Neurology Asia 2023; 28(2) : 367 – 375

Sleep disturbance and depressive tendency in bed partners of patients with obstructive sleep apnea

[1]Chih-Yu Huang *MD*, [2]Shao-Yun Wu *MSN RN NP*, [1,3]Chung-Chieh Yu *MD*, [1]Chien-Ming Chu *MD*

[1]Division of Pulmonary, Critical Care, and Sleep Medicine, Chang Gung Memorial Hospital, Keelung, Taiwan, Republic of China; [2]Department of Nursing, Nurse Practitioner, Chang Gung Memorial Hospital, Keelung, Taiwan, Republic of China; [3]College of Medicine, Chang Gung University, Taoyuan, Taiwan, Republic of China

Abstract

Background: Snoring, apnea, and arousal are commonly observed during sleep in patients with obstructive sleep apnea (OSA), and these nocturnal symptoms frequently disturb their bed partners. We aimed to evaluate the sleep disturbance and depressive tendency in the bed partners of patients with OSA. *Methods*: A cross-sectional, prospective study was conducted. A total of 136 patients with OSA and their bed partners were recruited. We analyzed the demographic data of both patients with OSA and bed partners and the polysomnography parameters of patients with OSA. The sleep quality of bed partners was assessed using the Chinese version of the Pittsburgh Sleep Quality Index (PSQI), and depressive symptoms were evaluated using the Center for Epidemiologic Studies Depression Scale (CES-D). *Results*: The mean apnea–hypopnea index (AHI) was 43.5/h among all participants. Among bed partners, the mean PSQI score was 7.8 and the mean CES-D score was 15.4. The prevalence of chronic disease was significantly higher in bed partners with sleep disturbance (PSQI > 5) and depressive tendency (CES-D ≥ 16). The AHI and snore index of patients with OSA were not associated with bed partners' sleep disturbance and depressive tendency respectively. The CES-D score was positively correlated with the PSQI score in the bed partners of patients with OSA ($r = 0.426$, $p < 0.001$). *Conclusions*: Bed partners tended to have sleep disturbance, which was unrelated to the severity of AHI and snoring in patients with OSA. Poor sleep quality may cause depressive tendency and chronic disease in the bed partners of patients with OSA.

Keywords: Bed partner, depressive symptoms, obstructive sleep apnea, questionnaires, sleep quality

INTRODUCTION

In the third edition of the International Classification of Sleep Disorders (ICSD-3), obstructive sleep apnea (OSA) is defined as a clinical syndrome characterized by the repetitive collapse of the upper airway, causing episodes of partial or complete airway obstructions during sleep. These obstructions decrease blood oxygen saturation and are usually terminated by arousal from sleep.[1] OSA is an extremely common sleep disorder; its estimated prevalence ranges from 9% to 38% in the adult population.[2] Untreated OSA is associated with long-term health consequences, including cardiovascular disease, stroke, metabolic disorders, cognitive dysfunction, and increased risk of accidents.[3,4] In addition, OSA not only affects patients' health but also influences their families. As the body attempts to restore the patency of the upper airway, patients experience recurrent arousals from sleep. Periodic leg movement in sleep (PLMS) is also common among patients with OSA.[5] Nocturnal symptoms, including loud snoring, apnea, restless sleep, and leg movement, mostly go unnoticed among patients with OSA but disturb the sleep of their bed partners.

Most research examining the influence of OSA on bed partners has found that OSA negatively affects sleep quality and quality of life.[6] In a cross-sectional study, 55% of the bed partners of 37 patients suspected of having OSA experienced decreased sleep quality due to snoring.[7] A study of 46 bed partners of patients with moderate to severe OSA observed that 66% of participants reported poor sleep quality.[8] Studies using polysomnography (PSG) to assess the sleep

Address correspondence to: Chien-Ming Chu, Division of Pulmonary, Critical Care, and Sleep Medicine, Chang Gung Memorial Hospital, Keelung, 222, Maijin Road, Keelung 204, Taiwan, Republic of China. Tel: 886-2-24313131 ext. 6204, E-mail: rocephen2000@yahoo.com.tw

Date of Submission: 26 January 2023; Date of Acceptance: 4 February 2023

https://doi.org/10.54029/2023xze

quality of the bed partners of patients with OSA have recorded significant sleep disturbance.[9-11] However, the causal association between nocturnal symptoms in patients with OSA and impaired sleep of their bed partners remains controversial.

Additionally, OSA interferes with patients' interpersonal relationships with their bed partners. A prospective study discovered that wives of men with apnea were 2.9 times more likely to sleep apart from their partner relative to their group composed of wives whose husbands did not have apnea.[12] In an early study, decreased marital satisfaction was reported by wives of OSA patients.[13] Sleep disruption of the bed partners from sleep apnea resulted in frustration and strained relationships.[14] McArdle *et al*. found that the bed partners of patients with sleep apnea or hypopnea reported poorer general health–related quality of life when compared with the general population, as indicated using a 36-item Short Form Health Survey (SF-36).[8] Doherty *et al*. reported that 52% and 18% of bed partners had symptoms of anxiety and depression, respectively.[15] These findings support the hypothesis that OSA has broader effects on the mental health of the bed partners.

The aim of this study was to evaluate sleep disturbance by using the PSQI score and depressive tendency by using the CES-D score recorded by the bed partners of patients with OSA. We investigated the effect of nocturnal symptoms from OSA on the subjective sleep quality of bed partners. In addition, the relationship between sleep disturbance and depressive tendency of bed partners was assessed.

METHODS

Participants

A consecutive series of patients who had sleep-disordered breathing and the presence of a bed partner for more than a month were prospectively recruited from a medical center and a regional teaching hospital in Northern Taiwan between December 2010 and October 2012. Patients were referred for an in-laboratory PSG. The exclusion criteria were age < 18 years and an apnea–hypopnea index (AHI) < 5. This study was approved by the Institutional Review Board of Chang Gung Memorial Hospital (99-3059B, 100-3664C), and informed consent was obtained from each participant and their bed partner. Patient confidentiality was maintained as no patients' identifiers were collected and the private will be carefully protected. All research process was in accordance with the Declaration of Helsinki.

Questionnaires

Each participant completed a questionnaire that inquired into their age, sex, marital status, and educational level and contained questions based on the Epworth Sleepiness Scale (ESS).[16] The body mass index (BMI) and neck circumference of all participants were recorded. Bed partners were asked to complete a questionnaire that inquired into their age, sex, educational level, and chronic disease status, including that of cerebrovascular disease, cardiovascular disease, diabetes mellitus, cancer, and chronic lung disease.

The Pittsburgh Sleep Quality Index (PSQI) is the most commonly used self-rated questionnaire for evaluating subjective sleep quality. The PSQI comprises 19 individual items, and the sum of the component scores yields a PSQI global score of sleep quality, which ranges from 0 to 21. When a cut-off score of > 5 was used, the PSQI reportedly had a sensitivity of 89.6% and a specificity of 86.5% in identifying cases of sleep disorders.[17] The Chinese version of the PSQI is also a reliable and valid tool for assessing sleep quality.[18] The sleep quality of bed partners was assessed using the Chinese version of the PSQI, and a cut-off score of > 5 was used to identify sleep disturbance.

The Center for Epidemiologic Studies Depression Scale (CES-D) is a commonly used questionnaire for evaluating the level of depressive symptoms. The CES-D is a 20-item self-report questionnaire with total scores ranging from 0 to 60. Higher scores indicate more severe depressive symptoms and scores ≥ 16 indicate depressive tendency.[19] The CES-D has been translated into Chinese and used to screen for depressive disorders.[20,21] Depressive symptoms were assessed using the CES-D, and a cut-off score of ≥ 16 indicated a clinically significant level of depressive symptoms. The questionnaires for the bed partner were given to the patient from the sleep laboratory, and they were asked to return the completed questionnaires by mail.

Polysomnography

Standard overnight PSG was performed using a computerized PSG system (N7000 Embla, Broomfield, USA). We measured the following: electroencephalogram (EEG), bilateral electrooculogram (EOG), submental and bilateral anterior tibialis electromyogram (EMG), and electrocardiogram (ECG) parameters and nasal and oronasal airflow (using a thermistor and indicated using nasal pressure), arterial oxygen

saturation (through finger probe pulse oximetry), chest and abdominal movements (through inductance plethysmography), and body position. Snoring was measured using a vibration sensor placed on the carotid triangle on the neck. Sleep stages were manually scored in 30-s epochs by using the American Academy of Sleep Medicine (AASM) scoring criteria.[22]

Obstructive apnea was defined as the absence of airflow for at least 10 s in the presence of respiratory effort, whereas central apnea was defined as the absence of airflow without concurrent respiratory effort. Hypopnea was considered to have occurred when a > 50% decrease in airflow occurred for over 10 s followed by at least 3% oxygen desaturation or EEG arousal.[22] AHI was defined as the average number of apneas and hypopneas per hour of sleep. The snore index was defined as the number of snore events per hour of sleep. Leg movement (LM) was defined as an 8-μV increase in the EMG voltage of the right and left anterior tibialis above the resting EMG voltage, lasting 0.5–10 s. LMs occurring in a wide time window extending from 0.5 s before the start of a respiratory event (apnea or hypopnea) to 0.5 s after its end were not counted. Periodic leg movement (PLM) was defined as a minimum of four consecutive LM events with a 5–90-s interval during sleep. The PLM index (PLMI) was scored as the number of PLM per hour of total sleep time.[23]

Statistical analysis

Statistical analysis was performed using the Statistical Package for the Social Sciences (SPSS) for Windows (version 19.0; SPSS Inc., Chicago, IL, USA). The characteristics of patients and bed partners are presented as the mean ± standard deviation for continuous variables and as frequency (percentage) for categorical variables. The sleep disturbance of bed partners was stratified according to PSQI score (> 5 and ≤ 5), and the depressive tendency of bed partners was stratified according to the CES-D score (≥ 16 and < 16). Differences in continuous variables were analyzed using the *t* test and Mann–Whitney U test. Differences in categorical variables were analyzed using the chi-square test. The variables associated with sleep disturbance and depressive tendency of bed partners were evaluated through multivariable logistic regression at the thresholds of PSQI score > 5 and CES-D score ≥ 16, respectively. Pearson correlation analysis was performed to quantify the degree of relationship between sleep quality, as determined through the PSQI score, and depressive symptoms, as determined through the CES-D score, among bed partners. A p value of < 0.05 was considered statistically significant.

RESULTS

Participant characteristics

Fourteen patients aged < 18 years or with an AHI of < 5 were excluded. A total of 136 patients and their bed partners were included in this study. The following characteristics and PSG findings of patients are listed in Table 1: age, sex, BMI, marital status, educational level, ESS score, AHI, snore index, and PLMI. The mean age of patients was 50.6 years, with the majority being male patients (76.5%). The mean BMI was 26.7 kg/m^2. PSG findings revealed that patients had a mean AHI of 43.5/h and a mean snore index of 147.0/h. The characteristics, sleep quality, and depressive symptoms of bed partners are listed in Table 2. The mean age of bed partners was 49.1 years, and 41.9% of them had chronic disease. The average PSQI score, indicating sleep quality, was 7.8, and the average CES-D score, indicating depressive symptoms, was 15.4.

Factors associated with PSQI and CES-D scores in bed partners

The comparison of various factors with sleep disturbance (PSQI > 5) and depressive tendency (CES-D ≥ 16) among bed partners and patients are detailed in Tables 3 and 4. No significant differences in age, sex, marital status, and educational level between those with PSQI > 5 versus PSQI ≤ 5 and those with CES-D ≥ 16 versus CES-D < 16 were observed in bed partners. The severity of OSA, AHI, snore index, and PLMI of patients did not vary significantly between bed partners with PSQI > 5 versus PSQI ≤ 5 and bed partners with CES-D ≥ 16 versus CES-D < 16. The proportion of chronic disease was significantly higher in bed partners with PSQI > 5 than in those with PSQI ≤ 5 (50.0% vs. 28.0%, p = 0.012). Bed partners with CES-D ≥ 16 had a higher prevalence of chronic disease compared with those with CES-D < 16 (60.8% vs. 30.6%, p = 0.001). Table 5 presents the multivariate logistic regression results of the factors associated with sleep disturbance and depressive tendency at the thresholds of PSQI score > 5 and the CES-D score ≥ 16. Among bed partners with PSQI > 5, the CES-D score (OR: 1.096, 95% CI: 1.039–1.156;

Table 1: Characteristics of the patients with obstructive sleep apnea

	Patients (n = 136)
Age (y)	50.6 ± 12.0
Gender	
Male	104 (76.5)
BMI (kg/m^2)	26.7 ± 4.5
Marital status	
Married	105 (77.2)
Education	
Less than high school	36 (26.5)
High school/junior college	45 (33.1)
College degree	45 (33.1)
Advanced degree	10 (7.4)
ESS	9.9 ± 4.8
AHI (events/h)	43.5 ± 23.2
Snore index (events/h)	147.0 ± 267.6
PLMI (events/h)	3.5 ± 5.9

Data are presented as means ± standard deviation or number (%)
BMI, body mass index; ESS, Epworth Sleepiness Scale; AHI, apnea-hypopnea index; PLMI, periodic leg movement index.

p = 0.001) was independently associated with sleep disturbance. Among those with CES-D ≥ 16, the presence of chronic disease (OR: 3.008, 95% CI: 1.199–7.545; p = 0.019) and PSQI score (OR: 1.266, 95% CI: 1.137–1.410; p < 0.001) were independently associated with depressive tendency. However, nocturnal OSA symptoms, including apnea, snoring, and LM, were not associated with sleep disturbance and depressive tendency among bed partners.

Association between PSQI and CES-D among bed partners

CES-D score was significantly higher in bed partners with PSQI > 5 than in those with PSQI ≤ 5 (18.1 ± 10.6 vs. 10.7 ± 7.3, p < 0.001; Table 3). Bed partners with CES-D ≥ 16 had a higher PSQI score compared with those with CES-D < 16 (10.4 ± 5.1 vs. 6.3 ± 3.2, p < 0.001; Table 4). Figure 1 illustrates the positive linear correlation between PSQI and CES-D scores in the bed partners of patients with OSA (r = 0.426, p < 0.001).

DISCUSSION

This study had a sample of 136 patients with OSA, and their bed partners were more likely to report sleep disturbance. Nevertheless, the frequency of apnea–hypopnea and snoring resulting from OSA did not negatively affect the sleep quality of bed partners. Self-reported depressive symptom

Table 2: Characteristics of bed partners of patients with obstructive sleep apnea

	Bed partners (n = 136)
Age (y)	49.1 ± 12.1
Gender	
Female	105 (77.2)
Education	
Less than high school	33 (24.3)
High school/junior college	45 (33.1)
College degree	52 (38.2)
Advanced degree	6 (4.4)
Chronic disease	57 (41.9)
PSQI	7.8 ± 4.4
CES-D	15.4 ± 10.1

Data are presented as means ± standard deviation or number (%)
PSQI, Pittsburgh Sleep Quality Index; CES-D, Center for Epidemiological Studies Depression Scale

Table 3: Sleep disturbance of bed partners stratified according to PSQI (> 5 and ≤ 5)

	PSQI > 5 (n = 86)	PSQI ≤ 5 (n = 50)	*p*
Factors of bed partners			
Age (y)	49.6 ± 12.7	48.1 ± 11.1	0.355
Female	62 (72.1)	43 (86.0)	0.062
Married	68 (79.1)	37 (74.0)	0.497
Education			0.555
Less than high school	24 (27.9)	9 (18.0)	
High school/junior college	30 (34.9)	15 (30.0)	
College degree	29 (33.7)	23 (46.0)	
Advanced degree	3 (3.5)	3 (6.0)	
Chronic disease	43 (50.0)	14 (28.0)	0.012*
CES-D	18.1 ± 10.6	10.7 ± 7.3	< 0.001*
Factors of patients			
AHI (events/h)	43.6 ± 24.1	43.3 ± 21.7	0.964
Snore index (events/h)	129.6 ± 255.5	176.8 ± 287.5	0.825
PLMI (events/h)	3.7 ± 6.0	3.2 ± 5.6	0.985
Severity of OSA			0.896
Mild to moderate	30 (34.9)	18 (36.0)	
Severe	56 (65.1)	32 (64.0)	

Data are presented as means ± standard deviation or number (%). Statistical comparison was performed with Mann–Whitney U test or chi-square test

*$p < 0.05$

PSQI, Pittsburgh Sleep Quality Index; CES-D, Center for Epidemiological Studies Depression Scale; AHI, apnea-hypopnea index; PLMI, periodic leg movement index; OSA obstructive sleep apnea.

Table 4: Depressive tendency of bed partners stratified according to CES-D (≥ 16 and < 16)

	CES-D ≥ 16 (n = 51)	CES-D < 16 (n = 85)	*p*
Factors of bed partners			
Age (y)	49.6 ± 13.0	48.8 ± 11.7	0.666
Female	38 (74.5)	67 (78.8)	0.562
Married	39 (76.5)	66 (77.6)	0.874
Education			0.220
Less than high school	15 (29.4)	18 (21.2)	
High school/junior college	15 (29.4)	30 (35.3)	
College degree	19 (37.3)	33 (38.8)	
Advanced degree	2 (3.9)	4 (4.7)	
Chronic disease	31 (60.8)	26 (30.6)	0.001*
PSQI	10.4 ± 5.1	6.3 ± 3.2	< 0.001*
Factors of patients			
AHI (events/h)	42.7 ± 24.0)	43.9 ± 22.8	0.536
Snore index (events/h)	107.0 ± 211.9	170.9 ± 294.6	0.124
PLMI (events/h)	2.9 ± 4.8	3.9 ± 6.4	0.177
Severity of OSA			1.000
Mild to moderate	18 (35.3)	30 (35.3)	
Severe	33 (64.7)	55 (64.7)	

Data are presented as means ± standard deviation or number (%). Statistical comparison was performed with Mann–Whitney U test or chi-square test

*$p < 0.05$

CES-D, Center for Epidemiological Studies Depression Scale; PSQI, Pittsburgh Sleep Quality Index; AHI, apnea-hypopnea index; PLMI, periodic leg movement index; OSA, obstructive sleep apnea.

Table 5: Multivariable logistic regression for the factors associated with sleep disturbance and depressive tendency of bed partners

Variables	PSQI > 5			CES-D ≥ 16		
	OR	95% CI	*p*	OR	95% CI	*p*
Factors of bed partners						
Age	0.994	0.956-1.033	0.751	0.984	0.948-1.022	0.412
Female	2.412	0.873-6.663	0.089	0.972	0.366-2.577	0.954
Chronic disease	1.652	0.640-4.263	0.299	3.008	1.199-7.545	0.019*
PSQI				1.266	1.137-1.410	< 0.001*
CES-D	1.096	1.039-1.156	0.001*			
Factors of patients						
AHI	1.004	0.987-1.022	0.646	0.995	0.977-1.014	0.619
Snore index	1.000	0.998-1.001	0.680	0.999	0.998-1.001	0.520
PLMI	1.032	0.962-1.107	0.377	0.959	0.886-1.039	0.307

*$p < 0.05$

PSQI, Pittsburgh Sleep Quality Index; CES-D, Center for Epidemiological Studies Depression Scale; AHI, apnea-hypopnea index; PLMI, periodic leg movement index.

scores and the prevalence of chronic disease were higher in bed partners with sleep disturbance. Additionally, bed partner–reported depressive symptoms were positively associated with sleep disturbance.

Studies have reported that OSA impairs sleep quality and daytime functioning in bed partners. A study involving 46 bed partners of patients with OSA, with a median AHI of 41/h, reported that 66% reported sleep disturbance, defined as PSQI > 5.[8] Virkkula et al. reported that 55% of bed partners reported snoring-induced sleep problems in patients with mild OSA (mean AHI: 13.7/h).[7] Consistently, our findings indicated that 63.2% (86 of 136) of bed partners reported poor sleep quality (PSQI > 5); the mean PSQI score of the 136 bed partners was 7.8. However, the causal relationship between the nocturnal symptoms of patients with OSA and the sleep problems of bed partners has long been discussed. In an early study of 46 bed partners of patients with OSA, the subjective reasons for sleep

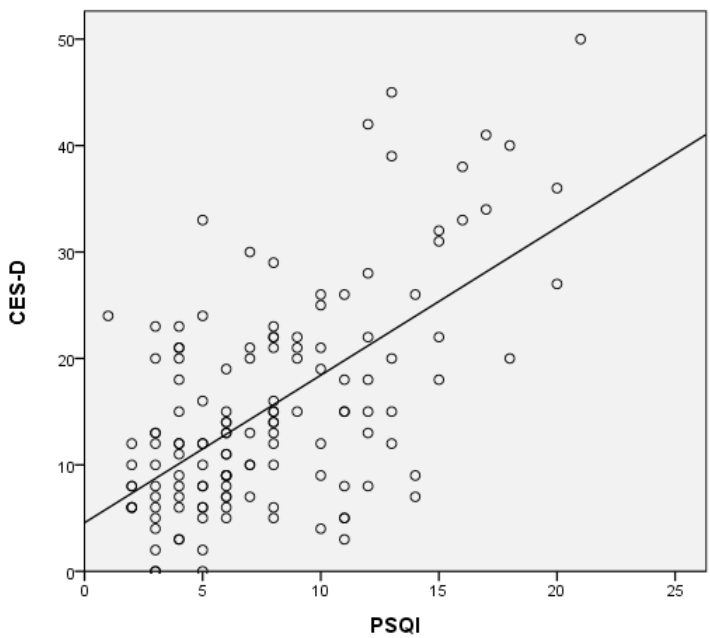

Figure 1. Pearson correlation analysis was performed to quantify the extent of the relationship between sleep quality, as determined through the PSQI score, and depressive symptoms, as determined through the CES-D score, in bed partners. A positive linear correlation ($r = 0.426$, $p < 0.001$) was found. *PSQI* Pittsburgh Sleep Quality Index, *CES-D* Center for Epidemiological Studies Depression Scale

disturbance included snoring (69%), apnea (54%), and restlessness (55%).[8] However, the objective causes associated with sleep disturbance in the bed partners of patients with OSA have not yet been determined. In our study, PSG was used to determine the sleep parameters of patients with OSA associated with sleep disturbance of their bed partners. Our data revealed that the nocturnal symptoms from OSA, including the severity of AHI, frequency of snoring, and PLMS, did not affect bed partner–assessed sleep quality. Thus, the PSG-based objective assessments of patients with OSA could not explain bed partners' subjective responses. A crossover study of 22 couples conducted by McArdle et al. indicated that the bed partners of patients with moderate to severe OSA did not experience a significant improvement in sleep quality, as determined by PSQI scores, after eliminating apnea–hypopnea and snoring in patients by using continuous positive airway pressure.[8] Therefore, we speculate that other OSA-related factors may cause sleep disturbance in bed partners; for example, the bed partner may be stressed about the patient's health or be preoccupied with observing the patients' breathing throughout the night after witnessing an apnea episode. More studies are warranted to identify the possible causes of sleep disturbance in the bed partners of patients with OSA.

OSA strains the personal relationships of patients, especially with their bed partners, and may lead to impaired mental functioning in the bed partners.[4] Few studies have examined the severity of depressive symptoms in the bed partners of patients with OSA. A prospective study of 45 patients with a mean AHI of 31.7/h revealed that 18% of their bed partners had symptoms of depression.[15] We found that 37.5% (51 of 136) of the bed partners had depressive symptoms (CES-D $\geq$ 16). Moreover, depressive tendency was independently associated with sleep disturbance and the level of depressive symptoms determined through CES-D scores had a positive correlation with the degree of sleep disturbance determined through PSQI scores in our study. Reporting a consistent finding, Raniti *et al*. discovered positive and moderate linear relationships (r = 0.58) between PSQI and CES-D scores in 889 participants.[24] A meta-analysis of prospective cohort studies involving 172 077 participants suggested that insomnia was significantly associated with an increased risk of depression.[25] A systematic review and meta-analysis indicated that treatment of insomnia eased depression.[26] These findings are consistent with ours; thus, we hypothesize that the depressive symptoms reported by the bed partners of patients with OSA could have been the result of their disturbed sleep and insomnia.

Mounting evidence suggests that sufficient sleep is crucial for maintaining good health and that inadequate sleep increases the risk of chronic diseases. A large cohort study involving 12,338 adults in Bangladesh observed that inadequate sleep was independently associated with chronic disease.[27] Our findings revealed that bed partners with sleep disturbance and depressive tendency were more likely to have chronic disease. Nevertheless, the mechanisms and associations among sleep disturbance, depressive tendency, and chronic disease remain unclear. Poor sleep quality and depression may directly or indirectly cause chronic disease. By contrast, chronic disease may either directly or indirectly lead to inadequate sleep or depressive symptoms. Further research is key to identifying any causal links among sleep disturbance, depression, and associated chronic diseases.

Our study had some limitations. First, the majority of the bed partners were female, and this may have independently influenced the higher incidence of both sleep disturbance and depressive symptoms. Second, we did not apply the PSG to the bed partners, and it was unclear whether the bed partners had OSA. Sleep disturbance may have been caused by bed partners' own OSA, and this may have influenced the results. Third, we investigated sleep disturbance and depressive tendency in the bed partners of patients with OSA by using only one type of questionnaire, which may not have been sensitive to some of the feelings experienced by bed partners. Further research should incorporate more questionnaires for assessing sleep quality and depressive symptoms. Fourth, the self-reported data may have been affected by recall bias, especially considering that individuals with depression tend to remember and report more negative things. This bias may have led to an overestimation of the relative risk involved with various factors and thereby influenced the results.

In conclusion, sleep disturbance is often a shared experience for the bed partners of patients with OSA. However, the night symptoms from OSA, including the severity of AHI, snoring, and PLMS, may not affect partner-assessed sleep. Depression and chronic disease are associated with the sleep disturbance of bed partners, but their causal relationship is unknown. Additional studies are warranted to recognize the causes of

poor sleep quality and the effects of OSA on bed partners.

ACKNOWLEGEMENT

The authors would like to thank all the physicians and members of the sleep centers at Chang Gung Memorial Hospital, Keelung, Taiwan, and Chang Gung Memorial Hospital, Linkou, Taiwan.

DISCLOSURE

Financial support: None

Conflict of interest: None

REFERENCES

1. Sateia MJ. International classification of sleep disorders-third edition: highlights and modifications. *Chest* 2014;146(5):1387-94. doi: 10.1378/chest.14-0970.
2. Senaratna CV, Perret JL, Lodge CJ, *et al*. Prevalence of obstructive sleep apnea in the general population: A systematic review. *Sleep Med Rev* 2017;34:70-81. doi: 10.1016/j.smrv.2016.07.002.
3. Malhotra A, White DP. Obstructive sleep apnoea. *Lancet* 2002;360(9328):237-45. doi: 10.1016/S0140-6736(02)09464-3.
4. Morsy NE, Farrag NS, Zaki NFW, *et al*. Obstructive sleep apnea: personal, societal, public health, and legal implications. *Rev Environ Health* 2019;34(2):153-69. doi: 10.1515/reveh-2018-0068.
5. Al-Alawi A, Mulgrew A, Tench E, Ryan CF. Prevalence, risk factors and impact on daytime sleepiness and hypertension of periodic leg movements with arousals in patients with obstructive sleep apnea. *J Clin Sleep Med* 2006;2(3):281-7.
6. Luyster FS. Impact of obstructive sleep apnea and its treatments on partners: A literature review. *J Clin Sleep Med* 2017;13(3):467-77. doi: 10.5664/jcsm.6504.
7. Virkkula P, Bachour A, Hytonen M, Malmberg H, Salmi T, Maasilta P. Patient- and bed partner-reported symptoms, smoking, and nasal resistance in sleep-disordered breathing. *Chest* 2005;128(4):2176-82. doi: 10.1378/chest.128.4.2176.
8. McArdle N, Kingshott R, Engleman HM, Mackay TW, Douglas NJ. Partners of patients with sleep apnoea/hypopnoea syndrome: effect of CPAP treatment on sleep quality and quality of life. *Thorax* 2001;56(7):513-8. doi: 10.1136/thorax.56.7.513.
9. Beninati W, Harris CD, Herold DL, Shepard JW, Jr. The effect of snoring and obstructive sleep apnea on the sleep quality of bed partners. *Mayo Clinic Proc* 1999;74(10):955-8. doi: 10.4065/74.10.955.
10. Sharief I, Silva GE, Goodwin JL, Quan SF. Effect of sleep disordered breathing on the sleep of bed partners in the Sleep Heart Health Study. *Sleep* 2008;31(10):1449-56.
11. Smith AK, Togeiro SM, Tufik S, Roizenblatt S. Disturbed sleep and musculoskeletal pain in the bed partner of patients with obstructive sleep apnea. *Sleep Med* 2009;10(8):904-12. doi: 10.1016/j.sleep.2008.08.013.
12. Billmann SJ, Ware JC. Marital satisfaction of wives of untreated sleep apneic men. *Sleep Med* 2002;3(1):55-9. doi: 10.1016/s1389-9457(01)00118-6.
13. Cartwright RD, Knight S. Silent partners: the wives of sleep apneic patients. *Sleep* 1987;10(3):244-8. doi: 10.1093/sleep/10.3.244.
14. Luyster FS, Dunbar-Jacob J, Aloia MS, Martire LM, Buysse DJ, Strollo PJ. Patient and partner experiences with obstructive sleep apnea and CPAP treatment: A qualitative analysis. *Behav Sleep Med* 2016;14(1):67-84. doi: 10.1080/15402002.2014.946597.
15. Doherty LS, Kiely JL, Lawless G, McNicholas WT. Impact of nasal continuous positive airway pressure therapy on the quality of life of bed partners of patients with obstructive sleep apnea syndrome. *Chest* 2003;124(6):2209-14. doi: 10.1378/chest.124.6.2209.
16. Johns MW. A new method for measuring daytime sleepiness: the Epworth sleepiness scale. *Sleep* 1991;14(6):540-5.
17. Buysse DJ, Reynolds CF, 3rd, Monk TH, Berman SR, Kupfer DJ. The Pittsburgh Sleep Quality Index: a new instrument for psychiatric practice and research. *Psychiatry Res* 1989;28(2):193-213. doi: 10.1016/0165-1781(89)90047-4.
18. Tsai PS, Wang SY, Wang MY, *et al*. Psychometric evaluation of the Chinese version of the Pittsburgh Sleep Quality Index (CPSQI) in primary insomnia and control subjects. *Qual Life Res* 2005;14(8):1943-52. doi: 10.1007/s11136-005-4346-x.
19. Weissman MM, Sholomskas D, Pottenger M, Prusoff BA, Locke BZ. Assessing depressive symptoms in five psychiatric populations: a validation study. *Am J Epidemiol* 1977;106(3):203-14. doi: 10.1093/oxfordjournals.aje.a112455.
20. Cheng CP, Yen CF, Ko CH, Yen JY. Factor structure of the Center for Epidemiologic Studies Depression Scale in Taiwanese adolescents. *Compr Psychiatry* 2012;53(3):299-307. doi: 10.1016/j.comppsych.2011.04.056.
21. Chien CP, Cheng TA. Depression in Taiwan: epidemiological survey utilizing CES-D. *Seishin Shinkeigaku Zasshi* 1985;87(5):335-8.
22. Berry RB, Budhiraja R, Gottlieb DJ, *et al*. Rules for scoring respiratory events in sleep: update of the 2007 AASM Manual for the Scoring of Sleep and Associated Events. Deliberations of the Sleep Apnea Definitions Task Force of the American Academy of Sleep Medicine. *J Clin Sleep Med* 2012;8(5):597-619. doi: 10.5664/jcsm.2172.
23. Grigg-Damberger MM. The AASM Scoring Manual four years later. *J Clin Sleep Med* 2012;8(3):323-32. doi: 10.5664/jcsm.1928.
24. Raniti MB, Waloszek JM, Schwartz O, Allen NB, Trinder J. Factor structure and psychometric properties of the Pittsburgh Sleep Quality Index in community-based adolescents. *Sleep* 2018;41(6). doi: 10.1093/sleep/zsy066.
25. Li L, Wu C, Gan Y, Qu X, Lu Z. Insomnia and the risk of depression: a meta-analysis of prospective cohort studies. *BMC Psychiatry* 2016;16(1):375. doi: 10.1186/s12888-016-1075-3.

26. Gebara MA, Siripong N, DiNapoli EA, *et al*. Effect of insomnia treatments on depression: A systematic review and meta-analysis. *Depress Anxiety* 2018;35(8):717-31. doi: 10.1002/da.22776.
27. Yunus FM, Khan S, Mitra DK, Mistry SK, Afsana K, Rahman M. Relationship of sleep pattern and snoring with chronic disease: findings from a nationwide population-based survey. *Sleep Health* 2018;4(1):40-8. doi: 10.1016/j.sleh.2017.10.003.