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Perceived sleep quality is associated with depression in a Korean elderly population

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ABSTRACT

Our study aimed to examine the relationship between perceived sleep quality and depression using Pittsburgh Sleep Quality Index (PSQI) and Cole's model to materialize the concept of perceived sleep quality in the non-cognitively impaired elderly. Older adults aged 60+ were recruited from the baseline study of Suwon Project (SP) between 2009 and 2011 (n = 2040). Perceived sleep quality was measured using the Korean version of the Pittsburgh Sleep Quality Index (PSQI-K), and depression was accessed using the Korean version of the Geriatric Depression Scale-Short Form (SGDS-K). We excluded the cognitively impaired elderly using the Korean version-Mini Mental Status Examination (K-MMSE) score less than or equal to 17. In multivariable adjusted logistic regression related to PSQI-K components, poor perceived sleep quality, including poor subjective sleep quality (Odds ratio (OR) = 1.27, 95% confidence interval (CI) = 1.01–1.61), longer sleep latency (OR = 1.32, 95% CI = 1.13–1.55) and the frequent use of sleeping medication (OR = 1.30, 95% CI = 1.10–1.53) were significantly associated with depression after adjusting for age, sex, education, living status, current smoking and current alcohol drinking, the number of comorbidity and Beck Anxiety Inventory (BAI). PSQI-K global score also had greater odds of reporting depression (OR = 1.12, 95% CI = 1.07–1.16). These results suggested that poor perceived sleep quality was associated with a greater level of depression in the elderly.

1. Introduction

The prevalence of insomnia in general population ranges from 10% to 30% in Western countries, with nearly 50% of the elderly reporting poor perceived sleep quality (Morin, LeBlanc, Daley, Gregoire, & Merette, 2006; Ohayon & Smirine, 2002). Approximately 50% of the community dwelling older adults reported poor perceived sleep quality in South Korea (Park, Yoo, & Bae, 2013). Despite the fact that poor perceived sleep quality is a common difficulty in the elderly, it has been under-diagnosed and neglected in the elderly population. Older adults and their caregivers have simply treated the poor perceived sleep quality as part of a normal aging process (Crowley, 2011).

Recently, several studies have emphasized that poor perceived sleep quality is an important warning sign of the psychiatric and medical disorders in the elderly (Ford & Kamerow, 1989; Hayashino et al., 2010; Phillips & Mannino, 2005). Older adults could not express their feelings and thoughts well verbally. In this case, assessing their sleep quality may be one way of evaluating their conditions. Among conditions related to perceived sleep

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quality, researchers have persistently focused on depression with perceived sleep quality because of its higher prevalence and adverse impact on health and the quality of life (Algul et al., 2009; Kaneita et al., 2009; Mayers, Grabau, Campbell, & Baldwin, 2009). While poor perceived sleep quality has simply been considered a symptom of depression, recent studies support a bidirectional relationship between perceived sleep quality and depression (Almeida & Pfaff, 2005; Maglione et al., 2012; Paudel et al., 2008). Many longitudinal studies have also demonstrated that perceived sleep quality is a major risk factor for developing the first onset and recurrent depression (Franzen & Buysse, 2008; Livingston, Blizard, & Mann, 1993; Perlis et al., 2006; Roberts, Shema, Kaplan, & Strawbridge, 2000; Turvey et al., 2002).

However, the relationship between perceived sleep quality and depression is unclear in the elderly. First, perceived sleep quality itself has a complex meaning that is difficult to define and measure objectively (Buysse, Reynolds, Monk, Berman, & Kupfer, 1989). Furthermore, study design, methods, and the characteristics of participants all influence the measurement of perceived sleep quality; this is because older adults may report a greater variety of perceived sleep quality than younger adults, and relying on simple methods like PSQI global score is not enough to show the complex structure of sleep quality in the elderly. Second, some researchers explained that both perceived sleep quality and depression could be easily affected by various factors in the elderly; co-morbid medical or psychiatric conditions, the number of comorbidity, alcohol problem, smoking and social isolation (Almeida, Alfonso, Yeap, Hankey, & Flicker, 2011; Paudel et al., 2008). Cognitive impairment is especially an important factor when researchers examine the relationship between perceived sleep quality and depression because it could decrease the accuracy of participants' subjective response. To the knowledge of the authors, previous studies did not exclude cognitively impaired older adults when investigating the association between perceived sleep quality and depression.

Based on the above two considerations, we aimed to examine the relationship between perceived sleep quality and depression using standardized scale and identified formulation of sleep quality among the community dwelling, non-cognitively impaired elderly. And we adjusted confounding factors that have been shown to be related to both perceived sleep quality and depression to clarify this relationship.

2. Materials and methods

2.1. Subjects

This study was based on the baseline examination derived from a large prospective study called the SP, a cohort comprising of non-random convenience samples of Koreans older than 60. In order to obtain an adequate sample, regional geriatric mental health centers were selected as the major sampling site. From 2009 to 2011, 2972 older adults who were enrolled in SP visited the public centers in Suwon city. Among them, 2327 (78.3%) older adults agreed to participate in our survey. 176 participants were excluded due to the following exclusion criteria: those with a history of significant hearing or visual impairment which rendered participation in the interview difficult, those with a history of neurological disorders (e.g., stroke, Parkinson's disease), those with psychiatric illness (e.g., schizophrenia, mental retardation, or mania), and those with a history of substance abuse except alcohol. Then we excluded the cognitively impaired elderly with a MMSE score less than or equal to 17. A Korean study in the community defined the cut-off point of the MMSE score while screening dementia as 17/18 points; the sensitivity and specificity of the findings were 91% and 86%, respectively (Kim, Shin, Yoon, & Lee, 2002). Further, based on a published article by JM Kim, the cognitively impaired was defined as the group with a MMSE score less than or equal to 17 (MMSE $\leq$ 17), and the non-cognitively impaired was defined as the group with a MMSE score greater than or equal to 18 (MMSE $\geq$ 18) (Kim et al., 2002). In total, a confirmed number of 2040 people participated in our study. The questionnaire of SP consists of 5 components: demographic factors, present or past history, life style, cognition, and mental health. All participants had given written formal informed consent to the study, which was then approved by the Institutional Review Board of Ajou University School of Medicine.

2.2. Assessments and measurements

2.2.1. Sleep quality

Sleep quality includes quantitative aspects of sleep, such as sleep duration, sleep latency, as well as more purely subjective aspects, such as subjective sleep quality. However, the exact components that consist of sleep quality may vary between individuals. So, PSQI was developed to provide reliable, valid standard measure of sleep quality (Buysse et al., 1989). The 19 self-rated questions of PSQI evaluate a wide variety of issues relating to sleep quality including the number of sleeping hours, problematic sleeping behaviors, and subjective sleep quality. They were measured on an open ended question or a 5-point Likert scale. According to the scoring guidelines provided by Buysse et al., the 19-item questionnaire is divided into seven components through various algorithms: subjective sleep quality, sleep latency, sleep duration, habitual sleep efficiency, sleep disturbance, the use of sleeping medication, daytime dysfunction (Buysse et al., 1989). The score of each component ranges from 0 to 3. These 7 components are standardized versions of area routinely assessed in clinical interviews of patients with sleep complaints. 7 components as well as 19 individual questions are internally consistent and are stable across time in clinical situation. The 7 components are summed to yield a global score of PSQI and it ranges from 0 to 21, with higher scores reflecting poorer sleep. Both global and 7 components score of PSQI could be clinically useful tools to assess sleep quality. In Korean study, a cut-off point of 8.5 in PSQI represents a sensitivity of 94% and a specificity of 84% for differentiating between 'good' and 'poor' sleepers, which is higher than the score of 5 in the original paper (Sohn, Kim, Lee, & Cho, 2012).

2.2.2. Perceived sleep quality

The concept of perceived sleep quality was adopted by a 3 factor-scoring model for PSQI, suggested by Cole, with community dwelling, both depressed and non-depressed, adults older than 60 years of age (Cole et al., 2006). Cole divided 7 components of PSQI into 3 factors; sleep efficiency, perceived sleep quality, and daily disturbances. Inspecting Cole's formulation in detail, Cole included sleep duration and habitual sleep efficiency among 7 PSQI components as part of sleep efficiency. Second, subjective sleep quality, sleep latency, and the use of sleeping medication were included as part of perceived sleep quality. Finally, Cole included sleep disturbance and daytime disturbance as part of daily disturbance. Cole insisted that this model is more reflective of the varied type and the nature of sleep quality than the original formulation of the PSQI in older population. We used Cole's formulation to interpret our results for the relationship between PSQI components and depression in the elderly. Perceived sleep quality means subjectively perceived cognition and emotions related to their night sleep. Among the 3 factors, perceived sleep quality represents more subjective and comparative aspects of sleep quality than the other factors.

2.2.3. Depression

We assessed depression using the SGDS-K, a validated self-report questionnaire for the elderly (Bae & Cho, 2004). It consists of 15 yes or no questions related to depression such as mood and feelings. A cut-off point of 8 has a sensitivity of 85% and a specificity of 69% for diagnosing a major depressive episode compared with the Diagnostic and Statistical Manual of Mental Disorders, Third Edition-Revised (DSM-III-R). GDS of elderly subjects was categorized into two groups based on clinical relevance: 0–7 (normal) and 8 (depressed).

2.2.4. Other variables

Covariates were included in multivariable models if there were known correlates of sleep quality or depression in the elderly. Socio-demographic information including age, sex, education, and living status (i.e., single or co-habitation) was recorded at baseline study. BAI was used to test for the possibility of anxiety in the elderly (Yook & Kim, 1997). Subjects were asked whether they are alcohol drinking or smoking. The presence and number of comorbid conditions has been associated with depression, which may, in turn, induce perceived sleep quality. It may also cause perceived sleep quality directly regardless of depression (Hayashino et al., 2010). So our study checked and calculated the sum of prevalent comorbidities including hypertension, diabetes mellitus, dyslipidemia, heart disease, stroke, thyroid disease, liver disease, renal disease, osteoarthritis, cataract, glaucoma, asthma, chronic bronchitis, tuberculosis, anemia, chronic gastritis, seizure, and cancer.

2.3. Statistical analysis

We investigated demographic, psychological and habitual characteristics in our participants who were divided into two groups based on PSQI global score; good sleepers and poor sleepers. The difference in each participant according to the level of PSQI global score was assessed using independent *t*-test or chi-square test. The data that were of a continuous nature and parametrically distributed were analyzed using the independent *t*-test; we used the chi-square test to compare frequencies among the categorical data. Pearson correlations were conducted to examine factors related to PSQI components and depression in the entire sample. To evaluate the association between sleep quality using PSQI components and depression, we conducted logistic regression by regressing the discrepancy between PSQI 7 component scores on GDS after adjusting for age, sex, education, living status, current smoking and alcohol drinking, the number of comorbidity and BAI in the non-cognitively impaired elderly. Then, the results of association between the two variables represented OR and 95% CI. Depression as dependent variable was treated as a categorical variable in logistic regression. PSQI global score and 7 components scores were conducted by logistic regression separately adjusting same covariates. The difference with $p < 0.05$ was considered statistically significant. SPSS version 18.0 was used for all analyses.

3. Results

3.1. General characteristics of the participants

The general characteristics of the participants are shown in Table 1. Out of the 2040 participants, 545 (26.7%) were male and 1495 (73.3%) were female; the male to female ratio was approximately 1:3. The average number of schooling was 5.8 ± 4.5 years, and age of the participants ranged from 60 to 97 and the mean age was 75.6 ± 6.7 years. Among the participants, older adults living alone were 21.0% ($n = 425$). 10.1% ($n = 199$) of the subjects were current smokers and 30.1% ($n = 589$) were current alcohol drinkers. The mean MMSE and BAI scores were 24.7 ± 3.6 and 6.0 ± 7.4, respectively. The average number of comorbid conditions reported was 1.3 ± 1.1. The mean score of GDS was 3.6 ± 3.6. The sample was stratified into two groups, with the normal group at 84.9% ($n = 1732$) and depression group at 15.1% ($n = 308$).

The differences in participant characteristics according to sleep quality are also shown in Table 1. The mean of PSQI global score was 6.0 ± 3.6. Among participants, good sleepers were 76.8% ($n = 1567$) and poor sleepers were 23.2% ($n = 473$). When we divided our participants into 2 groups based on the cut-off point of PSQI, we were able to note the significant differences of depression using independent *t*-test. Poor sleepers were more likely to be women, less educated, live alone, cognitively impaired, report more anxiety and more medical problems.

Table 1
Characteristics of participants according to sleep quality.

	Total participants $n = 2040$	Sleep quality using PSQI		
		Good sleepers (score < 8.5) $n = 1567$	Poor sleepers (score ≥ 8.5) $n = 473$	*p*-Value
Age (y)	75.6 ± 6.7	75.5 ± 6.7	76.0 ± 6.9	0.10
Sex (men %)	545 (26.7)	447 (28.5)	98 (20.7)	<0.001
Education (y)	5.8 ± 4.5	6.0 ± 4.5	5.1 ± 4.2	<0.001
Living (alone %)	425 (21.0)	300 (19.3)	125 (26.7)	<0.001
GDS	3.6 ± 3.6	3.0 ± 3.2	5.5 ± 4.2	<0.001
Depression (%)	308 (15.1)	160 (10.2)	148 (31.3)	<0.001
MMSE	24.7 ± 3.6	24.9 ± 3.5	24.2 ± 3.7	<0.001
BAI	6.0 ± 7.4	4.6 ± 5.6	10.7 ± 10.4	<0.001
Current smoking (%)	199 (10.1)	145 (9.6)	54 (12.0)	0.13
Current alcohol drinking (%)	589 (30.1)	466 (30.8)	123 (27.6)	0.19
Number of comorbidity	1.3 ± 1.1	1.3 ± 1.0	1.5 ± 1.2	<0.001
PSQI global score	6.0 ± 3.6	4.4 ± 2.0	11.3 ± 2.2	<0.001
Subjective sleep quality	1.1 ± 0.8	0.9 ± 0.6	1.9 ± 0.7	<0.001
Sleep latency	1.3 ± 1.1	1.0 ± 1.0	2.3 ± 0.8	<0.001
Sleep duration	1.4 ± 1.2	1.0 ± 1.0	2.5 ± 0.8	<0.001
Habitual sleep efficiency	0.7 ± 1.1	0.3 ± 0.7	2.0 ± 1.2	<0.001
Sleep disturbance	1.1 ± 0.4	1.0 ± 0.4	1.3 ± 0.5	<0.001
Use of sleeping medication	0.3 ± 0.8	0.1 ± 0.5	0.8 ± 1.2	<0.001
Daytime dysfunction	0.2 ± 0.5	0.1 ± 0.4	0.5 ± 0.9	<0.001

Note: MMSE (normal range: 18–30), BAI (normal range: 0–21), GDS (normal range: 0–7).

Table 2
Correlation analysis of the PSQI components and global score with other variables.

	PSQI	Subjective sleep quality	Sleep latency	Sleep duration	Habitual sleep efficiency	Sleep disturbance	Use of sleeping medication	Daytime dysfunction	Age	Sex	Education	GDS	BAI	Number of comorbidity
PSQI	1.00	0.71**	0.69**	0.69**	0.69**	0.36**	0.47**	0.42**	0.02	0.11**	−0.11**	0.37**	0.42**	0.11**
Age	0.02	0.04	0.09**	−0.04	0.02	0.02	−0.01	−0.06**	1.00	0.04	−0.24**	0.06*	−0.01	−0.03
Sex	0.11**	0.12**	0.11**	0.08**	0.04	0.06**	0.00	0.04		1.00	−0.43**	0.07**	0.15**	0.13**
Education	−0.12**	−0.13**	−0.12**	−0.04*	−0.06*	−0.10*	0.04*	−0.04			1.00	−0.16**	−0.14**	−0.06*
GDS	0.37**	0.35**	0.30**	0.10**	0.13**	0.27**	0.27**	0.27**				1.00	0.56**	0.12**
BAI	0.42**	0.40**	0.28**	0.12**	0.12**	0.43**	0.30**	0.42**					1.00	0.16**
Number of comorbidity	0.11**	0.11**	0.09**	0.00	0.05*	0.10**	0.09**	0.06**						1.00

Note: GDS (normal range: 0–7), BAI (normal range: 0–21).
* $p < 0.05$.
** $p < 0.01$.

3.2. Correlation between PSQI components, GDS, and other variables

All 7 components of PSQI and the GDS score were significantly correlated in subjects. Among them, subjective sleep quality ($r = 0.35$, $p < 0.001$) was strongly correlated with depression while sleep duration ($r = 0.10$, $p < 0.001$) and habitual sleep efficiency ($r = 0.13$, $p < 0.001$) were weakly correlated with depression in the elderly. There were also many variables in correlation to the PSQI components score. A high level of PSQI global score was significantly correlated with higher GDS score ($r = 0.37$, $p < 0.001$), lower education ($r = -0.11$, $p < 0.001$), higher BAI score ($r = 0.42$, $p < 0.001$), and more number of comorbidity ($r = 0.11$, $p < 0.001$). In particular, there was no significant correlation between PSQI global score and age in the entire sample (Table 2).

3.3. Association between perceived sleep quality and depression in the elderly

Table 3 shows the results from logistic regression model, examining the association between sleep quality assessing PSQI components score or Cole's 3-factor scores and depression, adjusted for age, sex, education, living alone, currently smoking, current alcohol drinking, BAI, and number of comorbidity. In the analysis of the relationship between 7 components of PSQI and depression, poor perceived sleep quality (OR = 1.30, 95% CI = 1.20–1.40) including poor subjective sleep quality (OR = 1.27, 95% CI = 1.01–1.61), longer sleep latency (OR = 1.32, 95% CI = 1.13–1.55) and frequent use of sleeping medication (OR = 1.30, 95% CI = 1.10–1.53) were significantly associated with higher GDS score in the elderly. In logistic regression analysis, higher levels of PSQI global score were also associated with higher odds of GDS score (OR = 1.12, 95% CI = 1.07–1.16).

4. Discussion

In the analysis of PSQI components applied to Cole's 3-factor model, we demonstrated that perceived sleep quality, including subjective sleep quality, sleep latency and the use of sleeping medication was only associated with depression in the elderly. In particular, longer sleep latency increased the highest odds of depression by 31.9% among 3 components. The use of sleeping medication and subjective sleep quality increased the odds of depression by 29.5% and 27.2%, respectively. Based on above results, we could interpret the relationship between perceived sleep quality and geriatric depression in this way. First, as we mentioned, sleep quality was generally found to consist of quantitative aspects and more subjective aspects (Buysse et al., 1989). The concept of perceived sleep quality adopted by Cole's 3-factor model was more involved in subjective aspects of sleep quality than quantitative one, such as sleep efficiency of Cole's model. Based on our results, we inferred that purely subjective aspects of sleep quality are more associated with depression than quantitative ones. Furthermore, older adults with poor perceived sleep quality at night are more likely to be associated with depression, compared to daily disturbance during daytime. According to Mayer's study, sleep satisfaction accessed by concept of perceived sleep quality is associated with depression while sleep efficiency is associated with anxiety (Mayers et al., 2009). Our results with regards to perceived sleep quality are similar to Mayer's findings. Definitely, sleep quality using PSQI global score is also associated with depression. As one point of PSQI global score increases, the odds of depression increase by 11.2%.

Our results were consistent with previous studies in regard to relationship between perceived sleep quality and depression in the elderly. For example, Maggi's cross sectional study involving 2398 community dwelling older persons aged 65 years and older was

Table 3
Logistic regression of the PSQI components and Cole's 3-factor score affecting depression after adjusting covariates.

Cole's 3-factor	PSQI 7 components	OR	95% confidence interval		*p*-Value
Sleep efficiency		0.96	0.89	1.04	0.32
	Sleep duration	0.93	0.80	1.10	0.40
	Habitual sleep efficiency	0.99	0.84	1.17	0.93
Perceived sleep quality		1.30	1.20	1.40	<0.001
	Subjective sleep quality	1.27	1.01	1.61	0.042
	Sleep latency	1.32	1.13	1.55	0.001
	Use of sleeping medication	1.30	1.10	1.53	0.003
Daily disturbance		1.13	0.92	1.38	0.25
	Sleep disturbance	1.30	0.91	1.87	0.15
	Daytime dysfunction	1.05	0.81	1.36	0.71

Note: Covariates: sex, age, education, BAI, living alone, current smoking, current alcohol drinking, number of comorbidity.

conducted to demonstrate associated factors with self-reported perceived sleep quality (Maggi et al., 1998). The participants with perceived sleep quality were almost two times more likely to have increased risk of depression. Similar to our study, Sukegawa used PSQI and GDS to measure sleep quality and depression in 2032 elderly people. Sukegawa concluded that perceived sleep quality increased the risk of depression by two times in the elderly (Sukegawa et al., 2003).

In our study, there may be some possibilities to explain the association between perceived sleep quality and depression in the elderly. First, reporting poor perceived sleep quality is involved in common symptoms of depression. It is easily understandable that depressed individuals are easy to perceive their sleep quality negatively. Individuals with depression are inclined to ruminate and worry constantly, and as a result, do more pessimistic, depressotypic interpretation of ambiguous information (Ree, Harvey, Blake, Tang, & Shawe-Taylor, 2005). This depressotypic interpretation may impede the capacity to perceive their sleep at night objectively and interrupts the person's morning judgment on sleep quality. The second is that poor perceived sleep quality might be associated with the development of depression. Poor perceived sleep quality itself produces more negative cognitions and emotions hindering sleep, like anxiety, anger, misattribution, and rumination. As these vicious cycles continue, the risk of depression increase (Alapin, Libman, Bailes, & Fichten, 2003; Rieman, Fischer, Mayer, & Peter, 2003). In this case, poor perceived sleep quality may be a marker of risk for depression. Third, perceived sleep quality and depression may share common risk factors in older population (Almeida et al., 2011). Gender, smoking, excessive drinking of alcohol, anxiety, and comorbid conditions including physical or mental disorders have been associated with both the risk of depression and perceived sleep quality (Almeida et al., 2007; Almeida & Pfaff, 2005; Almeida, Tamai, & Garrido, 1999; Foley, Monjan, Simonsick, Wallace, & Blazer, 1999; Janson, Lindberg, Gislason, Elmasry, & Boman, 2001). These shared risk factors could cause both perceived sleep quality and depression. In order to exclude confounding effects, we adjusted the covariates affecting both perceived sleep quality and depression when we conducted a statistical analysis. But it is possible that residual confounding factors that are unmeasured could still have an effect on both perceived sleep quality and depression as shared common risk factors.

Our study successfully demonstrated the following strengths. First, we had a large sample of community dwelling elderly. Second, unlike other community-based studies, we excluded cognitively impaired elderly persons using MMSE cut-off point to remove a bias. Third, we used the structural model suggested by Cole to conceptualize multidimensional aspects of sleep quality and analyzed PSQI components score as well as global score related sleep quality; it gave us a chance to understand the types or nature of perceived sleep quality in the elderly.

Despite the strengths, our study had some limitations as well. First, the cross-sectional nature of this study did not permit determination of causal relationships between perceived sleep quality and depression in the elderly. Future investigations are recommended to follow up a cohort of non-depressed subjects with poor perceived sleep quality to better understand causality between perceived sleep quality and depression in the elderly. Second, although the PSQI is a well-validated scale of sleep quality, the recall bias on the results cannot be ruled out thoroughly due to its retrospective nature. Third, the analyses were not designed to explore fully the covariates or interaction of variables influencing both perceived sleep quality and depression. Fourth, the subjects who participated in this study were not entirely representative samples of the elderly aged 60 years and above in Korea. Since our subjects were recruited from selected regional geriatric mental health centers in one city, a selection bias might be present. Our subjects are apt to be lower educational level than that of other geriatric studies. This is because the majority of participants are women and their levels of education are low. In Korea, older women had lower opportunity to be taught in their childhood due to poverty and son preference. When you interpret our results, it should be noted.

In conclusion, findings of the present study have contributed to the current literature on the relationship between perceived sleep quality and depression in the elderly. Furthermore, we supported that Cole's 3-factor model as well as original global and components score of PSQI might provide the reliable, valid measure of perceived sleep quality in geriatric studies especially related to depression.

Conflict of interest

None.

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