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Original Article

The Factors Affecting Sleep Quality in Community-Dwelling Older Adults, Based on Spielman's 3P Model of Insomnia

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Abstract

Background: We aimed to identify the factors affecting sleep quality in community-dwelling older adults.

Methods: This cross-sectional descriptive study was conducted from 6 to 13 October 2021. A hypothetical model based on Spielman's 3P model of insomnia was constructed using the multiple factors that influence sleep quality in older adults. Data were collected from 114 elderly adults at two welfare centers located in, South Korea and analyzed using IBM SPSS 21.0.

Results: The hierarchical regression model showing the predictors of sleep quality was significant, and it explained 23.9% of the variance (F=9.879, *P*<.001). Pre-sleep arousal (β=0.283, *P*=.005) and sleep hygiene (β=0.269, *P*=.014) were associated with sleep quality.

Conclusion: Sleep improvement interventions which consider pre-sleep arousal and sleep hygiene for older adults may improve sleep quality.

Keywords: Insomnia; Older adult; Sleep arousal; Sleep hygiene; Sleep quality

Introduction

In South Korea, the number of patients seeking medical attention for sleep disturbances has surged, escalating from 414,000 in 2014 to 515,000 in 2017—a phenomenon significantly influenced by the rapid rate of population aging (1). Evidence from longitudinal research, such as a 20-year follow-up study in Scotland, United Kingdom (2), as well as a large-scale Korean study (3), suggests that the altered sleep structure and patterns which accompany advancing age precipitate an increase in the incidence of sleep disorders such as insomnia, thus leading to the chronic transformation of these disorders.

The prevalence of chronic insomnia disorder is seen in approximately 10% of the general population, and increases with age (4, 5). Notably, insomnia has been reported at an elevated rate of 34.6% among those aged 60–69; approximately half of the older adult population report an average daily sleep duration of less than 6 h, 70% encounter challenges in initiating and sustaining sleep, 13%–22% report experiencing daytime drowsiness, and 14%–27% take sleeping pills (3, 6, 7). A study on sleep in community-dwelling older adults showed that 67.6% of the participants perceived deterioration in the quality of their sleep (8). Given these factors, it is impera-

tive to elucidate the predictors of sleep quality in a nonclinical older adult sample and to devise interventions aimed at mitigating the adverse effects of sleep disturbance on daily functioning.

The diminution of sleep quality in older adults' manifests in an array of adverse outcomes, including mental health issues such as depression and anxiety, chronic conditions, and cognitive decline, thus adversely impacting the individual's health and quality of life (9-11). Moreover, the mortality risk escalates by 1.93 times among older adults with sleep efficiency below 80% (12). A study investigating the factors that affect sleep among community-dwelling older women found that health status, family support, depression, and quality of life had significant impacts (8, 13). The aforementioned study focused solely on older women, and did not compare sleep patterns among those not living with a spouse or family. Furthermore, the elderly sleep model was applied to community-dwelling older adults, but encountered limitations in that their examination of changes in sleep only considered mental aspects (14).

In particular, the rapid surge in the older adult population in Korea is leading to an escalation of medical expenses and caregiving burdens, thus fueling intergenerational tensions and elevating societal concerns regarding the broad spectrum of health issues confronting this population. As the nation teeters on the brink of entering a super-aged society, welfare centers dedicated to older adults are assuming a central role in nurturing those adults' health and facilitating leisure activities, with an increasing number of older individuals expressing interest in utilizing these services (15). The clientele of such welfare centers spans from healthy individuals to those with chronic conditions, indicating heightened attention and concern for their health.

Managing sleep disorders in older adults can be difficult due to their multiple comorbidities and medication side effects (16). Unfortunately, most older adults use over-the-counter medication to self-manage their sleep quality, increasing the risk of dependence and addiction, as well as cognitive impairment. In this context, there is a high level of research interest in identifying the various factors associated with sleep (17). However, studies targeting the older adult population in Korea are scarce, and analyses based on sleep-related theories are rare. As such, we established a conceptual framework to identify the predictors of sleep quality among community-dwelling older adults based on Spielman's (18) 3P model of insomnia and existing literature. This is the most widely accepted model of insomnia and combines the genetic, cognitive, and hyperarousal mechanisms with the behavioral factors in a set of predisposing, precipitating and perpetuating factors (18, 19). With reference to this model, we considered genetic factors such as sex and advancing age as predisposing factors, and demographic factors, including frequency of urination during sleep, pre-sleep arousal, perceived stress, and sleep hygiene, as precipitating and perpetuating factors of the chronic progression of insomnia.

Insomnia can be triggered by exposure to precipitating factors such as major life events (e.g., illness, separation) or severe stress in daily life. Individuals susceptible to sleep disorders may experience chronic progression of insomnia (3). Furthermore, factors such as heightened arousal levels contribute to the chronic progression of insomnia (20). In general, pre-sleep arousal is a key factor in the onset and maintenance of insomnia (21). Traditionally, pre-sleep arousal has been conceptualized into two constructs: somatic and cognitive arousal (20). Somatic arousal refers to heightened levels of physiological tension, whereas cognitive arousal refers to increased levels of cognitive activity during the pre-sleep period (21). Cognitive arousal is more pertinent to insomnia than is somatic arousal (20). Sleep hygiene refers to the establishment of good personal sleep habits (22), and a comprehensive understanding of the regular sleep hygiene of patients aids not only the correct diagnosis of insomnia, but also the differentiation of its subtypes, thus making it possible to plan a rational approach to its management (23). Accordingly, the current study aimed to select variables through a review of existing literature on sleep among older adults, identify the predictors of sleep quality using

Spielman's (18) 3P model of insomnia, and generate foundational data that can be used to formulate strategies aimed at enhancing sleep quality among older adults.

This study aims to investigate levels of sleep quality, and identify the predictors of sleep quality among community-dwelling older adults. The specific objectives were as follows:

We first examined sleep quality according to demographic characteristics among community-dwelling older adults and then assessed the correlations between pre-sleep arousal, perceived stress, and sleep hygiene among community-dwelling older adults. Lastly, we identified the predictors of sleep quality among community-dwelling older adults.

Methods

This cross-sectional descriptive study was conducted from 6 to 13 October 2021. We recruited participants from older adults who utilize two welfare centers located in S city (a metropolitan area), Gyeonggi-do, South Korea. The inclusion criteria were set as follows: 1) age ≥ 65, 2) chronic insomnia disorder, defined as difficulty falling asleep, maintaining sleep, or feeling unrested after sleeping, at least three times a week in the past three months or longer by Diagnostic and Statistical Manual of Mental Disorders-5 (DSM-5) (23), and 3) ability to understand the questionnaire and communicate. The exclusion criteria were 1) use of drugs or substances (e.g., sleeping pills) and 2) diagnosis of a mental disorder or medical disease (e.g., dementia or cognitive impairment).

The sample size was calculated using the G*Power 3.1 program. The minimal number of participants was evaluated using a regression analysis, with significance level of 0.05, effect size of 0.15, power of 0.90, and three predicting factors. At least 99 samples were required. Overall, 120 participants were initially recruited through convenience sampling in consideration of the dropout rate of 20%. After excluding six with a Pittsburgh Sleep Quality Index (PSQI) of 5 or lower, data from 114 participants were included in the final analysis.

General characteristics

General characteristics included age, sex, marital status, education level, monthly income, cohabiting family members, drinking status, smoking status, caffeine consumption, exercise status, and frequency of urination during sleep (frequency of urination immediately before going to bed and throughout sleep).

Sleep quality

Sleep quality was assessed using the Pittsburgh Sleep Quality Index developed by Buysse, Reynolds, Monk, Berman, and Kupfer (24), which assesses multiple dimensions of sleep over one month. This tool consists of 19 items in seven components: subjective sleep quality, sleep latency, sleep duration, habitual sleep efficiency, sleep disturbance, use of sleep medication, and daytime dysfunction. Each item is rated on a four-point scale ranging from 0 to 3, with the total score spanning from 0 to 21. A total score greater than 5 and an increase in the score indicated poorer perceived sleep quality. Reliability (Cronbach's α) was .83 at the time of development and .72 in this study.

Pre-sleep arousal

Pre-sleep arousal was measured using the Pre-Sleep Arousal Scale developed by Nicassio, Mendlowitz, Fussell, and Petras (21). This tool comprises 16 items, including eight items for somatic manifestations of arousal and eight items for cognitive manifestations of arousal. Each item is rated on a five-point scale from 1 (strongly disagree) to 5 (strongly agree). The total score ranges from 16 to 90, with a higher score indicating a more aroused state before going to bed. Reliability (Cronbach's α) was .89 at the time of development and .94 in this study.

Perceived stress

Perceived stress was measured using Cohen and Williamson's (25) Perceived Stress Scale. It consists of 10 items including five items for stress

perception and five items for stress coping. This scale measures the degree to which an individual has perceived their life as unpredictable, uncontrollable, and burdensome over the past month. Each item is rated on a five-point scale from 0 (never) to 4 (very frequently). The total score ranges from 0 to 40, with higher scores indicating greater perceived stress. Reliability (Cronbach's α) was .78 at the time of development and .86 in this study.

Sleep hygiene

Sleep hygiene was assessed using Yang et al.'s (26) Sleep Hygiene Practice Scale, comprising nine items for sleep behavior, seven items for sleep schedule, six items for food and drink consumption, and eight items for sleep environment. Each item is rated on a six-point scale from 1 (never) to 6 (very frequently). The total score ranges from to 30 to 180, with higher scores indicating poorer sleep hygiene. The reliability (Cronbach's α) was .88 at the time of development and 0.89 in this study.

Data collection

Before visiting the facility, we explained the purpose and content of the study to the head of the facility, conducted a pre-study meeting, and obtained permission for the study. To recruit participants, study recruitment posters were posted in the central hallway of the welfare center and in front of the program rooms. Older adults who voluntarily wished to participate and met the eligibility criteria were given detailed information about the study, and the study questionnaires were distributed after obtaining written informed consent. Assistance was provided to those who requested help by reading the questionnaire aloud and allowing them to respond. The survey was conducted in meeting and training rooms within the welfare center. Data were collected using structured questionnaires, including general characteristics and various variables. It took approximately 20 min to complete the questionnaire. All participants were offered a token of appreciation.

Data analysis

The collected data were analyzed via IBM SPSS/WIN 22.0, using the following methods. Differences in sleep quality according to participants' demographic characteristics were analyzed using an independent t-test and one-way ANOVA, followed by the Scheffé test for post-hoc comparison. Correlations among the variables were analyzed using Pearson's correlation coefficients. To identify the predictors of sleep quality, hierarchical regression analysis was performed.

Ethical considerations

This study was approved by the Institutional Review Board (EUIRB2019-75), and adhered to the principles of the Declaration of Helsinki.

Results

General characteristics

The general characteristics of the participants are shown below (Table 1). The mean age was 76.64±6.05 yr, and there were more females (n=102, 89.5%) than males (n=12, 10.5%). Eighty-four (73.7%) participants did not have a spouse. Regarding education, 41 (36.0%) participants were uneducated, and 36 (31.6%) had received all elementary education. The monthly income was predominantly below 500,000 KRW (n=53, 46.5%). Eighty-four (73.7%) participants consumed caffeine. Additionally, the most common urination frequency before going to bed and throughout sleep was three times (n=42, 36.8%), followed by four or more times (n=18, 15.9%). Examining the differences in sleep quality based on the characteristics of the participants, there was a significant difference in sleep quality according to the urination frequency during sleep (F=4.220, *P*=.003).

Table 1: General characteristics (N=114)

Characteristics	***Categories***	***n (%) or Mean±SD***	***Sleep quality***	
			Mean±SD	t or F (*P*)
Age(yr)	65~69	15 (13.2)	7.60±2.82	1.694 (.189)
	70~79	59 (51.8)	8.90±3.99	
	≥80	40 (35.1)	9.70±3.90	
		76.64±6.05		
Sex	Male	12 (10.5)	7.25±2.83	-1.687 (.094)
	Female	102 (89.5)	9.22±3.91	
Spouse	Yes	30 (26.3)	8.30±2.93	-1.378 (.172)
	No	84 (73.7)	9.27±4.12	
Education level	No education	41 (36.0)	9.61±3.94	0.913 (.437)
	Elementary school	36 (31.6)	9.11±4.10	
	Middle school	21 (18.4)	8.52±3.94	
	≥ High school	16 (14.0)	7.88±2.75	
Monthly income	None	33 (28.9)	8.42±3.76	0.538 (.586)
	< 500,000 KRW	53 (46.5)	9.28±3.87	
	≥ 500,000 KRW	28 (24.6)	9.18±3.97	
Drinking status	Yes	18 (15.8)	8.39±3.85	0.743 (.459)
	No	96 (84.2)	9.13±3.86	
Smoking status	Yes	2 (1.8)	11.00±4.24	-0.736 (.463)
	No	112 (98.2)	8.97±3.85	
Caffeine consumption	Yes	84 (73.7)	9.17±3.91	0.779 (.438)
	No	30 (26.3)	8.52±3.77	
Exercise status	Yes	93 (81.6)	9.55±4.02	0.434 (.526)
	No	20 (17.5)	8.95±3.81	
Urination frequency during sleep	None	3 (2.6)	5.33±1.53	4.220 (.003)
	1 time	20 (17.5)	7.65±3.27	
	2 times	31 (27.2)	7.97±3.57	
	3 times	42 (36.8)	9.71±3.83	
	≥ 4 times	18 (15.9)	11.28±3.91	

Variables

The mean values of the variables were analyzed (Table 2). The mean score of pre-sleep arousal was 40.31±13.84, perceived stress 15.13±6.71, sleep hygiene 78.07±20.25, and sleep quality 9.01±3.85.

Table 2: Pre-sleep arousal, perceived stress, sleep hygiene and sleep quality (N=114)

Variables	***Range***	***Mean±SD***
Pre-sleep arousal	16~90	40.31±13.84
Perceived stress	0~40	15.13±6.71
Sleep hygiene	30~180	78.07±20.25
Sleep quality	0~21	9.01±3.85

Correlations among study variables

The correlations between sleep quality and the study variables were analyzed (Table 3). Sleep quality deteriorated with increased urination frequency during sleep (r=.269, *P*=.004), increased pre-sleep arousal (r=.425, *P*<.001), and poor sleep hygiene (r=.452, *P*<.001).

Table 3: Correlations among study variables (N=114)

Factors	***Sleep quality***
	r (*P*)
Urination frequency during sleep	0.269 (.004) **
Pre-sleep arousal	0.425 (<.001) **
Perceived stress	0.120 (.204)
Sleep hygiene	0.452 (<.001) **

**P<.01

Predictors of sleep quality

The results of the hierarchical regression analysis conducted to examine the factors influencing sleep quality are presented in Table 4. The adjusted R^2 for Model I which included predisposing factor (F=8.707, *P*=.004) was 6.4%, when precipitating factors were added in Model II (F=10.579, *P*<.001), the adjusted R^2 increased to 20.3%. The final sleep quality model, which included perpetuating factors, showed an adjusted R^2 of 23.9% (F=9.879, *P*<.001). In the final model, Model III, the statistically significant variables were pre-sleep arousal (β=0.283, *P*=.005) and sleep hygiene (β=0.269, *P*=.014).

Table 4: Hierarchical regression prediction of sleep quality (N=114)

Variable	***Model I***			***Model II***			***Model III***		
	β	t	*P*	β	t	*P*	β	t	*P*
Predisposing factor									
Urination frequency during sleep	0.269	2.951	.004	0.210	2.472	.015	0.111	1.212	.228
Precipitating factors									
Pre-sleep arousal				0.398	4.422	<.001	0.283	2.849	.005
Perceived stress				-0.013	-0.149	.882	-0.046	-0.525	.600
Perpetuating factor									
Sleep hygiene							0.269	2.502	.014
F (*p*)	8.707 (.004)			10.579 (<.001)			9.879 (<.001)		
R^2	.072			.224			.266		
Adjusted R^2	.064			.203			.239		

Discussion

This study identified the predictors of sleep quality among community-dwelling older adults and is significant because it was based on Spielman's (18) 3P model of insomnia. The results of the current study indicated that pre-sleep arousal and sleep hygiene are significant predictors of sleep quality.

In our work, the mean (SD) sleep quality score (0–21) was 9.01 (3.85). A previous study (8) reported a mean PSQI score of 7.09 (4.29) in older women, indicating that our participants had poor sleep quality. We considered genetic factors such as sex and advanced age as predisposing factors, and our participants were older on average (76.64 (6.05)) compared to the participants of the past study (8) (73.17 (6.6)), in addition to being pre-

dominantly female (n=102, 89.5% vs. male n=12, 10.5%). A study focused on analyzing the National Health Insurance Sample data reported that the prevalence of sleep disorders increases with advancing age, and sex is recognized as an important factor in insomnia, where the incidence of insomnia and rate of sleep dissatisfaction are higher among women than among men, which supports our findings (27, 28).

In our study, according to the international classification of "chronic insomnia" diagnostic criteria, insomnia should last for at least three months, with a frequency of at least three times a week (23). Pre-sleep arousal and sleep hygiene were the precipitating and perpetuating factors for the chronic progression of insomnia. Additionally, the urination frequency during sleep was significantly positively correlated with sleep quality. Previous studies (8, 29) have also reported a correlation between nocturia and sleep quality in older adults. The prevalence of nocturia was higher in the group with 6–8 h of sleep than in the group with < 6 h of sleep (30). In other words, older adults with nocturia wake up frequently during sleep to urinate, which contributes to shortened sleep duration and poorer sleep quality. Nocturia is defined as waking two or more times during sleep for urination, and its prevalence increases with advancing age; further, as it negatively impacts sleep in older adults, it impairs their ability to maintain daily living activities and deteriorates their quality of life (31). To effectively manage the health of the rapidly increasing population of older adults, it is crucial to enhance sleep quality, which requires the monitoring of nocturia. Therefore, future studies should explore the use of tools to assess nocturia and employ polysomnography to objectively ascertain its relationship with sleep quality.

Pre-sleep arousal was also identified as a significant predictor of sleep quality, which is consistent with previous findings showing that pre-sleep arousal is a potent predictor of overall sleep quality (32, 33). In other words, repetitive thoughts, such as rumination and worry before sleep, can increase arousal and thus affect sleep quality (34). Therefore, future studies should foster a deeper understanding of pre-sleep arousal, particularly cognitive arousal, as a predictor of sleep quality. In particular, since cognitive arousal tends to be higher in older adults than in younger adults (34), interventions that can modulate pre-sleep arousal in older adults with insomnia, such as cognitive behavioral therapy and mindfulness-based interventions (35), should be provided to improve sleep quality.

Sleep hygiene is also a significant predictor of sleep quality. Older adults who do not practice good sleep hygiene tend to have poor sleep quality, which is consistent with study findings suggesting that insomnia is less prevalent among individuals who engage in personal sleep habits (36). Improving adherence to sleep hygiene practices offers a cost-effective way to enhance sleep quality from both the cognitive and behavioral perspectives. Awareness of sleep hygiene is higher among women and those with a higher level of education (37); however, 86.0% of the participants in this study only had middle school, or less, education. Therefore, education on sleep hygiene targeting older adults should be prioritized, and sleep hygiene education tailored to the audience's educational level ought to be developed. In other words, effective interventions with nonpharmacological approach ought to be developed based on the findings of this study. Nonpharmacological intervention focuses on environmental modification to prevent harm and injuries of older adults and improve their sleep hygiene (16). Pulmonary disease, diabetes, sleep apnea, and daytime sleepiness are predictors of sleep hygiene (38), but these relevant diseases have not been investigated. Future studies should assess comorbidities in older adults to comprehensively understand the reasons for poor sleep hygiene.

However, this study has limitations in generalizing the results because the participants were conveniently sampled from older adults who utilize in two welfare centers. Caution should be exercised when estimating factors affecting sleep quality as a function of time in cross-sectional research. Additionally, all measurements were obtained using self-report questionnaires. Self-

assessment has a potential danger that could lead towards overestimation or underestimation of subjective sleep-related factors. Nevertheless, enhancing sleep quality is crucial for maintaining proper physical and cognitive function in older adults, it is imperative to develop interventions aimed at improving sleep quality. In particular, there is a need for approaches that consider pre-sleep arousal and sleep hygiene as precipitating and perpetuating factors for the chronic progression of insomnia in older adults. Accordingly, we recommend community-based interventions for self-management and comprehensive interventions with an integrated consideration of pre-sleep arousal and sleep hygiene to improve sleep quality.

Conclusion

This study is significant because it utilized the widely used Spielman's 3P model for insomnia for identifying predictors of sleep quality. In light of our findings highlighting pre-sleep arousal and sleep hygiene as significant predictors of sleep quality, we recommend that further studies develop and evaluate nursing interventions to improve sleep quality in older adults. Additionally, we recommend that subsequent studies include a greater variety of factors that reflect the quantitative and qualitative aspects of sleep. Such findings will serve as valuable foundational data for promoting the understanding and development of standardized interventions to improve sleep quality, which significantly impacts the health and quality of life of older adults in an impending super-aged society.

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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