



Testing bidirectional relationships between marital quality and sleep disturbances: A 4-year follow-up study in a Korean cohort

Hae-Chung Yang, Sooyeon Suh, Hyun Kim, Eo Rin Cho, Seung Ku Lee, Chol Shin *

Institute of Human Genomic Study, Korea University Ansan Hospital, Korea University College of Medicine, Ansan, Republic of Korea

ARTICLE INFO

Article history:

Received 24 September 2012

Received in revised form 9 January 2013

Accepted 14 January 2013

Keywords:

Marital quality
Sleep disturbance
Moderator
Epidemiology
Longitudinal

ABSTRACT

Objective: Both poor marital quality and sleep disturbances are risk factors for a broad range of mental and physical health morbidities. The purpose of the study was to investigate bidirectional relationships between marital quality and sleep disturbance and the moderating effects of age and gender.

Methods: Data from 1081 married individuals who participated in the Korean Genome and Epidemiology Study were analyzed. A marital quality questionnaire and the Pittsburgh Sleep Quality Index were used to assess marital quality and sleep disturbances at baseline and 4-year follow-up. Relevant covariates including sociodemographics, health status, health behaviors, and depressive symptoms were also measured.

Results: Hierarchical multiple regression models revealed that there was a significant interaction between marital quality and age predicting sleep disturbance ($P = .017$). While there was no association between marital quality and sleep disturbances for the younger group (ages 45–54; $n = 680$), persons with lower marital quality were more likely to have greater sleep disturbances 4 years later for the older group (ages 55–74; $n = 401$). By contrast, sleep disturbance was a significant predictor of marital quality 4 years later, regardless of age or gender ($P = .025$).

Conclusion: Poor marital quality is a risk factor for sleep disturbance for older adults but not for middle-aged individuals. In turn, sleep disturbance may lead to lower marital quality for all age groups. Clinicians should be aware of the bidirectional relationships between marital and sleep problems for more effective treatments for both.

© 2013 Elsevier Inc. All rights reserved.

Introduction

It has been well documented that marital quality contributes not only to one's mental health outcomes, including depression and anxiety, but also to various physical health outcomes [1–3]. Sleep, a major health behavior, also has critical implications for health, from various psychiatric conditions, such as depression and substance abuse [4] to physical health conditions, such as cardiovascular and metabolic diseases [5,6]. Thus, both marital and sleep problems are risk factors for a broad range of mental and physical health morbidities. Furthermore, an emerging body of literature has indicated that marital quality and sleep disturbances are closely linked to one another, affecting health and well-being [7]. Most married individuals sleep with their partners and people with low marital quality can be vulnerable to sleep disturbances [8–10]. Sense of security and emotional down-regulation are essential for a good night's sleep. However, marital relationships

evaluated as low quality often induce negative mood and high alertness, which may contribute to poor sleep [11]. Conversely, individuals with sleep difficulties may be at greater risk for low marital quality [12,13]. That is, people with disturbed sleep often exhibit high irritability and low tolerance for negative stimuli, which in turn can promote conflictual interactions between partners [14].

Recently, a conceptual framework linking marital quality and sleep via biopsychosocial pathways has been proposed [7]. According to this model, marital functioning and sleep may have a reciprocal relationship through chronobiological (e.g., sleep–wake cycle) [15], behavioral (e.g., physical activity and substance use) [16], psychological (e.g., psychological distress, depression, and anxiety) [4,11,14], and physiological (e.g., hypothalamic–adrenal–pituitary axis, autonomic nervous system, and inflammation processes) [17,18] mechanisms. This model also posits moderating effects of various vulnerability factors such as personality, psychiatric disorders, socioeconomic status, and gender on the relationship between marital quality and sleep [2,4,11,19,20]. More recently, this conceptual framework has been expanded to include the impact of the covariation between marital functioning and sleep on mental and physical health through various physiological pathways [21].

Although reciprocal relationships between marital quality and sleep have been implicated by this model, clear inferences on bidirectional associations have not been possible due to lack of longitudinal data and

* Corresponding author at: Division of Pulmonary, Sleep and Critical Care Medicine, Department of Internal Medicine, Korea University Ansan Hospital, 516, Gojan-1-dong, Danwon-gu, Ansan-si, Gyeonggi-do, 425-707, Republic of Korea. Tel.: +82 31 412 5603; fax: +82 31 412 5604.

E-mail address: chol-shin@korea.ac.kr (C. Shin).

direct tests of bidirectionality within a sample. Recently, a couple of studies attempted to provide some direct evidence for the bidirectional nature of the relationship between sleep and marital quality. In a study of 29 couples, Hasler and Troxel [22] tested whether sleep efficiency predicted the marital interactions the following day and vice versa for 7 days, and the results showed gender-specific effects. While poor sleep predicted more negative marital interactions for males only, increased negative marital interactions predicted lower sleep efficiency for females only. Rauer and Elsheikh [23] provided a different perspective focusing on physical and psychological abuse between marital partners. In 215 couples with school-aged children, they found that both husbands and wives with sleep disturbance were more likely to engage in psychological abuse toward their partners 11 months later. However, the level of partner violence did not predict later sleep disturbance, for which they did not provide any plausible explanations. These studies have provided some novel preliminary data and invaluable insights on directionality of the relationships between sleep and marital functioning. However, the inconsistent findings within and between studies, small sample sizes, and short follow-up durations call for further studies with a larger sample and with a longer follow-up duration.

The current study utilized data from a community-based epidemiological study with a 4-year follow-up duration to determine directionality of the relationship between sleep disturbances and marital quality. Substantially longer follow-up duration of 4 years, compared to days or months from previous studies, allowed us to examine long-term effects of more persistent sleep and marital problems. Based on the theoretical framework proposed by Troxel et al. [7,21], we hypothesized that lower levels of marital quality would predict higher levels of sleep disturbances 4 years later. We also hypothesized that the reverse relationship would be true; higher levels of sleep disturbances would predict lower levels of marital quality 4 years later.

In addition, we tested moderating effects of gender on the relationships between marital quality and sleep. Although it has been suspected that the links between relationship functioning and sleep quality may be stronger for women than men due to women's greater sensitivity to both marital and sleep problems [2,24], there have been no studies directly testing this hypothesis. Age was also explored as a moderator. Marital quality in older couples may influence sleep differently in comparison with younger couples, as many aspects of the aging process lead to changes in sleep [25]. With a wider range of age (45 to 74 years) compared with previous studies, the current study tested differences between middle-aged (age range 45–54) versus older adults (age range 55–74) in the relationship between marital quality and sleep disturbances. We chose 55 as the age cut-off to reflect the average retirement age for Korean men [26], and other life course events (i.e., children leaving the household) that may affect one's marital dynamics as well as the pattern and quality of sleep [25,27]. Retirement and experiencing empty nest syndrome often lead to feelings of loss and distress, and require individuals to adjust to new daily routines and couples to renegotiate their marital roles [28].

Examining bidirectional relationships between marital quality and sleep disturbances may contribute to a better understanding of mechanisms linking close relationship functioning with mental and physical health outcomes. Furthermore, identifying vulnerable populations for marital and sleep problems may have implications for clinical practices.

Methods

Study design and sample

Participants of the present study were part of a larger study, namely the Korean Genome and Epidemiology Study (KoGES), which is an ongoing, population-based cohort study that started in 2001 under the original title, Korean Health and Genome Study. Detailed information on the study design and aims of the KoGES have been previously reported [29]. The current study used a subset of individuals from the

original cohort members recruited from Ansan, South Korea who participated in the follow-up assessments in the years 2007 (Baseline) and 2011 (Follow-up). These time points were selected since these were the only times when marital quality, the main focus of the current study, was assessed.

The current study focuses on 1604 participants who were present at the baseline assessment in 2007. Because the main topic of the present study is the relationship between marital quality and sleep disturbances, individuals who did not complete the marital quality questionnaire at baseline were excluded, which resulted in 1100 individuals. All 1100 participants were married. Additional exclusion criteria were pre-existing dementia, cerebrovascular disease, and/or traumatic brain injury. Nineteen participants met this criteria (13 cerebrovascular disease and 6 traumatic brain injury), resulting in a final sample of 1081 participants. An informed consent form was signed by each participant, and the study procedure was approved by the institutional review board of the Korea University Ansan Hospital.

At 4-year follow-up, 86% ($n=932$) of the sample continued to participate in the study. Individuals who did not participate in the follow-up assessment ($n=149$) were significantly older ($P=.020$) and with lower family income ($P<.001$) compared with the follow-up participants. There were no significant differences in gender, education, or employment status (P -values $\geq .121$).

Measures

Marital quality

A 7-item measure from the English Longitudinal Study of Aging [30] was used to assess one's overall subjective perceptions on the marital relationship. This measure includes items evaluating one's perception on the level of understanding, dependency, openness, criticism, disappointment, dislike of spouse's behavior, and intimacy in the relationship with spouse. Items were rated on a 4-point Likert scale and averaged to obtain a total score ranging from 0 to 3 with higher scores indicating higher levels of marital quality. For example, to the question of "how much do they really understand the way you feel about things?" a '0' indicates "not at all" and a '3' indicates "a lot." The Cronbach's alpha reliability was .79. At follow-up, an abbreviated version of the original questionnaire was used to assess the level of intimacy and overall marital satisfaction. The two items were also averaged for a total score ranging 0–3 with higher scores indicating higher marital quality. Correlation coefficient between baseline and 4-year follow-up marital quality was .53 ($P<.001$).

Sleep disturbances

The Pittsburgh Sleep Quality Index (PSQI) [31] was used to measure the quality and disturbances of sleep during the past month. Eighteen self-rated items generate 7 component scores each ranging 0–3: subjective sleep quality, sleep latency, sleep duration, habitual sleep efficiency, sleep disturbances, use of sleep medication, and daytime dysfunction. The component scores are summed to produce a global score ranging 0–21 with higher scores indicating higher sleep disturbances. A global score greater than 5 indicates a poor sleeper [31]. Sound psychometric properties of the Korean version of PSQI have been documented [32]. The Cronbach's alpha was .70.

Covariates

Sociodemographics. All participants provided information on age, gender, level of education, marital status, family income, and employment status including working night shifts, menopausal status, and presence of children in the household.

Health status. Data on history and current use of psychotropic or sleep medications were collected. General health status was measured using one item derived from the Medical Outcomes Study SF-12 [33]

asking the participant's perception of health. A 5-point Likert scale ranging from 0 (poor) to 4 (excellent) was used. The participants' perception on their spouse's health was also rated using the same scale.

Health behaviors. Current smoking status (non-smoking vs. smoking), alcohol consumption [no drinking to light drinking (0–15 g/day) vs. moderate to heavy drinking (> 15 g/day)] [34], and regular exercise status (no vs. yes for exercise more than once per week) were considered.

Depressive symptoms. The Beck Depression Inventory (BDI) [35] is a 21-item self-report inventory used to assess the severity of depressive symptoms. Participants are asked to indicate which statement best describes the way they have been feeling over the past week. Total scores on the BDI can range from 0 to 63, with higher scores reflecting higher levels of depressive symptoms. A total score of 10 or greater indicates clinical level of depression [36]. The sleep-related item was removed to avoid construct overlapping with PSQI in the main analyses.

Statistical analysis

Hierarchical multiple regression (HMR) analyses were conducted to test associations between marital quality and sleep disturbances. Initially, two HMR models were tested: 1) a model with baseline marital quality as a predictor and PSQI at follow-up as an outcome and 2) a model with baseline PSQI as a predictor and marital quality at follow-up as an outcome. Additional HMR analyses testing gender or age group [younger (ages 45–54; $n = 680$) vs. older (ages 55–74; $n = 401$)] as a moderator between marital quality and sleep disturbances were conducted.

Due to concerns of multicollinearity, collinearity test statistics were checked and any covariates highly correlated ($r > .5$) with other covariates were removed from the regression analyses. Thus, employment status and menopausal status were removed from the covariate list based on the high correlation with gender and age, respectively. In addition, baseline outcome was controlled for in all regressions to test the effect of a baseline predictor on outcome at follow-up above and beyond the effect of the outcome variable at baseline. Thus, variables were entered into the regressions in the following order: (a) control variables in the order of sociodemographics, health status and health behaviors, and depressive symptoms; (b) outcome variable at baseline; and (c) predictor variable at baseline. For the models testing moderating effects of gender or age group, variables entered into the regressions in the following order: (a) control variables; (b) outcome variable at baseline; and (c) predictor variable at baseline; (d) moderator; and (e) the interaction term for predictor and moderator. The interaction term was computed as the product of z scores of predictor and moderator. All continuous covariates were centered for easier interpretation.

Results

Descriptive and preliminary analyses

Table 1 provides descriptive statistics for the participants' characteristics at baseline. The majority of the participants were females (60%) in their 40s and 50s (77%) with some high school education or more (63%). About 25% of the participants reported above the normal range of depressive symptoms ($BDI \geq 10$). Means and standard deviations for PSQI and marital quality by gender and age groups at baseline and follow-up are presented in Table 2. Results from the group difference tests are also indicated. Women and older group reported greater sleep disturbances and lower marital quality compared with men and younger group both at baseline and follow-up (P -values $\leq .098$). There were no significant changes from baseline to follow-up in their average marital quality or level of sleep disturbances (P -values $\geq .837$). Regarding the rates of sleep disturbances, about 30% were identified as "poor sleepers" by $PSQI > 5$. The statistics using the cutoff scores are provided only for the clinical description of the sample, and the continuous scores of PSQI and BDI were used for the subsequent main analyses.

Tests of Marital Quality as a Predictor of Sleep Disturbances

Baseline marital quality was not a significant predictor of PSQI at follow-up after controlling for the relevant covariates including sociodemographics, health status and health

Table 1
Descriptive statistics for the participants' characteristics ($N = 1081$).

Variables	%	Mean (SD)
Sociodemographics		
Age (years)		54.34 (7.06)
Male	40.1	
Education (years)		
<7	14.4	
7–9	22.2	
10–12	45.2	
> 12	18.3	
Family income (US\$/month)		
<850	11.5	
850–1700	17.1	
1700–2550	24.2	
2550–3400	21.1	
> 3400	26.1	
Employed	51.2	
Night shifts (% among employed)	7.76	
Presence of children	73.4	
Menopausal status (% among women)	Pre 21.8	
	Peri 18.0	
	Post 60.2	
Health status		
History of psychotropic/sleep medication use	1.5	
Health status of participant		1.75 (0.71)
Health status of spouse		2.31 (0.98)
Health behaviors		
Currently smoking	11.4	
Moderate to heavy drinking (> 15 g/day)	4.5	
Regular exercise (\geq once/week)	53.8	
Depressive symptoms (BDI)	25.2 ($BDI \geq 10$)	6.75 (6.24)

BDI = Beck Depression Inventory.

behaviors, depressive symptoms as well as baseline PSQI ($P = .553$). HMR model testing gender as a moderator between marital quality and sleep disturbances revealed that gender was not a significant moderator ($P = .221$). However, age group was a significant moderator between marital quality and sleep disturbances ($P = .017$). Table 3 provides a summary of HMR models testing gender or age group as a moderator. A significant interaction between marital quality and age predicting PSQI 4 years later is graphically depicted in Fig. 1. While there was no association between marital quality and sleep disturbances for the younger group (ages 45–54), older persons (ages 55–74) with lower marital quality were more likely to have clinically significant levels of sleep disturbances 4 years later.

Tests of sleep disturbances as a predictor of marital quality

As shown in Table 4, PSQI was a significant predictor of marital quality after controlling for the relevant covariates including sociodemographics, health behaviors, mental and physical health status as well as baseline marital quality ($P = .025$). Thus, persons experiencing poorer sleep quality are more likely to have lower marital quality 4 years later. Both gender and age were not significant moderators of PSQI predicting marital quality (P -values $\geq .169$).

Discussion

This was a population-based longitudinal study over a 4-year interval investigating the bidirectional relationship between marital quality and sleep disturbances. The findings of our study partly support the hypotheses that there was a bidirectional relationship between marital quality and sleep over 4 years. More specifically, there was a significant interaction between marital quality and age at baseline predicting sleep disturbances at the 4-year follow-up. Thus, older individuals (ages 55–74) with lower marital quality were more likely to have sleep disturbances at follow-up. In reverse, the level of sleep disturbances was a significant predictor of marital quality 4 years later, regardless of age or gender.

To date, this was the first study of this length and magnitude to investigate this bidirectional relationship, including both males and females and a wide age range of participants. One of the large-scale

Table 2
Means and standard deviations for the sleep disturbance and marital quality by gender and age groups at baseline and 4-year follow-up.

	Gender		Age group		Total (N = 1081)
	Male (n = 433)	Female (n = 648)	45–54 (n = 680)	55–74 (n = 401)	
Sleep disturbance (PSQI)	Mean (SD)/PSQI > 5	Mean (SD)/PSQI > 5	Mean (SD)/PSQI > 5	Mean (SD)/PSQI > 5	Mean (SD)/PSQI > 5
Baseline ^{a,b}	4.07 (2.59) 22.6%	4.78 (3.10) 32.0%	4.32 (2.82) 25.7%	4.79 (3.08) 32.3%	4.49 (2.93) 28.2%
Follow-up ^{a,c}	3.89 (2.76) 23.7%	4.83 (3.20) 34.1%	4.33 (2.96) 27.3%	4.67 (3.24) 36.6%	4.45 (3.07) 30.0%
Marital quality	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)
Baseline ^{a,b}	2.30 (0.49)	2.15 (0.63)	2.25 (0.55)	2.14 (0.62)	2.21 (0.58)
Follow-up ^{a,b}	2.42 (0.54)	2.11 (0.62)	2.28 (0.59)	2.16 (0.63)	2.24 (0.61)

PSQI = Pittsburgh Sleep Quality Index.

^a Indicates gender difference at $P < .05$.

^b Indicates age group difference at $P < .05$.

^c Indicates age group difference at $P < .10$.

studies investigating the effect of marital quality on sleep is by Prigerson et al. [8], who found that increased marital satisfaction was associated with fewer sleep problems at 3-year follow-up in 927 women. However, their research did not include men, and they used single-item measures

Table 3
Summary of hierarchical regressions testing gender or age group (45–54 vs. 55–74) as a moderator between marital quality at baseline and sleep disturbances (PSQI) at follow-up.

Steps and variables	Adjusted R^2	ΔR^2	β	t
<i>Gender as a moderator</i>				
1. Sociodemographics	.020	.025***		
Age group			.053	.249
Education			.046	.566
Family income			-.081	-1.378
Night shifts			-.682	-1.523
Presence of children			-.135	-.597
2. Health and health behaviors	.093	.079***		
Medication use			.093	.122
Health status			-.279	-1.985*
Spouse's health status			.058	.598
Smoking			-.490	-1.620
Drinking			.571	1.299
Exercise			-.072	-.405
3. Depressive symptoms (BDI)	.132	.040***	.051	2.869***
4. Baseline PSQI	.316	.182***	.497	15.035***
5. Marital quality	.315	<.001	-.078	-.825
6. Gender	.316	.001	.121	1.149
7. Marital quality \times Gender	.316	.001	.117	1.225
<i>Age group as a moderator</i>				
1. Sociodemographics	.036	.041***		
Gender			.231	1.080
Education			.038	.475
Family income			-.071	-1.208
Night shifts			-.689	-1.543
Presence of children			-.134	-.596
2. Health and health behaviors	.098	.068***		
Medication use			.064	.084
Health status			-.293	-2.093*
Spouse's health status			.044	.458
Smoking			-.427	-1.413
Drinking			.652	1.492
Exercise			-.046	-.256
3. Depressive symptoms (BDI)	.134	.037***	.050	2.853**
4. Baseline PSQI	.317	.181***	.492	14.895***
5. Marital quality	.317	<.001	-.037	-.396
6. Age group	.316	<.001	-.001	-.015
7. Marital quality \times age group	.319	.004*	-.209	-2.387*

Beta weights and t statistics are from the final step.

BDI = Beck Depression Inventory without sleep-related item; PSQI = Pittsburgh Sleep Quality Index

* $P < .05$.

** $P < .01$.

*** $P < .001$.

to assess both sleep quality and marital satisfaction. Another recent study by Troxel et al. [9] investigated marital happiness and sleep disturbances in a community-based sample of 1938 women. Their research found that women with higher levels of satisfaction with their marriage reported fewer sleep disturbances. But this study also did not include a male sample, used a single-item measure for marital quality, and was limited to a cross-sectional design. Other smaller studies investigating the relationship between sleep and marital quality have also been limited by small sample sizes, cross-sectional designs, and insufficient sleep and marital quality measurements [7,21]. The only previous study investigating the reciprocal relationship between sleep and marital functioning was by Hasler and Troxel [22], who examined both sleep and relationship functioning in 29 dyads over a 7-day period. Our study expands this previous study by confirming that this bidirectional relationship exists over longer periods of time (4 years), with population-based data.

Another strength of this study was the wide age range of the sample, which allowed us to examine age as a moderator in the relationship between marital quality and sleep. One of the novel findings of our study demonstrates that individuals with lower marital quality are more likely to have sleep disturbances at follow-up for older adults only (ages 55–74), and not in younger adults (ages 45–54). Based on these findings, we can speculate that marital quality may have a greater influence on sleep in older adult couples compared with middle-aged couples. Between the ages of 55 and 74, most couples experience life transitions, such as experiencing empty nest syndrome and retirement, which often lead to feelings of loss and psychological distress and require couples to renegotiate their marital roles [28]. Previous

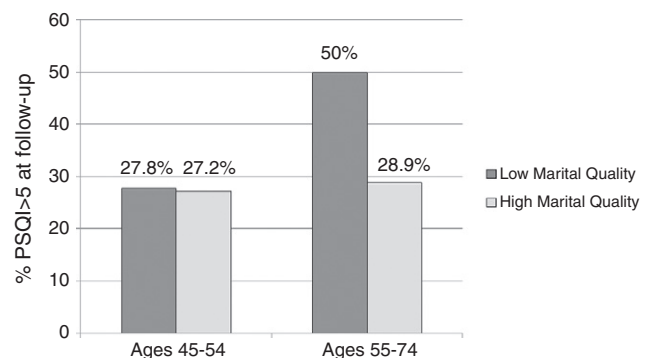


Fig. 1. Significant interaction between marital quality and age predicting sleep disturbances 4 years later ($P = .017$). While there was no difference in the proportion of poor sleepers (PSQI > 5) at follow-up between participants with low vs. high marital quality for the younger group (ages 45–54), the older group (ages 55–74) with low marital quality had a significantly larger proportion of poor sleepers at follow-up. PSQI = Pittsburgh Sleep Quality Index.

Table 4
Summary of hierarchical regression testing sleep disturbances at baseline predicting marital quality at follow-up.

Steps and variables	Adjusted R^2	ΔR^2	β	t
1. Sociodemographics	.078	.085***		
Gender			-.243	-5.854***
Age group			-.123	-3.007**
Education			-.001	-.045
Family income			-.006	-.537
Night shifts			.063	.720
Presence of children			.022	.509
2. Health and health behaviors	.104	.032***		
Medication use			-.102	-.663
Health status			.014	.497
Spouse's health status			.007	.386
Smoking			-.103	-1.768
Drinking			<.001	-.004
Exercise			.028	.815
3. Depressive symptoms (BDI)	.129	.026***	-.006	-1.836
4. Baseline marital quality	.343	.211***	.516	16.583***
5. Sleep disturbance (PSQI)	.346	.004*	-.015	-2.249*

Beta weights and t statistics are from the final step.

BDI = Beck Depression Inventory without sleep-related item; PSQI = Pittsburgh Sleep Quality Index.

* $P < .05$.

** $P < .01$.

*** $P < .001$.

research supports that marital quality varies based on life course events such as retirement [27]. In Korea, there has been a notable rise in later life divorce in recent years [37]. Korean couples often devote all of their energy to work and parenting, and pay less attention to the marital relationship during midlife. However, after children leave for college or due to marriage and after retirement, existing marital problems that have been ignored may resurface, and/or new sets of challenges are introduced. Thus, marital quality may become a more salient factor for overall well-being including sleep for older adults. Studies on the populations from other cultures will be needed to examine whether this moderating effect of age is specific to Korean culture or can be generalized to broader cultural context.

By contrast, marital quality may play a smaller role in sleep disturbances for younger couples. For middle-aged individuals, there may be other aspects besides marital quality that influence sleep. For example, menopausal status of the two groups might have had differential influences on sleep. In our younger group, 27% of the women were peri-menopausal while all women in the older group were post-menopausal. Research has shown that menopausal symptoms such as vasomotor instability and low estrogen can have detrimental effects on sleep [38,39]. For males in the younger group, the proportions of smokers (30.5% vs. 21.1%) and moderate to heavy drinkers (12.3% vs. 6.8%) were substantially larger than those for the older group. Thus, detrimental effects of smoking and drinking on sleep [40,41] might be stronger than the effects of marital quality in midlife men compared with older men.

Additionally, the well-documented effect of age on sleep quality was not found in the current study. Research indicates that a large proportion of sleep disturbance in older adults often stem from various age-related physical and mental conditions and medications for treating these conditions rather than from age itself [25,42]. Thus, it is possible that the lack of age effect on sleep quality in the current study was because we controlled for the effects of physical health status, depressive symptoms, and medication use.

Compared with the study by Hasler & Troxel [22], our study did not find a gender-specific effect in the relationship between marital quality and sleep. In their study, sleep efficiency predicted daytime marital functioning for males only, while the reverse relationship was true only for females. The discrepancy in our findings may be explained by the differences in the conceptualizations of the main study variables and the follow-up duration. The current study assessed the subjective

levels of both sleep disturbances and marital quality via questionnaires 4 years apart. In contrast, Hasler and Troxel [22] used both subjective (diaries) and behavioral (actigraphy) measures for sleep efficiency, and a visual analog scale capturing momentary interactions between spouses for a week. Furthermore, the mean age for our sample was 54 years, while participants in Hasler and Troxel's study were significantly younger (mean age 26 ± 5). Additionally, it may simply be a result of the limited statistical power, due to the small sample size of Hasler and Troxel's study. Future studies with larger sample size and broader age range will be needed to clarify gender differences in the relationship between marital quality and sleep.

Despite the strengths of this study, our study had some limitations. First, our assessment of sleep disturbances relied only on a subjective measure, and we did not have objective measures such as polysomnography. Furthermore, we used only a global measure of marital quality. It will be important for future studies to clarify which specific dimensions of marital quality (e.g., conflict, closeness) and areas of marital functioning (e.g., sexual intimacy, communication processes) are linked with sleep disturbances. Additionally, the construct of marital quality assessed at baseline and follow-up might not have been exactly the same, since an abbreviated version of the measure was used at follow-up. Another notable limitation is that similar studies included dyads in their sample in order to investigate not only within-person effects but also cross-partner effects, with the goal to examine the relationship between marital quality and sleep. Future studies should consider using dyads to investigate whether cross-partner effects of the relationship are stable long-term. Finally, our study did not assess co-sleeping status for this sample.

In conclusion, this was the first large population-based longitudinal study investigating the bidirectional relationship between marital quality and sleep disturbances. The results of this study indicate a bidirectional relationship between marital quality and sleep over an interval of 4 years for older adults. These novel findings provide some support to recent conceptual models proposing a bidirectional association between marital quality and sleep. Future research should examine biobehavioral mechanisms that further clarify the complex interplay among sleep, marital quality, and health. From a clinical perspective, it will be important for clinicians who are treating either sleep or marital problems to be aware of the bidirectional nature of the relationship between sleep disturbance and marital quality for more effective interventions for both.

Conflict of interest statement

The authors have no conflicts of interest to report.

Acknowledgments

This study was supported by grants from the Korea Center for Disease Control and Prevention (Grant 2007-E71001-00, Grant 2011-E71004-00), the National Research Foundation of Korea (NRF-2012-S1A5BA01), and Korea University.

We thank the participants in the Korean Genome and Epidemiology Study and the professional and research staff.

References

- [1] Burman B, Margolin G. Analysis of the association between marital relationships and health problems: an interactional perspective. *Psychol Bull* 1992;112:39–63.
- [2] Kiecolt-Glaser JK, Newton TL. Marriage and health: his and hers. *Psychol Bull* 2001;127:472–503.
- [3] Yang HC, Schuler TA. Marital quality and survivorship: slowed recovery for breast cancer patients in distressed relationships. *Cancer* 2009;115:217–28.
- [4] Ford DE, Kamerow DB. Epidemiologic study of sleep disturbances and psychiatric disorders. An opportunity for prevention? *JAMA* 1989;262:1479–84.
- [5] Gangwisch JE, Heymsfield SB, Boden-Albala B, Buys RM, Kreier F, Pickering TG, et al. Short sleep duration as a risk factor for hypertension: analyses of the first National Health and Nutrition Examination Survey. *Hypertension* 2006;47:833–9.

- [6] Hall MH, Muldoon MF, Jennings JR, Buysse DJ, Flory JD, Manuck SB. Self-reported sleep duration is associated with the metabolic syndrome in midlife adults. *Sleep* 2008;31:635–43.
- [7] Troxel WM, Robles TF, Hall M, Buysse DJ. Marital quality and the marital bed: examining the covariation between relationship quality and sleep. *Sleep Med Rev* 2007;11:389–404.
- [8] Prigerson HG, Maciejewski PK, Rosenheck RA. The effects of marital dissolution and marital quality on health and health service use among women. *Med Care* 1999;37:858–73.
- [9] Troxel WM, Buysse DJ, Hall M, Matthews KA. Marital happiness and sleep disturbances in a multi-ethnic sample of middle-aged women. *Behav Sleep Med* 2009;7:2–19.
- [10] Rauer AJ, Kelly RJ, Buckhalt JA, El-Sheikh M. Sleeping with one eye open: marital abuse as an antecedent of poor sleep. *J Fam Psychol* 2010;24:667–77.
- [11] Fincham FD, Beach SRH, Harold GT, Osborne LN. Marital satisfaction and depression: different causal relationships for men and women? *Psychol Sci* 1997;8:351–7.
- [12] Strawbridge WJ, Shema SJ, Roberts RE. Impact of spouses' sleep problems on partners. *Sleep* 2004;27:527–31.
- [13] Cottrell L, Khan A. Impact of childhood epilepsy on maternal sleep and socioemotional functioning. *Clin Pediatr (Phila)* 2005;44:613–6.
- [14] Kahn-Greene ET, Lipizzi EL, Conrad AK, Kamimori GH, Killgore WDS. Sleep deprivation adversely affects interpersonal responses to frustration. *Pers Individ Differ* 2006;41:1433–43.
- [15] Larson JH, Crane D, Smith CW. Morning and night couples: the effect of wake and sleep patterns on marital adjustment. *J Marital Fam Ther* 1991;17:53–65.
- [16] Lewis MA, Rook KS. Social control in personal relationships: impact on health behaviors and psychological distress. *Health Psychol* 1999;18:63–71.
- [17] Kiecolt-Glaser JK, Glaser R, Cacioppo JT, Malarkey WB. Marital stress: immunologic, neuroendocrine, and autonomic correlates. *Ann N Y Acad Sci* 1998;840:656–63.
- [18] Miller MA, Kandala NB, Kivimaki M, Kumari M, Brunner EJ, Lowe GD, et al. Gender differences in the cross-sectional relationships between sleep duration and markers of inflammation: Whitehall II study. *Sleep* 2009;32:857–64.
- [19] Brissette I, Cohen S. The contribution of individual differences in hostility to the associations between daily interpersonal conflict, affect, and sleep. *Pers Soc Psychol Bull* 2002;28:1265–74.
- [20] Gallo LC, Matthews KA. Understanding the association between socioeconomic status and physical health: do negative emotions play a role? *Psychol Bull* 2003;129:10–51.
- [21] Troxel WM. It's more than sex: exploring the dyadic nature of sleep and implications for health. *Psychosom Med* 2010;72:578–86.
- [22] Hasler BP, Troxel WM. Couples' nighttime sleep efficiency and concordance: evidence for bidirectional associations with daytime relationship functioning. *Psychosom Med* 2010;72:794–801.
- [23] Rauer AJ, El-Sheikh M. Reciprocal pathways between intimate partner violence and sleep in men and women. *J Fam Psychol* 2012;26:470–7.
- [24] Hislop J, Arber S. Sleepers wake! The gendered nature of sleep disruption among midlife women. *Sociology* 2003;37:695–711.
- [25] Ancoli-Israel S. Sleep and its disorders in aging populations. *Sleep Med* 2009;10:S7–S11.
- [26] Statistics Korea. Annual report on the economically active population survey in 2011; 2012.
- [27] Adelman PK, Chadwick K, Baerger DR. Marital quality of Black and White adults over the life course. *J Soc Pers Relat* 1996;13:361–84.
- [28] Etaugh CA, Bridges JS. Midlife Transitions. Handbook of girls' and women's psychological health: gender and well-being across the lifespan. New York, NY: Oxford University Press; 2006. p. 359–67.
- [29] Kim J, In K, Kim J, You S, Kang K, Shim J, et al. Prevalence of sleep-disordered breathing in middle-aged Korean men and women. *Am J Respir Crit Care Med* 2004;170:1108–13.
- [30] Marmot MB, Blundell R, Lessof C, Nazroo J, editors. Health, wealth and lifestyles of the older population in England: the 2002 English Longitudinal Study of Ageing (Wave 1). London; 2003.
- [31] Buysse DJ, Reynolds CF, Monk TH, Berman SR, Kupfer DJ. The Pittsburgh Sleep Quality Index: a new instrument for psychiatric practice and research. *Psychiatry Res* 1989;28:193–213.
- [32] Sohn SI, Kim DH, Lee MY, Cho YW. The reliability and validity of the Korean version of the Pittsburgh Sleep Quality Index. *Sleep Breath* 2012;16:803–12.
- [33] Ware J, Kosinski M, Keller SD. A 12-item short-form health survey: construction of scales and preliminary tests of reliability and validity. *Med Care* 1996;34:220–33.
- [34] Baik I, Shin C. Prospective study of alcohol consumption and metabolic syndrome. *Am J Clin Nutr* 2008;87:1455–63.
- [35] Beck AT, Ward CH, Mendelson M, Mock J, Erbaugh J. An inventory for measuring depression. *Arch Gen Psychiatry* 1961;4:561–71.
- [36] Beck AT, Steer RA, Garbin GM. Psychometric properties of the Beck Depression Inventory: twenty-five years of evaluation. *Clin Psychol Rev* 1988;8:77–100.
- [37] Statistics Korea. Marriage and divorce statistics in 2011; 2012.
- [38] Lukacs JL, Chilimigras JL, Cannon JR, Dormire SL, Reame NE. Midlife women's responses to a hospital sleep challenge: aging and menopause effects on sleep architecture. *J Womens Health (Larchmt)* 2004;13:333–40.
- [39] Shin C, Lee S, Lee T, Shin K, Yi H, Kimm K, et al. Prevalence of insomnia and its relationship to menopausal status in middle-aged Korean women. *Psychiatry Clin Neurosci* 2005;59:395–402.
- [40] Brower KJ. Alcohol's effects on sleep in alcoholics. *Alcohol Res Health* 2001;25:110.
- [41] Phillips BA, Danner FJ. Cigarette smoking and sleep disturbance. *Arch Intern Med* 1995;155:734–7.
- [42] Foley D, Ancoli-Israel S, Britz P, Walsh J. Sleep disturbances and chronic disease in older adults: results of the 2003 National Sleep Foundation Sleep in America Survey. *J Psychosom Res* 2004;56:497–502.