	-3.32	0.001*
High	-0.119	0.204	-1.86	0.063
Marital status				
Unmarried†				
Married	0.133	0.490	2.78	0.006*
Depression				
No†				
Yes	-0.156	0.239	-3.18	0.002*
	Sleep difficulty			
Variable	**OR**	**SE**	**95% CI**	***p***
Gender				
Male†				
Female	1.852	0.403	1.209-2.838	0.005*
Income, family				
Low†				
Middle	0.663	0.167	0.404-1.086	0.102
High	0.466	0.170	0.229-0.952	0.036*
Perceived stress				
Less†				
More	1.945	0.555	1.111-3.403	0.020*
Likelihood-ratio test of the proportional odds assumption: χ^2 (16)=19.99, *P*=0.221				
Note. CI, confidence interval; OR, odds ratio; SE, standard error. *P<0.05, † reference				

Results of the multiple ordinal logistic regression analysis are also shown in Table 3. As to sleep difficulty, gender, family income, and perceived stress were significant factors. Specifically, women or people having more perceived stress tended to have more sleep difficulty than men or people with less stress, while people with high family income were less likely to have sleep difficulty than those with low family income. The proportional odds assumption for the multiple ordinal logistic regression was not significant (χ^2=19.99, *P*=0.221).

Discussion

We found that people with COPD had 6.73 hours of sleep duration on average, which is less than the 7-hour recommendation for normal sleep time.

Previous research has reported that people with COPD had shorter sleep duration than people without COPD, showing 4.7 hours of sleep on average (15). Additionally, one study reported that 63.6% of people with COPD had sleep duration of less than 7 hours (16); another found that people with COPD and insomnia had 6.3 hours of mean sleep duration (10). Thus, our results are generally consistent with previous findings that short sleep duration is prevalent in people with COPD.

We found that the factors significantly associated with sleep duration were education, marital status, and depression as well as individual income. In our study, people with COPD having a low education level were more likely to have short sleep duration than those who completed middle school or high school. Furthermore, people with COPD who were unmarried tended to have shorter sleep duration than those who were married. This evidence supports previous findings that people with less than a high school education most commonly reported short sleep (17) and that being married was associated with 9 hours of nighttime sleep duration in the COPD population (16). We also found that depression was significantly associated with short sleep duration in people with COPD. The prevalence of depression in people with COPD, especially severe COPD, has been shown to be higher than in people without COPD (18). However, depression is often unrecognized in people with COPD due to difficulties in distinguishing between psychological and COPD-related symptoms (19). As depression in people with COPD is often reflected in short sleep duration, this COPD indicator should not be overlooked by clinicians.

In our study, 54.2% of people with COPD reported mild to severe difficulty sleeping. The prevalence of sleep-related problems has been inconsistently reported, ranging from 16.7% to 94% in people with COPD. For example, 35% to 94% of people with COPD were found to have poor sleep quality (4,20-22), and 16.7% to 33.1% experienced sleep disturbances (23-25). Our study findings support previous evidence of high prevalence of sleep difficulty in the COPD population, but research in this area is still sparse. As sleep difficulties have been associated with COPD exacerbation (24), poor quality of life (10), and impaired daytime functioning (26), comprehensive sleep assessment should be included in the treatment strategies of clinical settings.

We found that severity of sleep difficulty was significantly associated with gender, perceived stress, and family income. Compared to men, women with COPD were 1.9 times more likely to have greater sleep difficulty (27). In general, women experience more complex sleep difficulty that is interrelated with biological, psychological, and social factors that play different roles throughout the lifespan (28). As to perceived stress, we found that people with COPD having more perceived stress were more likely to have greater sleep difficulty than those with less perceived stress. Stress induces physiological and cognitive arousal that can contribute to insomnia and sleep disturbance (29). From a different perspective, sleep offers an opportunity for recovery from daily stress, and thus effective sleep management can relieve stress.

More severe sleep difficulty and short sleep duration have often been related to low income in various populations (17). Our study found that people with COPD having a low family income were more likely to have greater sleep difficulty than those with high income. This result is consistent with previous findings that lower income was associated with more sleep complaints (30). However, our study differed from previous research in that we found that people with COPD who had low individual income tended to have longer sleep duration than those who had mid-level individual income. In this regard, the KNHANES survey measured sleep duration simply as mean sleep duration without differentiating between nocturnal sleep time and daytime sleep. Thus, as an explanation for the discrepancy between our and previous findings, we speculate that compared to people with COPD having higher income, those with low income may have greater daytime sleep opportunity due to their lack of employment. Additional research is recommended to examine the relationship between sleep duration and income levels in the COPD population.

The relationship between SES and sleep duration is not well characterized because of the complexities of that relationship (31). As emerging evidence suggests that sociodemographic factors play important roles in sleep duration as well as in sleep problems and disorders (32), future research is required to better characterize these relationships in order to develop effective sleep interventions. Furthermore, among the previous studies employing KNHANES data, only one found that short sleep duration was significantly associated with quality of life in people with COPD, indicating that the effects of sleep duration on health outcomes remain poorly understood in the Korean COPD population (33). As the socioeconomic burden imposed by COPD in South Korea is higher than that in most other developed countries (34), greater research and clinical attention should be paid to sleep and its influencing factors in Koreans with COPD.

Limitations

This study has several limitations. First, because pulmonary function testing was performed only for participants aged 40 to 80 years, people potentially having COPD would not have been identified if they refused the test or were outside this age range. However, as the age range of high COPD prevalence is known to be 40 to 80 years, this bias was likely minimal. Second, given the characteristics of a population-based study, sleep variables as well as other variables included in our study may not have been comprehensively measured. For example, most symptom-related survey questions employed dichotomous responses of "yes" and "no." Also, for sleep duration variables, participants were simply asked to indicate their daily sleep duration without differentiating between nocturnal sleep time and daytime sleep. Nonetheless, the findings of this study enhance the external validity of the national survey. In addition, because the KNHANES first included the sleep difficulty variable in 2019, the findings of this study contribute new insights into the sleep of people with COPD.

Conclusion

This national population-based study provides evidence that people with COPD have short sleep duration, averaging 6.73 hours per day, and that over 54% experience mild to severe sleep difficulty. In the COPD population, education level, individual income, marital status, and depression were found to be significantly associated with sleep duration. The factors associated with sleep difficulty were gender, family income, and perceived stress. Development of sleep interventions for the COPD population should include consideration of the sociodemographic disparities in sleep health observed in this study.

Journalism Ethics considerations

Ethical issues (Including plagiarism, informed consent, misconduct, data fabrication and/or falsification, double publication and/or submission, redundancy, etc.) have been completely observed by the authors.

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Conflict of Interest

The authors declare that there is no conflict of interests.

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